ANNALS
OF THE
UNIVERSITY OF ORADEA

FASCICLE OF TEXTILES, LEATHERWORK

VOLUME XV, 2014

No. 2

ISSN 1843 – 813X

ANNALS
OF THE
UNIVERSITY OF ORADEA

FASCICLE OF TEXTILES, LEATHERWORK

VOLUME XV, 2014

No. 2

This volume includes papers presented at International Scientific Conference "Innovative solutions for sustainable development of textiles and leather industry", 23rd-24th of May 2014, Oradea, Romania

Contact and Editors' Address:

Liliana INDRIE,
UNIVERSITATEA DIN ORADEA,
FACULTATEA DE INGINERIE ENERGETICĂ ŞI MANAGEMENT INDUSTRIAL
DEPARTAMENTU: INGINERIE ŞI MANAGEMENT INDUSTRIAL ÎN TEXTILE ŞI PIELĂRIE
Str. B.St.Delavrancea nr. 4,
Oradea, 410058, Romania,
Tel.: 00-40-259-408448
E-mail : lindrie@uoradea.ro

Published by
Editura Universităţii din Oradea
Universitatea din Oradea, Str. Universităţii Nr. 1, 410087, Oradea, Bihor, Romania
ISSN 1843 – 813X

Indexed in:
Index Copernicus
EBSCO-Textile Technology Complete
Ulrich's Update - Periodicals Directory
Directory of Open Access Journals (DOAJ)
Directory of Research Journals Indexing (DRJI)
InnoSpace - SJIF Scientific Journal Impact Factor
International Impact Factor Services
SCIPIO

CNCSIS ACCREDITATION since 2007 "Clasa B"

CONTENTS

STUDY ON MORPHOLOGICAL AND STRUCTURAL CHANGES INDUCED BY ULTRASONIC DEGREASING OF WOOL AND HUMAN HAIR WASTES

BĂLĂU MÎNDRU Tudorel[1], POIANĂ Ovidiu[2], PRUNEANU Melinda[3], BĂLĂU MÎNDRU Iulia[4], MUREŞAN Augustin[5]

[1, 2, 3, 4, 5] *Technical University " Gheorghe Asachi of Iaşi, România, Department of Chemical Engineering in Textile – Leather, Faculty of Textile Leather and Industrial Management, B_dul Dimitrie Mangeron, no. 53, postal code 700500, Iaşi, România, E-mail: tbalau@ch.tuiasi.ro*

Corresponding author: Bălău Mîndru Tudorel, E-mail: tbalau@ch.tuiasi.ro

***Abstract**. Recovery and reuse of wool and hair waste is a challenge with the ultimate goal environment protection. One of the early stages of the recovery process is the operation of scouring-degreasing wool and human hair waste. In recent decades the use of ultrasound technology has established an important place in different industrial processes and has started to revolutionize environmental protection. The power of ultrasound can enhance a wide variety of chemical and physical processes, mainly due to the phenomenon known as cavitation in a liquid medium. The objective of the present work is to develop eco-friendly effective degreasing system for keratin fiber waste with the aid of ultrasound, using distilled water and also trichlorethylene as a medium of propagation-degreasing, and realized a comparative analysis of efficiency of fat extraction by Soxhlet classical method and via ultrasonication. This work investigate the effect that ultrasonic irradiation has on the structure of wool and hair fibers. Thus were highlighted both morphological and structural changes of treated materials using optical microscopy, and FTIR spectroscopy. By using the unconventional method of cleaning and degreasing with an ultrasonic resonator tube are possible reductions in utility and solvents consumption together with changes in the cuticular layer of wool and hair fibers.*

***Key words:** keratin wastes, morphological structure, resonator tube, scouring, spectral analysis*

1. INTRODUCTION

Recycling organic waste from preliminary operations of wool processing industry and human hair from hairdressing salons, aims to use the resulting by-products in areas as diverse as agriculture, cosmetics, building materials, biomaterials, etc [1-3].

For cleaning and removal of fatty substances in the composition of human hair and wool waste the following methods are used [4]:

- degreasing in an aqueous medium with a non-ionic surfactant;
- degreasing in a solvent medium;
- degreasing in an aqueous medium with an organic solvent and a non-ionic surfactant;
- degreasing by pressurized extraction with a fluid;
- degreasing by supercritical extraction with a fluid.

In recent decades the use of ultrasound technology has established an important place in different industrial processes and has started to revolutionize environmental protection.The idea of using ultrasound in textile wet processes is not a new one [5, 6] but the ultrasound-assisted wet wool and hair processes have not been implemented on an industrial scale as yet [7, 8]. In practice, for wool and hair wet processes are reported use of the frequency 20-100 kHz [9].

The power of ultrasound can enhance a wide variety of chemical and physical processes, mainly due to the phenomenon known as cavitation in a liquid medium that is the growth and explosive collapse of microscopic bubbles. Sudden and explosive collapse of these bubbles can generate ‘‘hot spots’’ i.e., localized high temperature, high pressure, shock waves and severe shear force capable of breaking chemical bonds [10-12].

The objective of the present work is to develop eco-friendly effective degreasing system for keratin fiber waste with the aid of ultrasound using distilled water and also trichlorethylene as a medium of propagation-degreasing, and realized a comparative analysis of efficiency of fat extraction by Soxhlet classical method and via ultrasonication.

This work investigate the effect that ultrasonic irradiation has on the morphological and chemical structure of wool and hair fibers. Thus were highlighted both morphological and structural changes using optical microscopy, and FTIR spectroscopy.

2. APPARATUS AND MATERIALS

For the scouring-degreasing comparative experiments some specific reagents were used such as: trichloroethylene (TCE), distilled water, sodium carbonate, and hydroalcoholic solution.

The analysis techniques were: IR-ATR spectroscopy using a DIGILAB – SCIMITAR Series FTS 2000 spectrometer with ZnSe crystal, 750 - 4000 cm^{-1} range, 4 cm^{-1} resolution, and optical microscopy using an Optical Microscope EUROMEX ME 2665(Holland) with video digital camera.

For degreasing a classic Soxhlet installation and an ultrasonic device Sonic Vibrocell type with resonator tube were used. The ultrasonic device worked at the following parameters: power: 750 W; frequency: 25 kHz; duty cycle: 2 s.

3. WORKING METHOD

The washing of wool and hair poses some technical problems, and need to be designed to minimise fiber movement but maximise liquor transfer so as to avoid felting. For the same reason detergents for scouring process need to be in a slightly alkaline range (pH ~ 8.5). Thus, in the first phase, wool and hair samples were cleaned in distilled water at 50^{o}C, and then washed with a solution of 2 g/l Na_2CO_3 and a surfactant solution of 0.5 g/l concentration.

Soxhlet extraction method

The traditional method for determining grease content within wool and hair fiber samples [13] is solvent extraction process in Soxhlet equipment using organic solvents. Thus six parallel hair and wool samples with a weight of 5 g each were extracted individually by Soxhlet equipment with 300 ml of trichloroethylene for 3 h with approximately three extractions performed per hour.

After fat extraction sample cartridges were subjected to washing with 50% alcohol solution, and then dried at 50^{o}C for 24 hours and conditioned at 20 ^{o}C and 65% humidity for 24 hours.

Ultrasonic extraction

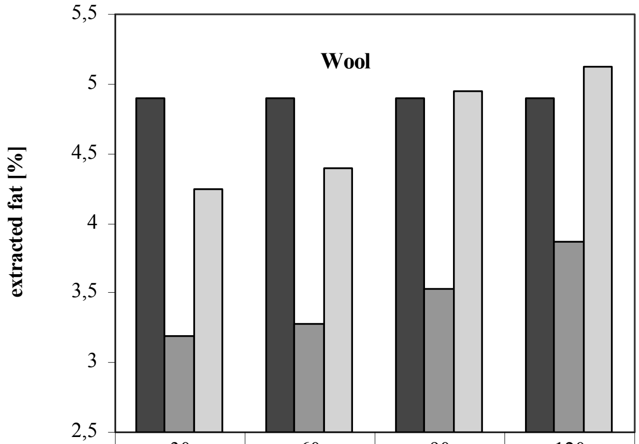
In this experiment six parallel hair and wool samples with a weight of 5 g each were ultrasonicated with a resonator tube for 30 min to 120 min, in 150 ml of distilled water, and trichloroethylene, respectively. The extracted hair and wool samples were then washed with 50% hydroalcoholic solution to recover any remaining organic residue, and then dried in the same conditions as above.

4. RESULTS AND DISCUSSION

The measured percent extractables of the hair and wool samples depended upon the method and solvent used as can be seen in figure 1.

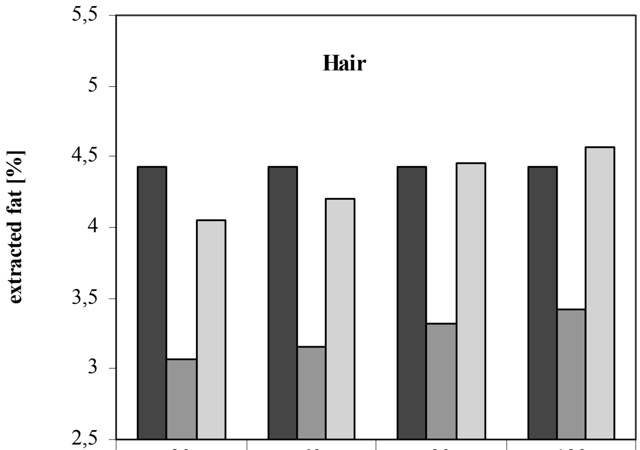
These data show that the extracted fat percentages increase in the order: ultrasonic treatment in water bath, Soxhlet extraction, and ultrasonic treatment in TCE bath. However, the extraction by Soxhlet method has a longer duration (3h) comparated with ultrasound extraction (2h), and also uses a two-fold amount of solvent.

The highest percentage of fat is removed for 2h duration of ultrasonic extraction regardless whether the sample is degreased by ultrasonication in distilled water or in solvent bath. Concomitant use of sonication and degreasing solvent enhances the cavitation effect enabling a more rapid removal of fat.



	30	60	90	120
Soxhlet	4,9	4,9	4,9	4,9
US-water	3,19	3,28	3,53	3,87
US-TCE	4,24	4,4	4,95	5,12

time [min]



	30	60	90	120
Soxhlet	4,43	4,43	4,43	4,43
US-water	3,07	3,15	3,32	3,42
US-TCE	4,05	4,2	4,46	4,57

time [min]

Fig.1. *Percent extractables of wool and hair samples depending on the duration and the method of degreasing.*

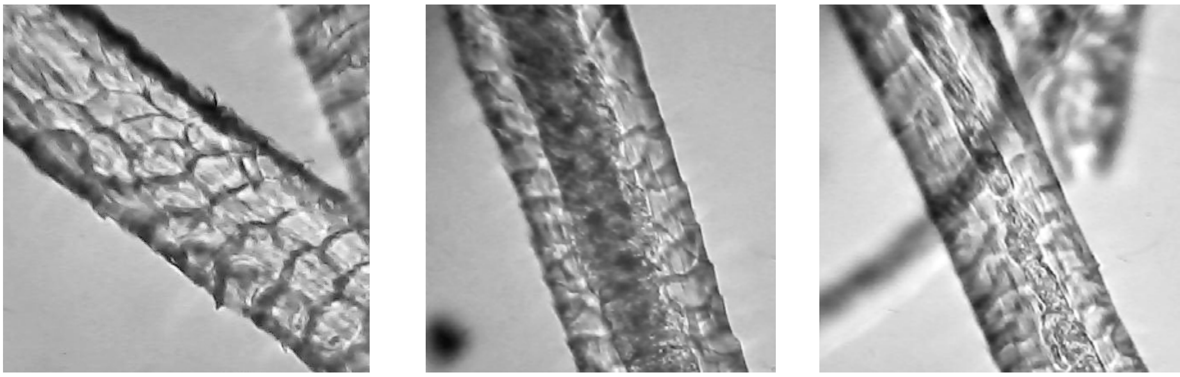
Fibers surface morphology

Microscopic images of initial samples (un-scoured) and after fat extraction by ultrasonic treatment in water and solvent (TCE) respectively, are shown in figure 2 and 3.

Microscopy studies of wool and hair fibres revealed that the ultrasonic waves induced changes in fibre cuticle structure. The defatted fibers have the grease and other surface contaminant removed and show good scale definition and a clean surface.

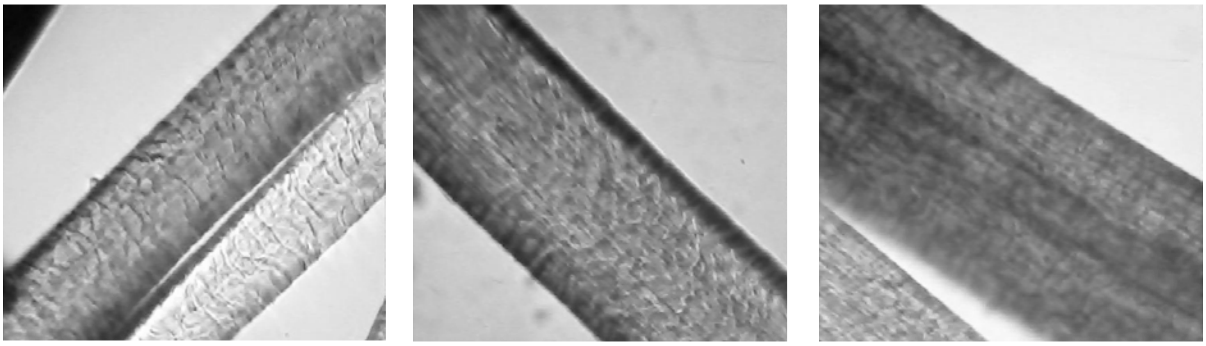
Wool samples (fig. 2c) show a change at the surface of cuticular layer as well as in its depth due to the cavitation effect induced by ultrasonication and further emphasized by the presence of solvent in the treatment bath. Treatment in water only (fig. 2b) left a cushion of air on the surface or within the fibre that limited the impact of cavitation to a mild cracking of the cuticle.

Human hair samples treated with solvent in ultrasonic bath (fig. 3c) reveal also a more affected cuticular layer at the surface and in its depth comparated with the initial sample (fig. 3a) and samples ultrasonicated in distilled water, respectively (fig. 3b). This destruction of the cuticle is more pronounced than for wool samples degreased in the same conditions.



a b c

Fig.2. *Microscopic images of wool samples: a) initial sample; b) ultrasonicated in water for 2h; c) ultrasonicated in TCE for 2h.*



a b c

Fig.3. *Microscopic images of human hair samples: a) initial sample; b) ultrasonicated in water for 2h; c) ultrasonicated in TCE for 2h.*

Spectral analysis

IR-ATR spectra of the initial sample and of the samples degreased via sonication in water and TCE for 2 h are presented in figure 4 and 5.

In the figure 4a and 5a the spectra of both initial samples of hair and wool respectively, showed a band at 3470 cm^{-1} assigned to the H-bonded OH stretch of water residing in keratin. The cuticular layer of hair and wool samples (b) affected by cavitation effect presents a lower signal intensity in this spectral zone, and samples (c), sonicated in TCE bath show a shift of the same band to the left indicating a more tightly bound water structure and possible new intermolecular bonds in different positions in the affected cuticle.

Both initial samples (a) show spectral bands at 3000-2700 cm^{-1} wich are assigned to the stretching modes of the lipid alkyl chains (the methyl CH_3 are observed at 2955 and 2933 cm^{-1}, and CH_2 at 2875 and 2855 cm^{-1}). In the case of ultrasonicated samples signal strength in these areas decreases as well as its response surface, and the hair sample degreased in TCE (fig. 4c) shows the most attenuated signal. This may be due to the degreasing produced by cavitation effect during sonication.

Region between 1700-1500 cm^{-1} contains the most intense features, arising from peptide bond (-CONH-) from protein structures such as amide I and amide II: amide I at 1670-1657 cm^{-1} which is an indicative of alpha-helical structures, is mainly associated with the C=O vibration and is directly related to the backbone conformation; amide II at 1547-1538 cm^{-1} corresponds to N-H bending and C-N vibrations; amide III at 1266-1230 cm^{-1} corresponds to the in-phase combination of C-N stretching and N-H bending, with some contribution from C-C stretching and C=O bending vibrations. The latter is a complex band, and depends on the nature of side chains and hydrogen bonding.

The sonicated hair and wool samples (b and c in figures) shows a lower signal intensity in these spectral zones wich is much more attenuated for the solvent degreased samples; this could be atributted to conformational changes in secondary structure and possible reformation of intramolecular hydrogen bond in the α helical structures and β layers, which can affect also cystine bonds occuring in the near spectral zone.

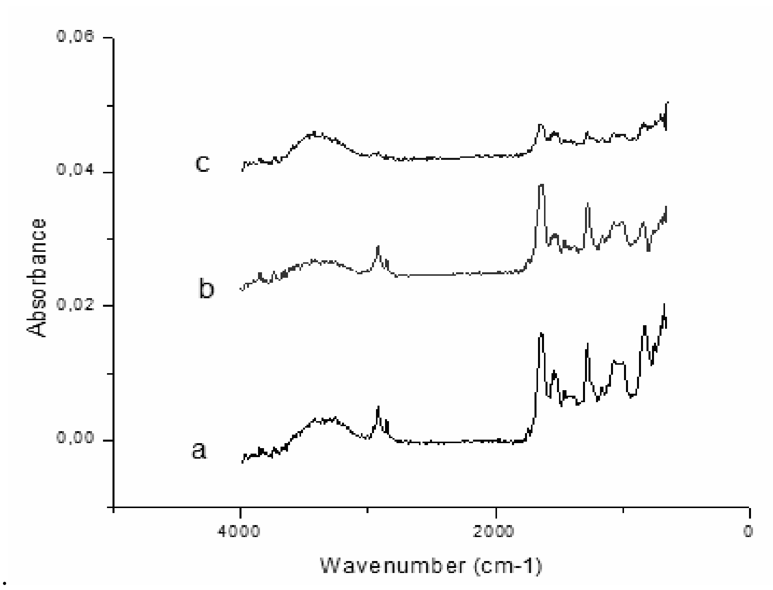


Fig.4. *Human hair IR spectra: a) initial sample, b) ultrasonicated in water for 2h; c) ultrasonicated in TCE for 2h.*

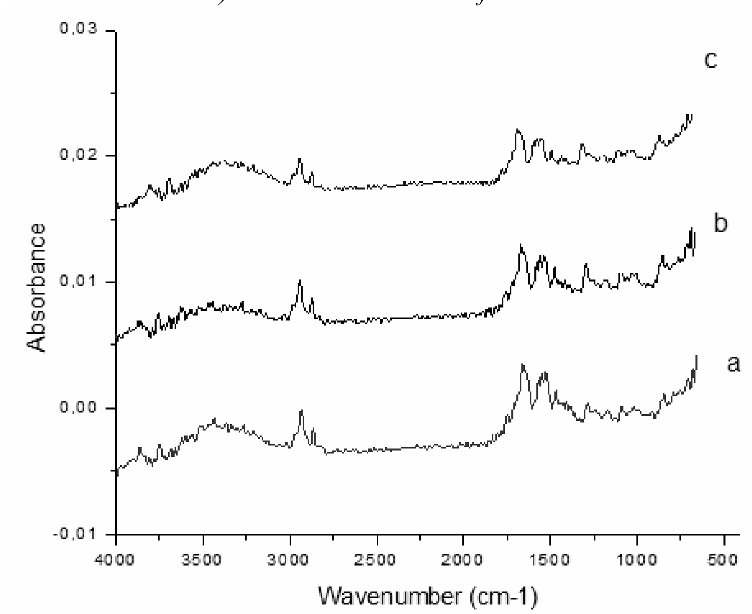


Fig.5. *Wool IR spectra: a) initial sample, b) ultrasonicated in water for 2h; c) ultrasonicated in TCE for 2h.*

5. CONCLUSIONS

1. Concomitant use of sonication and degreasing solvent (TCE) significantly improves the removal of fat from hair and wool fibers.
2. The sonication in solvent bath is superior to the conventional Soxhlet method, at the same time decreasing the amount of solvent used for degreasing and reducing the working time.
3. Ultrasonic extraction in aqueous bath enables also a good removal of fat from the fibers helping to minimize or eliminate the use of detergents and solvents.
4. Human hair treated with solvent in ultrasonic bath reveal a more affected cuticular layer, destruction wich is more pronounced compared with degreased wool samples under the same conditions.
5. IR-ATR highlights the structural changes that occur in both wool and hair after sonication, more pronounced by concomitant use of solvent.

6. The results can be a starting point in finding new ways of extracting components of interest from these sources of waste such as waxes, lanolin, some amino acids, melanin pigments, cholesterol, etc.

REFERENCES

[1] J. R. Barone, W.F. & C.F. Liebner, *"Thermally processed keratin films"*, Journal of Applied Polymer Science, vol. 97, pp. 1644-1651, 2005.

[2] V. D. Zheljazkov, J. L. Silva, M. Patel, J. Stojanovic, Y. Lu, T. Kim, T. Horgan, "*Human Hair as a Nutrient Source for Horticultural Crops" Hort Technology* October-December, vol. 18, no. 4, pp. 592-596, 2008

[3] C. Popescu, *Wool – Structure, Mechanical Properties and Technical Products based on Animal Fibres,* in Industrial Applications of Natural Fibres Structure, Properties and Technical Applications Ed. John Wiley &Sons, pp. 255-266, 2010.

[4] J. Dyer and A. Grosvenor, "*Protein Fibre Surface Modification*", in Natural Dyes, E. Akcakoca Kumbasar, Publisher Intech., chapt. 7, pp. 111- 124, 2011.

[5] J. H. Bradbury, and D. E. Peters, "*Method for the complete removal of cuticle from wool fibres."* Textile Research Journal: vol. 42(4), pp. 248-250, 1972.

[6] A. Riza, "*The Use of New Technologies in Dyeing of Proteinous Fibers"*, in Eco-Friendly Textile Dyeing and Finishing, Ed. M. Günay, pp.103-147, 2013.

[7] M.M. Kamel, R.M. El-Shistawy, H.L. Hana, and N.S.E. Ahmed, "*Ultrasonic-Assisted Dyeing: I. Nylon Dyeability with Reactive Dyes",* Polymer International, vol. 52 (3), pp. 373-380, 2003.

[8] M. Akalin, N. Merdan, D. Kocak, and I. Usta, "*Effects of Ultrasonic Energy on The Wash Fastness of Reactive Dyes",* Ultrasonics, vol. 42, pp. 161-164, 2004.

[9] S. Vajnhandl, and A.M. Le Marechal, "*Ultrasound in Textile Dyeing and The Decoloration/Mineralization of Textile Dyes",* Dyes and Pigments, vol. 65(2), pp. 89-101, 2005.

[10] E. Sanz, R. Munoz-Olivas, C. Dietz, J. Sanz and C. Camara, *Alternative extraction methods for arsenic speciation in hair using ultrasound probe sonication and pressurised liquid extraction,* J. Anal. At. Spectrom., vol. 22, pp. 131–139, 2007.

[11] V.S. Moholkar, V.A. Nierstrasz, and M.M.C.G. Warmoeskerken, "*Intensification of Mass Transfer in Wet Textile Processes by Power Ultrasound",* AUTEX Research Journal, vol. 3(3), pp. 129-138, 2003.

[12] V.S. Moholkar, S. Rekveld, and M.M.C.G. Warmoeskerken, "*Modeling of The Acoustic Pressure Fields and The Distribution of The Cavitation Phenomena in A Dual Frequency Sonic Processor",* Ultrasonics, vol. 38, pp. 666-670, 2000.

[13] ASTM D2257 – 98, Standard Test Method for Extractable Matter in Textiles, 2012

BLEACHING NEPTUNE BALLS

**BONET Maria Angeles [1], BOU-BEDA Eva [2],
MONLLOR PÉREZ Pablo[3], GISBERT PAYÁ Jaime [4], DÍAZ GARCÍA Pablo[5]**

[1, 2, 3, 4, 5] *Universitat Politècnica de València, Textile and Paper Department, Plaza Ferrándiz y Carbonell s/n, 03801, Alcoy, Spain*

Corresponding author: Bonet, M. E-mail: maboar@txp.upv.es

Abstract: *Posidonia Oceanic is a seaweed from Mediterranean Sea and it is more concentrated at the Balerian SEA. This implies the Valencian Community also. It forms vaste underwater meadows in the sea and are part of the Mediterranean ecosystem. It is a seagrass specie with fruits and flowers. Leaves are ribbon-like and they grow in winter and at the end of summer some of them are separated and arrive to some sea line. Fuit is separated and can floate, it is known as "the olive of the sea" mainly in Italy, or as the Neptune Balls. As it can be used in different fields, it is is being studied in order ro have the precitice tests.*
Some authors have reported the manufacturing of fully bio-based comites with a gluten matrix by hot-press molding. And it has been considered as an effective insulator for building industry or even though to determine the presence of mercure in the Mediterranean sea some years ago. As many applications can be designed from that fibres, it has been considered to be bleached in order to used them in fashinable products. Consequently, its original brown color is not the most suitable one and it should be bleached as many other cellulosic fibres.
The aim of this paper is to bleache neptune balls however, the inner fibres were not accesible at all and it implied not to bleach the inner fibres in the neptune ball. Further studiesd will consider bleaching the individualised fibres.

***Key words*:** *Fiber, seaweed, Neptune ball, bleaching, and cellulose.*

1. INTRODUCTION

Posidonia Oceanic is a seaweed from Mediterranean Sea and it is more concentrated at the Balerian SEA. This implies the Valencian Community also. It forms vaste underwater meadows in the sea and are part of the Mediterranean ecosystem. It is a seagrass specie with fruits and flowers. Leaves are ribbon-like and they grow in winter and at the end of summer some of them are separated and arrive to some sea line. Fuit is separated and can floate, it is known as "the olive of the sea" mainly in Italy, or as the Neptune Balls.

Because of a Eurpean directive about Habitats it is considered a Priority Habitat of Community Interest. However, When tehy arrive to the sea line, it is considered a solid residue which is water up taken from the sea in the beaches so as to clean them.

Some authors have reported the manufacturing of fully bio-based composites with a gluten matrix by hot-press molding [1]. And it has been considered as an effective insulator for building industry ore ven though to determine the presence of mercure in the Mediterranean sea some years ago. [2]. As many applications can be designed from that fibres, it has been considered to be bleached in order to used them in fashinable products. Consequently, its original brown color is not the most suitable one and it should be bleached as many other cellulosic fibres [3-6]. Some authors have reported its chemical composition [7] and some have used it as reinforcement of some composites [8]. However, not many papers have been published about the topic.

The aim of this paper is to bleache neptune balls however, the inner fibres were not accesible at all and it implied not to bleach the inner fibres in the neptune ball. Further studiesd will consider bleaching the individualised fibres.Regarles its concerns on environmental protection, it is importan to consider those fibres for some technical products or as the main component of some conventional garments. Thus it must be bleached so that it can follow the fashion standards in the future. The aim of this study is the suitability of bleaching Neptune balls in order to use them in a different color from the characteristic brown as it can be observed in figure 1.

Fig. 1: *Neptune ball appearance*

2. EXPERIMENTAL

2.1 Materials

Seaweed from the Valencian Region have been used.

2.2 Bleaching

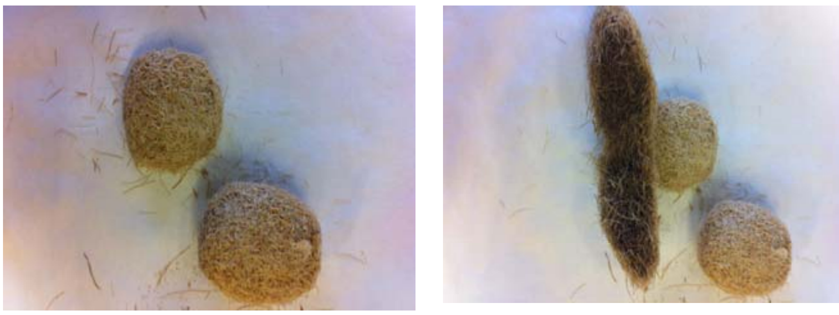
Two bleaching agents have been used, NaClO and H_2 O_2.. NaClO has been used at room temperature with different concentrations considering a bath ratio of 1/40 for periods of time from 1 h to 12 h. H_2O_2 has been used at 100º C for periods od 1 h and the same liquor ratio.

2.4. SEM microscopy.

Fibres surface was obserbed by SEM microscopy. A scanning electron microscopy (Phenom Microscope FEI Company, Hillsboro, OR, USA) was used. Each sample was fixed on a standard sample holder and sputtered with gold and palladium accurately in order to convert the sample into a conductive one so as to be observed properly.

3. RESULTS AND DISCUSSION

Balls treated with NaClO were treated at different concentrations, 4gCl/L and 6 gCl/L. Balls were inmersen in the NaClO solution for 1 hour at room temperature. Then the balls were observed and as apparently no changes had occurred, it was observed in periods of 1 hour until 6 hoours had passed., although it seemingly no changes were observed they were rinsed wth water and dried at room temperature. Once the Neptune balls had been dried it was confirmed that no changes in colour were observed. Thus, some new balls were immersed in NaClO for 12 hours, and it could be appreciated a slightly difference in the fibre colour (figure 2).



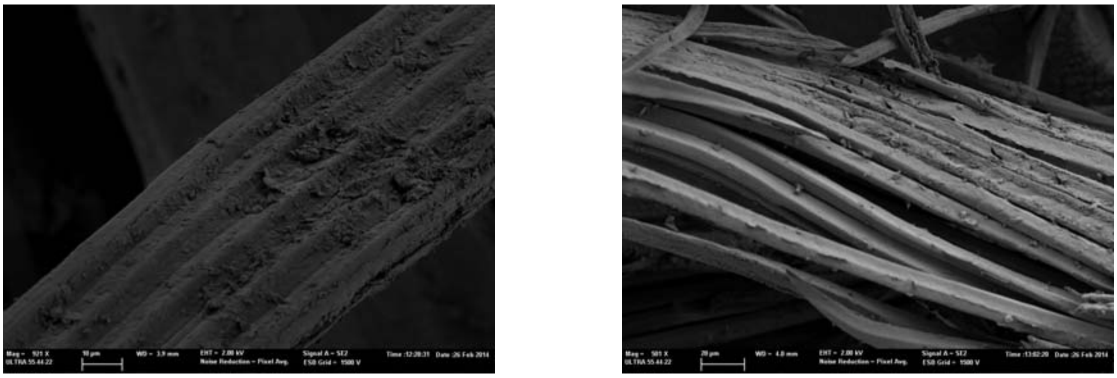
a) ***b)***

Fig. 2: *Neptune ball appearance after 12 hours with NaClO. a) Otside part. b)inner part*

However, as soon as the balls were opened, it could be clearly appreciated that it was a superficial treatment and the inner parts were no affected by the changes in colour.

Simmilar behavior is appreciated when H_2O_2 samples were oserved, despite the fact that it was at boiling temperature.

The most streaking result to emerge from the data is that the most superficial fibres were treated but not the inner part, despite the high ratio of hydrophobicity stated by previous authors [1]. In order to determine the reason of its low reduction in the brown colours from the balls microscopy technique was used. Figure 2a shows the fibre and ot can be observes that it seems a grooved surface, and when it has been treated by different processes it seems to be divided into different hollow fibres, as it can be observed in figure 2b.



a) **b)**

Fig. 2: *Neptune ball appearance. a) without treatment. B) with NaClO (12 h) treatment*

However, when the fibres are observed conciosely, it can be observed that it is formed by different fibres which ares disposed in a way which offers the grooved surface. When the coating is removed, it is clearly appreciated that fibrils are hollow ones as it can be observed in figure 3. This is the reason why they flotate.

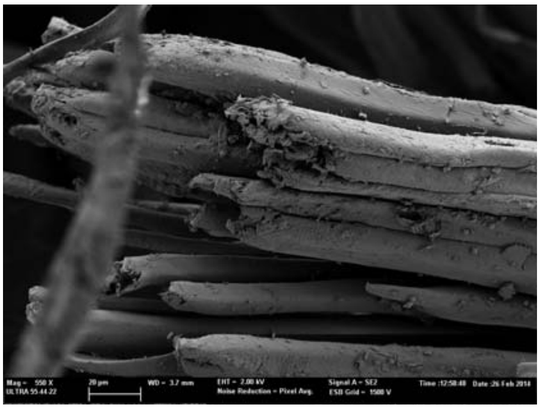


Fig. 3: *Neptune ball appearance after bleaching treatment.*

When fibres were trerated under long periods of time (12 hours) it can be appreciated that balls´surface show a courios state. It seems to be severely feltered on its surface and the reduction in brown colour is not considerably appreciated. Figure 4 shows this effect.

Fig. 3: *Neptune ball appearance after bleaching treatment in extreme conditions.*

4. CONCLUSIONS

It must be pointed out that the number of treatments could have been increased by the variation of different concentrations. However, it is not worth from an industrial point of view to treat the balls as its colour is slighty reduced and the inner fibres remain more or less in the same conditions. Further tests will control the belaching from Neptune fibres but not in the shape of balls but with the dibre without being sticked together.

REFERENCES

[1] C. Pergent-Martini. "*Posidonia oceanica: a biological indicator of past and present mercury contamination in the mediterranean sea*" Marine Environmental Research . 45.2. 1998. 101-111. http://dx.doi.org/10.1016/S0141-1136(97)00023-8

[2] B. Ferrero, M. Samper, O. Fenollar, a. Carbonell, R. Balart, *" Fully bio-based composites from gluten and seaweed waste fibers"*. Plastics Research Online. DOI: 10.2417/spepro.005025

[3] Hashem, Mohamed ; El-Bisi, Manal ; Sharaf, Samer ; Refaie, Rakia. *Pre-cationization of cotton fabrics: An effective alternative tool for activation of hydrogen peroxide bleaching process*. Carbohydrate Polymers, 2010, Vol.79(3), pp.533-540.

[4] Vankar, Padma S. ; Shanker, Rakhi. *Ecofriendly ultrasonic natural dyeing of cotton fabric with enzyme pretreatments*. Desalination, 2008, Vol.230(1), pp.62-69.

[5] Chollakup, Rungsima ; Suesat, Jantip ; Ujjin, Suchada. *Influence of Eri silk fibre on the physical characteristics and dyeing properties of Eri silk/cotton blended yarn.* Coloration Technology, Feb, 2010, Vol.126(1), p.42(6).

[6] Tonoli, G. ; Belgacem, M. ; Bras, J. ; Pereira-da-Silva, M. ; Rocco Lahr, F. ; Savastano, H. *Impact of bleaching pine fibre on the fibre/cement interface*. Journal of Materials Science, 2012, Vol.47(9), pp.4167-4177

[7] Salvatrice Vizzini, Gianluca Sarà, Miguel A. Mateo, Antonio Mazzola. δ13C and δ15N variability in Posidonia oceánica associated with seasonality and plant fraction. Aquatic Botany. July 2003, Vol. 76 (3), pp. 195-202.

[8] B. Ferrero, V. Fombuena, O. Fenollar, T. Boronat, R. Balart. Development of Natural Fiber-Reinforced Plastics (NFRP) Based on Biobased Polyethylene and Waste Fibers from Posidonia oceanica Seaweed.Polymer Composites. DOI 10.1002/pc.23042

HEAT TREATMENTS INFLUENCE ON THE BREAKING TORSION OF WOOL TYPE FIBERS

BORDEIANU Demetra Lăcrămioara[1], HRISTIAN Liliana[2], VÎLCU Adrian[3]

[1, 2, 3] *"Gh.Asachi" Technical University of Iasi, Faculty of Textile, Leather and Industrial Management, Prof. Dr. Doc. Dimitrie Mangeron Str., No. 29, 700050, Iasi, Romania*

Corresponding author: Bordeianu Lăcrămioara Demetra, e-mail: dlb@tex.tuiasi.ro

Abstract: *In order to convert the textile fibers in yarns, these must be subjected to twisting operation which confers them a certain tensile strength. Twisting also results in certain effects, such as crepe effect. The importance of knowing the twisting behavior consists in the possibility to avoid fiber degradation as the result of an excessive twisting.*
The present work took for study three types of chemical fibers (wool-type rayon, wool-type polyester, wool-type polyacrylonitrile) and two types of wool fibers S11 and S12. The main characteristics of wool type chemical fibers (fiber count, nominal length, breaking length, relative elongation, brightness) and of wool fibers (diameter, almeter length, uster irregularit) have been measured. Then the fibers were subjected to thermal treatments in certain conditions.
From the researches performed for the both wool blends, S11 and S21, one can notice that the torsional rigidity/stiffness increases after the thermal treatment and the wool fibers changes their handle accordingly.
The rayon fibers present the biggest torsional rigidity, as compared to the other types of analyzed fibers, both untreated and heat treated. After heat treatment, the rayon fibers considerable improves their handle.
The variation coefficient of breaking torsion increases in the case of heat treated polyester and poly-acrylonitrile fibers while for rayon and wool fibers this coefficient decreases.

Key words: *wool, breaking torsion, heat treatment, frequency polygon, variation coefficient*

1. INTRODUCTION

The present work took for study five types of fibers whose main characteristics are summarized in the Tables 1 and 2.

Table1: *Characteristics of wool-type chemical fibers*

No.	Characteristics	Fiber type		
		Rayon	PES	PAN
1.	Fiber count, dtex (den)	4.2(3.75)	4.4(4)	3.3(3)
2.	Deviations from fiber count, %	± 5	± 10	
3.	Nominal length, mm	80	88	95
4.	Deviation from nominal length, %	± 5	± 5	
5.	Breaking length, Km	19.5	3.5	2.2
6.	Relative elongation, %	19	40	
7.	Brightness, %	78	70	75

Table 2: Characteristics of wool fibers

No.	Characteristics	Fiber type	
		Wool S11	Wool S21
1.	Maximum diameter, μm	24	29
2.	Coefficient of variation, max, %	22	27
3.	Almeter length mm	48	53
4.	Almeter variation coefficient, max, %	46	46
5.	Fibers with length under 40mm, %	35	25
6.	Fibers with length above 25mm, %	10	8
7.	Uster irregularity, %	5.5	5.5
8.	Fat content, max, %	11	11

For the investigation of the stress properties of the studied fibers we used pre-stressed fibers with 0.5 cN/tex, on a torsiometer with a distance of 10 mm between clamps.

The angle corresponding to the breaking torsion [1] was calculated with relation :

$$\mathrm{tg}\alpha = \frac{l}{\pi \cdot d \cdot T} \qquad \textbf{(1)}$$

where: l – initial fiber length, i.e. the distance between torsiometer's clamps;

d – fiber diameter;

T – number of twists before breaking.

The thermal treatments to which the fibers were subjected lasted 15 minutes and were performed at 100^{o}C.

2. EXPERIMENTAL PART

The complexity of reality requires, in statistical surveys, the follow-up of two directions:
- description of a population by a feature or multiple features highlighting;
- comparison between populations [2].

In practice, the textile material must exhibit an optimum behaviour to repeated strains, flexions and abrasions during wearing process [3].

The obtained results were graphically summarized in Figure 1.a, 1.b, 1.c, 1.d, 1.e.

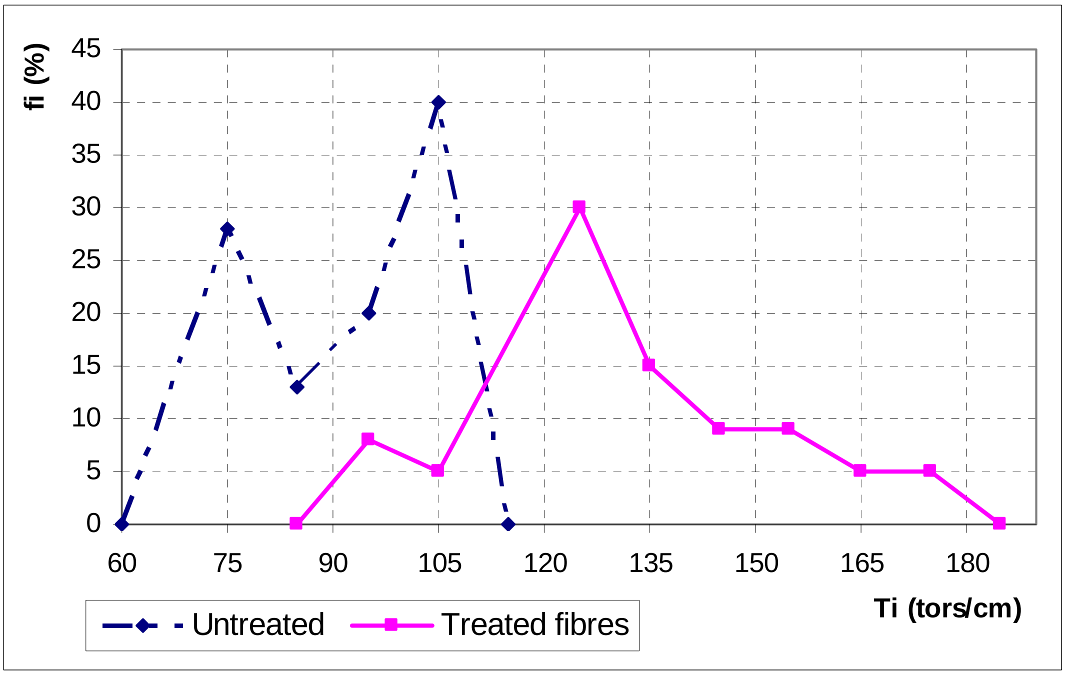


Fig. 1.a. *Diagram of distribution according to turns to break of the fibers of wool-type rayon*

The structural modifications of the fibres, which were determined during the processing phases determine the variance of the tension and of the viscoelastic characteristics, which can be pursued rigorously and the experimental values become usefully in the adoption of the correct technological processing parameters.

Frequency polygon is an important graph to approximate not only the shape of the distribution of studied population, but also for comparing two distributions on the same chart.

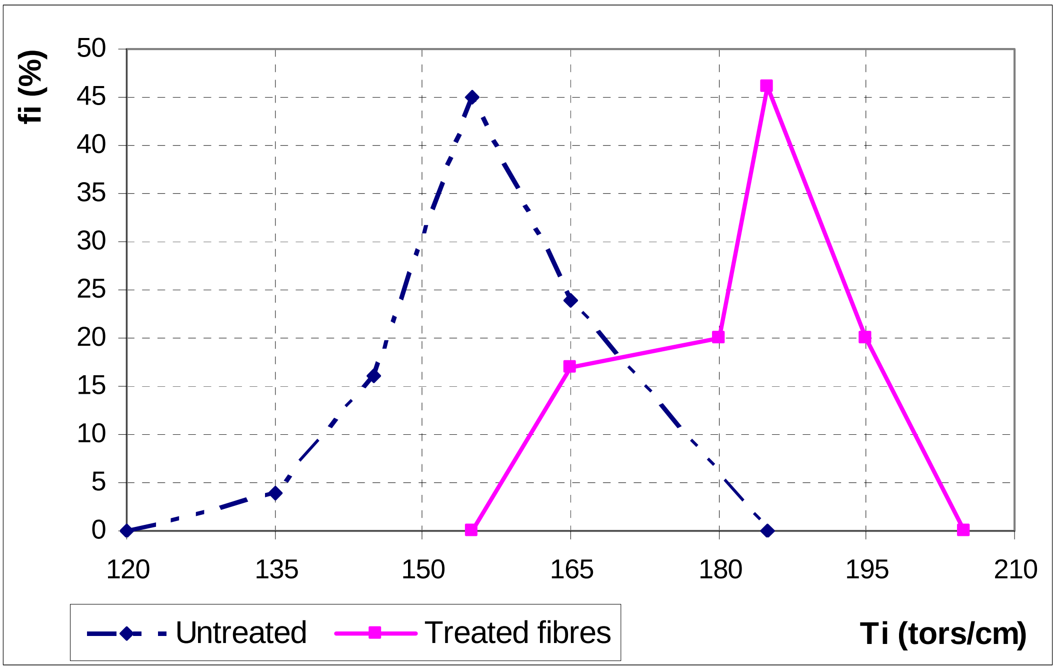


Fig. 1.b: *Diagram of distribution according to turns to break of the fibers of wool-type polyester*

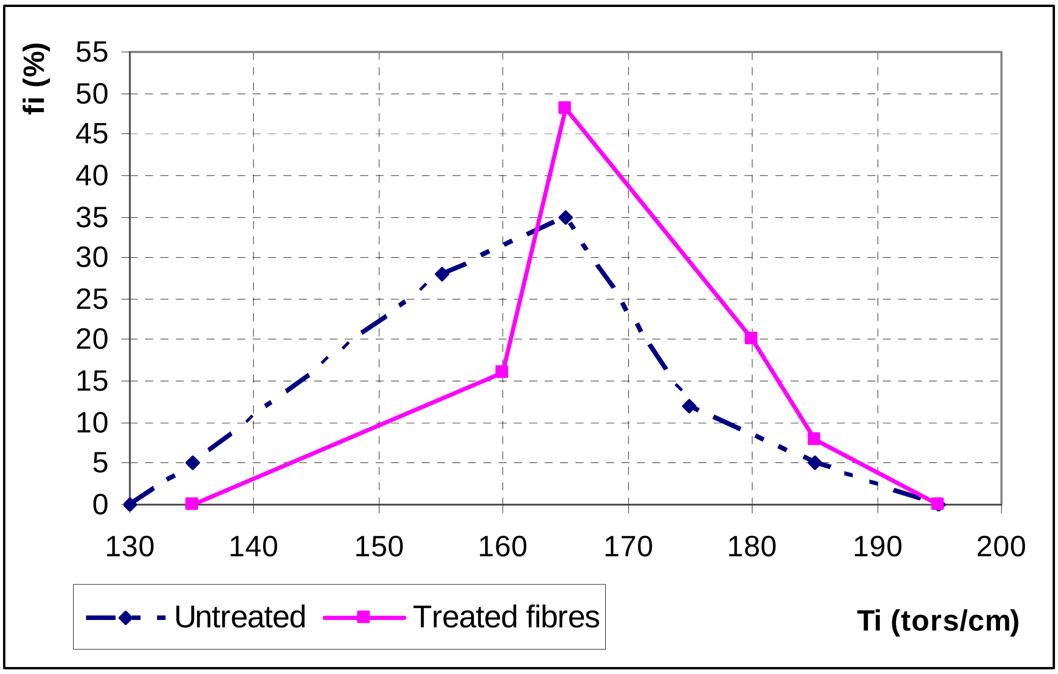


Fig.1.c: *Diagram of distribution according to turns to break of the fibers of wool-type polyacrylonitrile*

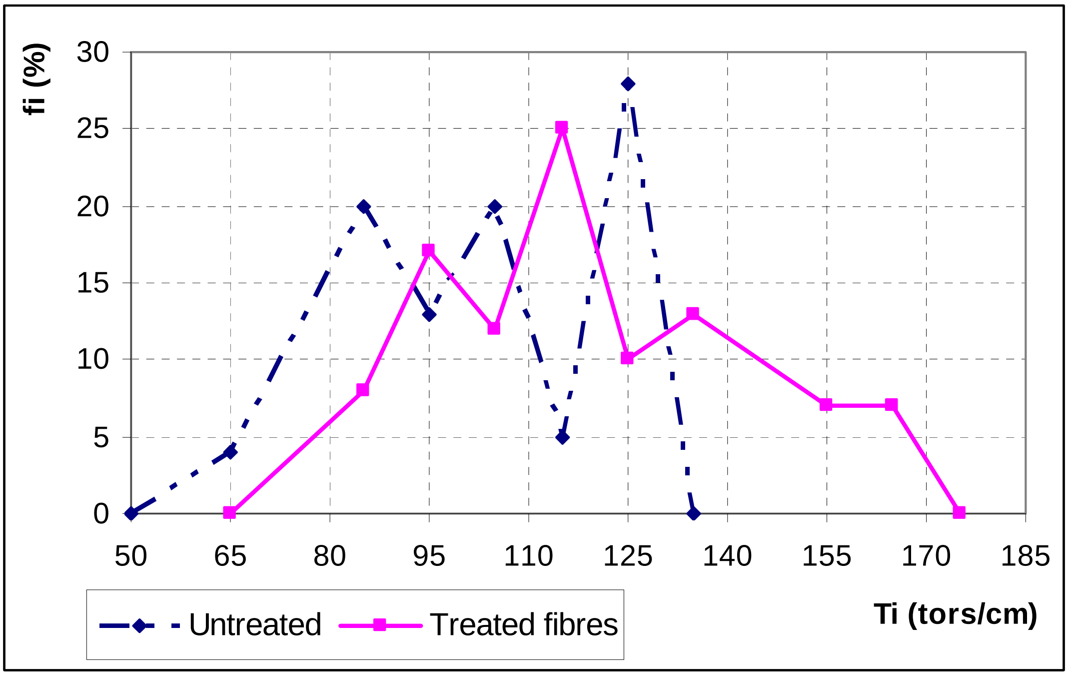


Fig. 1.d: *Diagram of distribution according to turns to break of the fibers of wool S11*

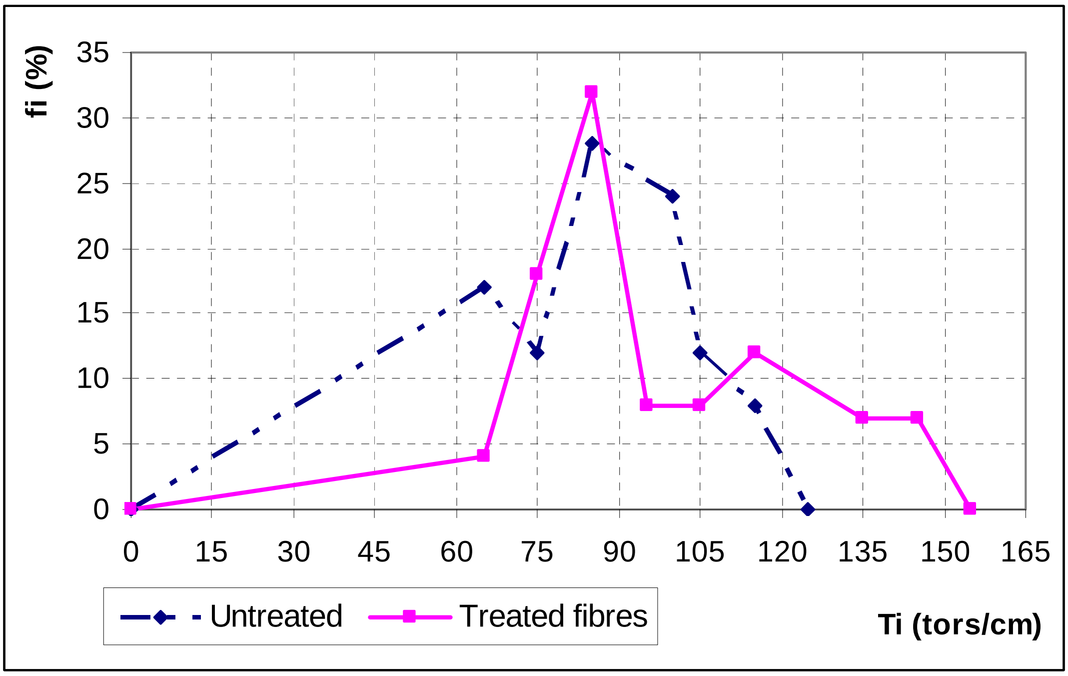


Fig. 1.e: *Diagram of distribution according to turns to break of the fibers of wool S12*

Table 3: *Summarizing*

No.	Sample name	T_t tex	Untreated				Thermally treated			
			$\overline{T}$ (tors/cm)	α_r (^{0})	α_{mod} (^{0})	CV (%)	$\overline{T}$ (tors/cm)	α_r (^{0})	α_{mod} (^{0})	CV (%)
1.	Rayon	0.42	129	52	53	14.4	93	61	58	12.4
2.	PES	0.44	182	40	40	5.74	157	45	45	5.95
3.	PAN	0.33	166	45	45	5.99	160	46	45	6.68
4.	Wool S11	0.7	113	47	46	19.8	100	50	44	19.4
5.	Wool S21	0.87	95	49	52	22.2	87	51	52	17.1

From the researches performed for the both wool blends, S11 and S21, one can notice that the torsional rigidity/stiffness increases after the thermal treatment and the wool fibers changes their handle accordingly.

The wool fibers consist of three structural parts, namely: cortical layer, cuticle layer and medullar layer, and the cuticle cells consist of keratin that belongs to the class of protein substances. Thus the keratin molecules contain some large side chains that obstruct the tight packing, necessary for a fiber with big orientation degree, the basic conditions for fiber big resistance.

If one compares the two wool brands, one can notice that the fibers of wool 21 have a bigger torsional rigidity as compared to the fibers of wool 11, both under the conditions of a heat treatment and untreated.

The angle α corresponding to breaking torsion increases from $\alpha = 47^o$ to $\alpha = 50^o$ under the conditions of the heat treatment for fibers of wool S11, while for fibers of wool S21 it increases from $\alpha = 49^o$ to $\alpha = 51^o$ under the conditions of the heat treatment.

From the graphical representations of the distribution in terms of breaking torsion, Figure 1d and Figure 1e, one can notice a quite large range of breaking torsion variation for both, the fibers subjected to heat treatment and for those untreated.

After the heat treatment, the coefficient of variation decreases for the both wool brands. Most fibers are irregular, and they are often subjected to combined loading conditions during processing and end-use.

The results indicate that twist and level of fiber irregularity have a major impact on the mechanical properties of the fiber and the effect of the frequency of irregularity is relatively small [4].

The coefficient of variation (CV), also known as “relative variability”, equals the standard deviation divided by the mean. CV is often presented as the given ratio multiplied by 100.

The CV for a single variable aims to describe the dispersion of the variable in a way that does not depend on the variable's measurement unit. The higher the CV, the greater the dispersion in the variable.

The CV for a model aims to describe the model fit in terms of the relative sizes of the squared residuals and outcome values. The lower the CV, the smaller the residuals relative to the predicted value. This is suggestive of a good model fit [5], [6].

3. CONCLUSIONS

1. As the result of the performed researches, it was found that the rayon fibers present the biggest torsional rigidity, as compared to the other types of analyzed fibers, both untreated and heat treated.

2. Subjected to heat treatment, the rayon fibers considerable improves their handle; this has to be considered during the fiber processing, finishing, and with respect to the utilization of the finite products. The increase of the torsional rigidity will result in obtaining a more pleasant handle for yarns.

3. As the result of the heat treatment, the polyester and polyacrylamidic fibers suffer a quite small modification of the torsional rigidity (especially the polyacrylamidic fibers), still maintaining their soft handle after the heat treatment.

4. Comparing the two investigated wool brands, S11 and S21, one can notice that the fibers of wool S11 have a little bigger increase of the torsional rigidity as compared to the fibers of wool S21, which is semi-fine wool. Yet, generally the torsional rigidity increases for the wool fibers subjected to heat treatment and the wool fibers modify their handle after the heat treatment.

5. The coefficient of variation increases in the case of polyester and poly-acrylonitrile fibers, as compared to the coefficient of variation for the untreated polyester and polyacrylonitrile fibers.

6. For the rayon and wool fibers, the coefficient of variation decreases when they are subjected to heat treatment.

REFERENCES

[1] Bordeianu L. D.,*"Textile fiber"* vol. I, Ed. Performantica, 2004, Iasi.

[2] Hristian L., Lupu I.G. and Bordeianu L. D. "*Employing the ANOVA model for the differentiation of wool type woven materials based on their handle properties*", International Scientific Conference 19-20 November, Gabrovo, 2010, vol. II, pp. 342-348.

[3] Hristian L., Lupu I. G., Bordeianu L. D. and Cramariuc O., "*Study regarding the creasing behavior of fabrics made from combed yarns type wool*," Annals of the University of Oradea Fascicle of Textiles, Leatherwork, vol. XIII, 2012, No. 2, ISSN 1843 – 813X, pp. 78 – 82.

[4] Weiyu He, Xungai Wang, *"The combined tensile and torsional behavior of irregular fibers",* Fibers and Polymers, March 2002, Volume 3, Issue 1, pp 31-37

[5] Cojocaru N., "*Metode statistice aplicate în industria textilă, Ed tehnică"*, Iaşi, 1986.

[6] Ciocoiu M., *"Bazele statistico-matematice ale analizei si controlului calitatii in industria textile"*, Ed. Performantica, Iasi, 2002.

INFLUENCE OF RESIN TO BIND SILICA PARTICLES ON THE COTTON FABRIC

BOU-BEDA Eva[1], BONET Maria Angeles [2], MONLLOR PÉREZ Pablo[3], GISBERT PAYÁ Jaime [4], DÍAZ GARCÍA Pablo[5]

[1,2,3,4,5] *Universitat Politècnica de València, Textile and Paper Department, Plaza Ferrándiz y Carbonell s/n, 03801, Alcoy, Spain.*

Corresponding author: Bonet, M.A E-mail: maboar@txp.upv.es

Abstract: *Functionalization of textiles has been the aim of many studies in the field of intelligent materials. The aplication of nanoparticules on the fabric is one of approaches used for get textile functionalization. Normally, there is no attraction between inorganic particles and polymeric materials such as textiles. The difference between surface energy of two aforementioned organic and inorganic materials causes a kind of repellency in their interfaces. This problem is intensified by using nanoparticles because of their high specific surfaces In this research, treated samples with silica particles are compared to evaluate the effectiveness of the binder used. Cotton fabrics´ surfaces were observed by scanning electron microscopy (SEM) and energy dispersive using X-Ray (EDX). EDX technique showed that it was a suitable method to detect Si particles presence on fabric surface, this technique offers quantitive results which help to compare different formulations. We confirm that the treated fabric with resin contained higher quantity of Ti particles than the one treated without resin. We analyzed %weight (Si/O) for unwashed and washed treated samples with and without binder. We concluded that whased samples which had been treated using acrylic resin contain higher quantity of the silica particles onto fabric than those whased samples which had been treated without resin.*

Key words: *Silica particles, SEM, coulter, durability, washing machine.*

1. INTRODUCTION

Functionalization of textiles has been the aim of many studies in the field of intelligent materials. The aplication of nanoparticules on the fabric is one of approaches used for get textile functionalization. These can impart new properties to the fabric, such as antimicrobial [1], UV protection [2], self cleaning [3], flame retardancy [4], hydrophobic [5], etc. These properties depend on the type of particle used.

Normally, there is no attraction between inorganic particles and polymeric materials such as textiles [6]. The difference between surface energy of two aforementioned organic and inorganic materials causes a kind of repellency in their interfaces. This problem is intensified by using nanoparticles because of their high specific surfaces [7]. Consequently, surface modification of textiles with nanoparticles is not permanent, especially against washing.

The aim of this work was to determine the influence of resin on the presence of silice particles on the fabric surface after the application of washing cycles. Therefore, we treated the fabrics with domestic washing cycles, and analyzed the way in which particles are lost from the fabric surface by means of image analysis.

For surface observation, a scanning electron microscope was used. Each sample was fixed on a standard sample holder and sputter coated with palladium and gold. Samples were then examined with suitable acceleration voltaje and magnification. To get a quantitive result the washed and unwashed samples were analyzed by energy disperse X-Ray Spectroscopy (EDX-SEM).

2. EXPERIMENTAL

We used a 100% cotton fabric with the weight of 115 gr/m^2. All cotton fabric samples were impregnated with four diferent solutions. To study the behavior of the resin, silica particles and acrilyc binder STK-100, suministrated by Color-Center, were used. The size of the particles are around 3 μm.

We prepared four different solutions, these are shown in the table 1.

Table 1: *Formulation used in each treatment.*

Samples	**Si Particles (g/L)**	**Resin (g/L)**
10 Si	10	0
10 Si 5 R	10	5
5 Si	5	0
5 Si 5 R	5	5

The samples were immersed in the aqueous solution and then were passed through squeeze rolls to give a specified pick-up, we obtained 75% in both treated samples.

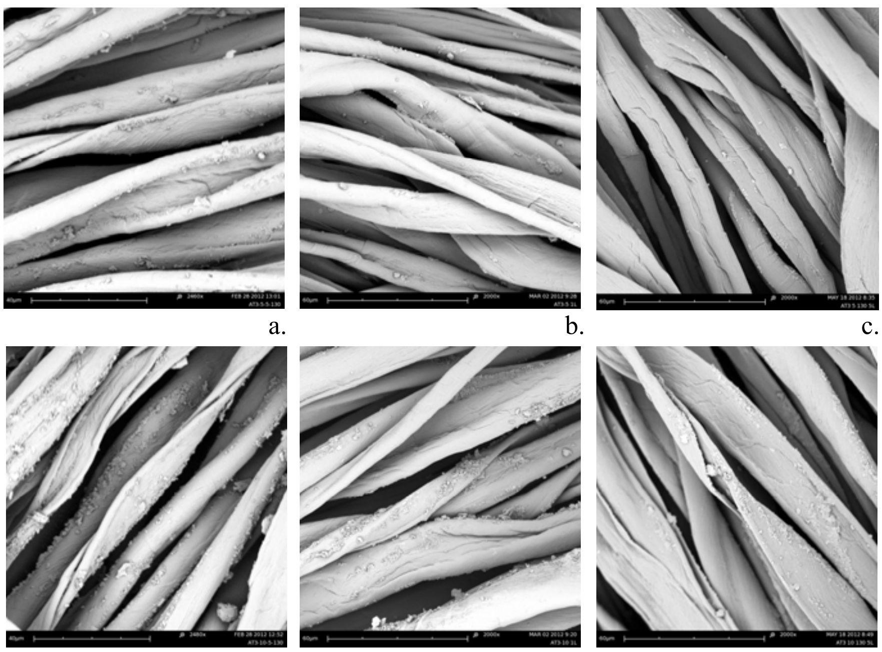
Treated samples were washed by following UNE EN ISO 6330 method no. 2A, 5 cycles of washes were carried out.

To verify the existece of silica particles on the fiber surface, treated samples were observed with a scanning electron microscope FEI model Phenom (Fei, Oregon, USA). Prior to sample observation, samples were covered with a gold–palladium alloy in a Sputter Coater EMITECHmod. SC7620 (QuorumTechnologiesLtd., EastSussex, UK). Samples were then examined with suitable accelerating voltage and magnification.

To obtain quantitive results Energy dispersive X-Ray (EDX) was used. Analyses were condusted using a Scanning Electron Microscope JEOL JSM-6300. All the electron microscopy images were obtained with an accelerating voltaje of 10 KeV. The EDX spectrums were also performed to verify the elemental composition of the deposited material on the fiber surface. Analysis of this data allowed comparisons of Si particles at different locations on the fabric.

3. RESULTS ANS DICUSSION

To check the presence of the particles on the surface fiber, some images from SEM were taken from the fabrics that have been studied in this work. In Figure 1, we can observe the laundered treated samples with different concentration of silica particles.



a. b. c.

d. e. f.

Fig. 1: *SEM images of the treated samples using different concentration of silica particles and 5 g/L of resin at 2000 magnifications.a, b, c)5 g/L silica particles and d, e, f)10 g/L silica particles. a, d) unlaundered samples, b, e) treated fabric after 1 washing cycle, c, f) treated fabric after 5 washing cycle.*

After the washing cycles, we can observe the presence of particles on the fabric, but when we used greater quantity of silica particles, the quantity of microcapsules on the fabric surface is higher in all cases. But images get by microscope SEM do not allow us to obtain a quantificate result. For this reason energy dispersive X-Ray (EDX) was used to compare different treatments. In order to know the quantity of Si bonded located on the fabric, every sample was analized on the same area (120x90 um), then we calculated the ratio Si atoms/O atoms, these results are represented in the figure 2.

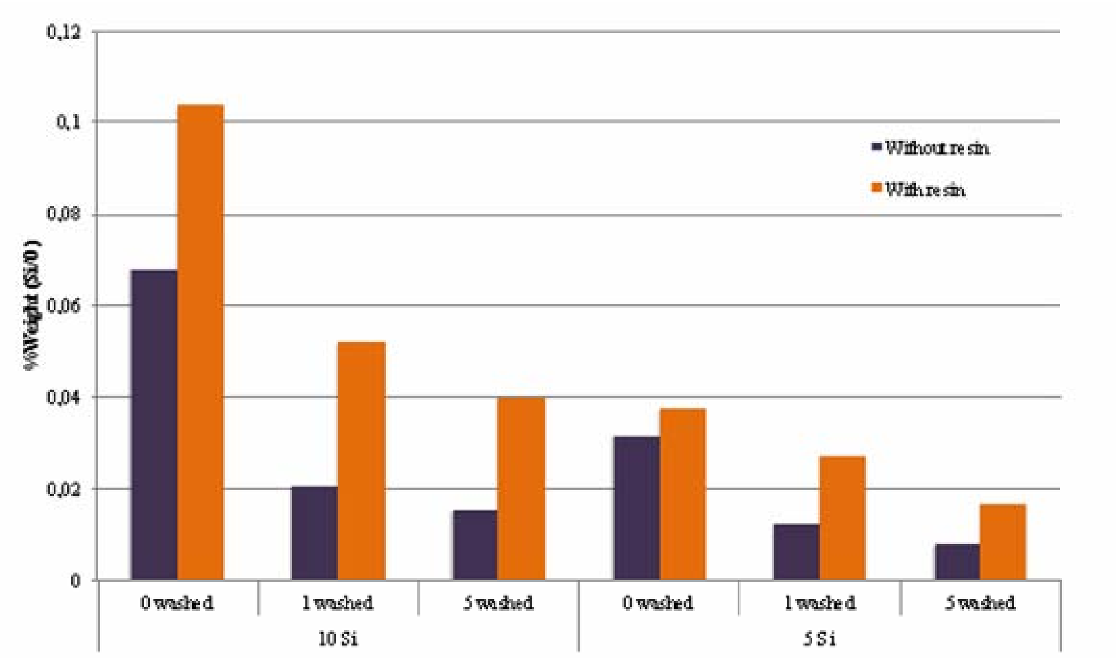


Fig. 2: *Representation the ratio %weight (Si/O) obtained of the treated samples with different silica particles concentration after different wash cycles.*

We can observe with these results that this ratio, which expres the quantity of particles on the surface of the analized samples, decreases when washing cycles are applied. If we compare the results between treated samples with different concentration of silica particles with and without resin, we can see that there are more quantity of the silica particles on the treated samples with resin after the aplication. As expected, this quantity decreases less than treated samples without resin after 1 and 5 wash cycles.

4. CONCLUSIONS

Samples analysis by EDX evaluated the effect of silica particles durability. We analyzed %weight (Si/O) for unwashed and washed treated samples with and without binder. We concluded that whased samples which had been treated using acrylic resin contain higher quantity of the silica particles onto fabric than those whased samples which had been treated without resin. This points out the acrylic resin as a good adhesive to join this kind of particles onto the fabric.

REFERENCES

[1] C.A. Impellitteri, T.M. Tolaymat, K.G. Scheckel, "*The Speciation of Silver Nanoparticles in Antimicrobial Fabric Before and After Exposure to a Hypochlorite/Detergent Solution*", Journal Of Environmental Quality, 38(4), 2009, pp.1528-1530.

[2] M. M. Abdelhady, "*Preparation and Characterization of Chitosan/Zinc Oxide Nanoparticles for Imparting Antimicrobial and UV Protection to Cotton Fabric*," International Journal of Carbohydrate Chemistry, 2012, 2012, http://dx.doi.org/10.1155/2012/840591.

[3] M. Radetia, "*Functionalization of textile materials with TiO.sub.2 nanoparticles*," Journal of Photochemistry & Photobiology, C: Photochemistry Reviews, 16, 2013, pp.62-77.

[4] M. Hadi, S. Abdollah, Z. Mohammad, "*Flame-retardancy and photocatalytic properties of cellulosic fabric coated by nano-sized titanium dioxide*," Journal of Thermal Analysis and Calorimetry, 140(2), 2011, pp.717-725.

[5] Roe, Barry ; Zhang, Xiangwu, "*Durable hydrophobic textile fabric finishing using silica nanoparticles and mixed silanes*," Textile Research Journal, 79(12), 2009, pp.1115-1122.

[6] Q. Cheng, C. Li, V. Pavlineck, P. Saha, H. Wang, "*Surface-modified antibacterial TiO2/Ag nanoparticles: Preparation and properties*," Applied Surface Science, 252, 2006, pp. 4154-4160.

[7] X. Man, F. Jun-quiang, C. Xiao-long, "*Electrical properties of nano-silver/polyacrylamide/ethylene vinyl acetate composite,*" Journal of Shanghai University, 12 (1), 2008, pp. 85-90.

SUSTAINABLE ALTERNATIVES FOR WOOL VALORIZATION

BUCIŞCANU Ingrid - Ioana

"Gheorghe Asachi" Technical University of Iaşi, Romania, Faculty of Textiles, Leather and Industrial Management, Str. Prof. Dr. Doc. Dimitrie Mangeron, No. 29, 700500 Iaşi, Romania, E-Mail: ibuciscanu@yahoo.com

Corresponding author: Bucişcanu, Ingrid, E-mail: ibuciscanu@yahoo.com

Abstract: *Use and valorization of renewable resources is a key factor within the sustainable development concept. In this context, natural fibers have known a well-deserved revival, both for clothing and non-clothing applications. During the last decades, wool production and prices has fall, due to the rise and diversification of synthetic fibers. Great amounts of wool are treated as waste and are burnt or landfilled. At present, in search for sustainable resources,wool is regarded as a biodegradable renewable resource and due to its complex chemical composition and physical structure, can find various value- added application. Two main directions to add value to wool fibers have been developed: applications that use native or slightly chemically modified fibers and applications that use the keratin biopolymer, previously extracted from the solubilized fibers. Lately, intensive research has been done on wool and its potential non-conventional applications as renewable resource. Innovative application and valorization solutions are reported in the specialty literature and different kinds of products are patented and marketed. The aim of this paper is to present the actual and potential possibilities for the valorization of native wool fibers in novel, non-clothing applications, and their contribution to the economic, environmental and social pillars of sustainable development.*

Key words:. *Renewable resources, sustainable development, biofiber, keratin, waste valorization*

1. INTRODUCTION

The history of natural fibers coincides with the history of mankind. Population growth and the development of chemical industry has driven the production of synthetic fibers, which proved to be much more easier to manufacture and process, and exhibit superior properties for certain applications.

Chemical fibers with 60 % in world fiber production in 2006 have already greatly surpassed natural fibers like cotton (38 %) and wool (2 %) [1]. The world wool production, as well as prices, has steadily declined since1990; its 2008 level, with about 1200 Mt clean wool produced, was only 20 % greater than the production of 1950 and accounted for only 2.5% of the total yearly fibre consumption [2]. As a consequence, many farmers prefer to treat the wool as a waste product and end up burning or burying it. Within the last decades, wool has become an underrated, underused resource, even if it is a high quality fiber, used for expensive textiles.

One of the main operational principles of sustainable development is the use of renewable resources of plant or animal origin. Within this context, a resurgence of interest for natural fibers and for their uses for clothing and industrial applications has been noticed. With increasing demand for sustainable materials, wool is being regarded a a renewable, sustainable, biodegradable resource, worthy of a better exploitation.

2. WOOL AS A BIOFIBER AND RENEWABLE RESOURCE

Biofiber means a natural fiber, naturally coming from a plant or animal source, which exists in nature. Wool is such a fiber and its unique properties rely on its main constituent, which is the keratin.

As a protein, keratin is made up of amino acid building-blocks, of which cystine is characteristic. Cystine, a sulphur-rich amino acid accounts for the disulfide bridges, which crosslink the adiacent macromolecules and confers toughness, resistance and insolubility to the whole assembly.

Wool fiber is an ordered collection of elongated cells, consisting of multiple types of keratin proteins. Each fiber is divided into three main areas: the cuticle, cortex, and medulla (see **Fig.1**). The cuticle is a scaly outer layer that function to protect the fiber from physical and chemical damage. The cortex is the major body of the hair fiber, which is composed of many spindle-shaped cells that contain keratin filaments. Two main groups of proteins can be found within the cortex of the hair fiber: (1) low-sulfur, "alpha" keratins (MW 40−60 kDa) and (2) high-sulfur, matrix proteins (MW 10−25 kDa). Collectively, the wool fiber consists of 50−60% alpha keratins and 20−30% matrix proteins. Keratin may account for up to 95% of the dry matter of a wool fiber. The alpha keratins assemble together to form microfibrous structures known as keratin intermediate filaments (KIFs) that impart toughness to the wool fiber. The matrix proteins function primarily as a disulfide crosslinker or binder that holds the cortical superstructure together and are also termed keratin associated proteins or KAPs .

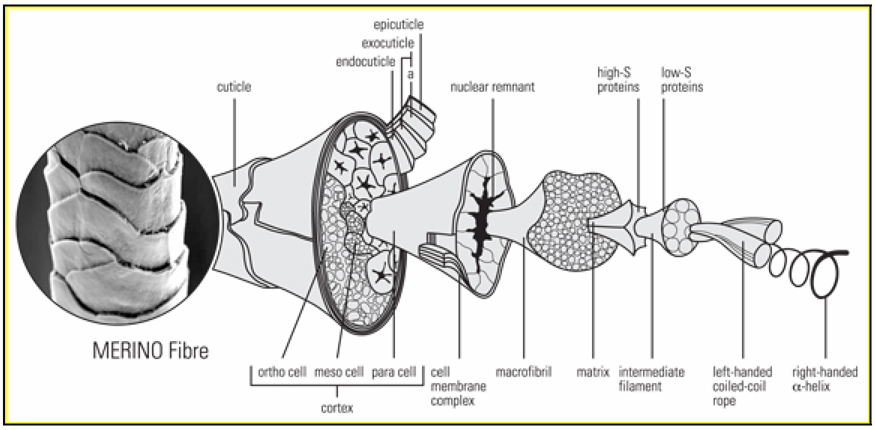


Fig.1: *Exploded view of the various structural units of the wool fibre [3]*

Wool can be considered a natural polymer matrix-fiber reinforced composite, having the most advanced hierachical organization nature has ever produced. Every year a sheep produces one new fleece, making it a renewable resource.

3. MAIN DIRECTIONS FOR SUSTAINABLE VALORIZATION OF WOOL

Valorization of wool and other keratin-based materials have been developed in two main application ranges:

- applications that make use of native fibers subjected to non-distructive, non-solubilizing treatments, such as cleaning degreasing , cutting, comminution; some mild, surface chemical treatments, such as oxidation, may be also are applied, so that the physical integrity of the fiber is not affected;
- applications in which keratin is extracted in different forms and degradation degrees from the solubilized wool fiber and is used in various applications.

The first pathway mainly makes use of low quality (coarser grades) raw wool, but also can use wool wastes coming thus avoiding the landfill or burning.

Keratin is a versatile, bioactive polymer, which became very attractive for advanced applications, from agriculture and cosmetics to bioplastics and biomaterials used in tissue engineering, regenerative medicine etc. Keratin extraction from the containing resources is a difficult task and can be achieved by chemical or enzymatic methods. An ideal solubilization should keep intact the peptide backbone and split the disulfide bond only and protect the newborn functional groups, which become available for subsequent reactions, by which added-value materials are obtained.

4. SUSTAINABLE ACTUAL AND POTENTIAL USES OF NATIVE WOOL FIBERS

4.1 Wool fibers as thermal and acoustic insulation material

Determined not only by demand for more natural building products, but also by a surplus of underused wool worldwide, sheep wool is beginning to appear as a feasible building insulation material due to its remarcable properties [4,5]. Significant properties of wool related to the insulation ability , compared with other common thermal insulators are given in **Table 1**.

Sheep wool offers a safe, natural, renewable and environmentally friendly insulation material. It is healthy as it causes no irritation to the eyes, skin or lungs and has a higher flame retardancy than cellulose and cellular plastic insulation. For best performances in terms of density and strength, wool is used in combination with other recycled fibers, usually low density polyester, in a ratio wool: other fibres = 3:1.

Table 1: *Wool properties, compared with other common insulation materials* (data from [4])

Insulation material	Thermal conductivity (W/m·K	Embodied energy (GJ/m^3)	Sound absorption coefficient (500 -2000 Hz)	Water absorption (% wt/wt)
Sheep wool	0.037	0.11	0.77 (60 mm) [5]	up to 35 %
Glass wool	0.032 – 0.04	0.83	0.65 (100 mm)	0.2 %
Polystyrene foam	0.033 – 0.035	3.03	0.35 (50 mm)	0.03 – 0.1 %

Precautions are related to the use of certain toxic chemicals during sheep grazing, which can be found in wool and the use of preservatives and antirodents (that must be applied to wool to protect it mainly if it is used in humid conditions) with potential toxic effects on humans.

Sheep's wool insulation is still a new product on the market, mainly used for the so-called green buildings [5] but a high performance, sustainable alternative.

4.2 Wool as agricultural amendment

One of the main qualities of wool is biodegradability, which means that when buried into soil, the keratin biopolymer is degraded by microorganisms and releases nutrients essential to the crops.

Wool is quite resistant to the attack of microorganisms, which are able to breakdown the keratinous fiber only in hydrophilic conditions. The degradation is obvious in terms of months: the representative functional groups of wool start to degrade and convert into biomass after 4 weeks, and in hydrophylic conditions, the weight loss is 33% in three months [6].

Because wool slowly decomposes in soil it can be used as a slow-release fertiliser, and will act as a source of nitrogen-based nutrients and sulfur over a much longer period than conventional fertilisers. Low grade raw wool or wool waste can be used as agricultural amendments, layed directly in the bottom of the planting pits , or addeed to the compost mixture, to improve the nitrogen content and water retention. Wool in non-woven form can be also used as weedmats, which initially inhibit weed growth but then slowly break down to release nutrients for the crops [7].

Experiments were done to check out the fertilizing potential of wool on the growth and yield of tomato, sweet peppper and eggplant [8]. Layers of clean wool (10 g per 1 dm^3 substrate) were inserted into the soil at 5 cm from the pot bottom, in order to force root penetration through wool. It was found that wool amendment caused changes in nutrients content of substrate and leaves and up to 33% higher yields, especially for tomato and pepper. Addition of wool or hair waste to soil increased yields of basil, thorn apple, peppermint and garden sage, increased the nitrogen content in soil and in plant tissue, stimulated soil microbial biomass.Wool acted as a slow-release fertilizer, and only 3.3 g per 1 kg of soil may support two to five harvests [9].

4.3 Wool as fiber reinforcement in polymer-fiber composites

Fiber reinforced polymer composites (FRPC) are a class of engineering materials, best suited for advanced applications such as automotive, civil infrastructure, packaging, disposable consumer products. Conventional reinforcing fibers, such as carbon or glass fibers, are expensive their preparation or use may be hazardous. Natural fibers can succesfully replace conventional reinforcement fibers and apart from using a cheap, renewable, environmentally friendly resource, they can impart some additional properties to the composite, such as biodegradability, low density, easy processability, good thermal and mechanical properties. Plant fibers, such as flax, hemp, jute, sisal, coir, pineapple etc. are succesfully combined with synthetic or biobased polymer matrices

Use of animal fibers is a solution for keratinous waste disposal. Chicken fibers can be succesfully used to reinforce high density polypropylene, for the obtaining of composites with high flexural, tensile and acoustic properties. Low fibre weight content led to better enhancement of the mechanical properties and 1-3 % wt/wt gave the best results [10].

Wool has certain applications in fiber – reinforced composite materials. It is used in native state or after some chemical surface treatments that improve the adherence to the polymer matrix.

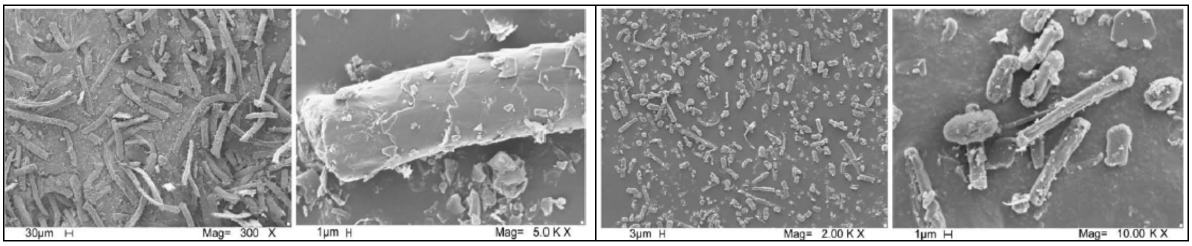
Geopolymers are inorganic aluminosilicate materials that possess relatively good mechanical properties and thermal stability but exhibit failure behavior similar to brittle solids. Strength and toughness can be improved by fiber reinforcement. New aluminosilicate inorganic polymer reinforced composites with an average fiber content of 5 % wt/wt were prepared from kaolinite-type clay and wool, previously degreased with solvents and alkalies [11]. Improvement of fiber hydrofilicity by degreasing determined a better interaction with the hydrophilic inorganic matrix, which resulted in a homogenous fiber distribution. The flexural strength and failure/fracture characteristics of the composite were improved by 40 % compared with the matrix and the thermal stability was also higher. Moreover, environmentally friendliness and relatively low cost make these composites potentially attractive for some construction applications.

Keratinous waste from a tannery, more precisely from the hair-saving liming proces, was used as a filler of synthetic acrylonitrile-butadiene rubber (NBR) [12]. The hair waste was grinded, mixed with ZnO and added to a acrylonitrile-butadien rubber. The rubber filled with 5 % wt/wt keratin fiber waste exhibited increased cross-linking density of the polymer matrix, shorter vulcanization time, improved resistance to thermal ageing and improved biodegradability. It is expected that similar waste, such as wool, will induce the same effects.

4.4 Wool powder

Wool can find promising applications by powderization, when the physical state is altered but the macromolecule structure is intact or slightly modified. Basicly, powders from natural fibers are obtained by cutting into short pieces and grinding. Due to high break and elongation strength of wool fiber, grinding is difficult and energy consuming, so certain pretreatments are applied before grinding, which reduce crystallinity and break some chemical bonds, in order to promote brittleness. By fiber comminution, some functional groups are exposed and become available for certain interactions and the specific surface increases; thus, the powder gains the characteristics of an active solid.

Wool powders can be obtained in different sizes within the micrometric range, from fine (200 -500 µm) to ultrafine (max 15 µm) depending on the grinding process parameters. For example, Xu and coworkers [13] obtained ultrafine wool powder (diameter 2 µm, length 5-10 µm, needle shape), starting from 25 µm Australian wool, by cutting in short pieces with a rotary blade (max. 3 mm) applying a mild surface oxidative treatment and grinding on a ball mill. As the powder particle size decreased, the temperature corresponding to the crystal cleavage and the destroying of the crosslinkages increased to around150°C from 120°C of the control wool fiber. Higher thermal stability



(a) (b)

Fig. 2: *SEM images of wool powders: (a) Merino wool ground on a rotary ceramic mill (medium particle size 51 µm); (b) Merino wool ground on a rotary ceramic mill, chemically treated by chlorination and milled by air-jet milling (medium particle size 4.5 µm) [14].*

suggest that the powder can be used for high temperature applications. FTIR spectra proved that no significant chemical modification of the keratin macromolecule takes place and little change of the X-ray diffraction pattern show slight change of the crystaline structure and only amorphous portions are affected.

Chemical treatment and combined milling techniques allow the obtaining of low particle sizes (see **Fig.2**) and impart new properties, such as fast uptake of anionic dyes, which was comparable to those of activated charcoal with specific surface 100 times greater [14].

4.5. Biobased films and coatings from wool powder

At present, fossil fuel-based or conventional plastics are in flagrant contradiction with the sustainable development concept, as they are obtained from non-renewable resources and, because of their low biodegradability, create substantial solid waste disposal issue . This problem has driven the development of bioplastics, a class of innovative biodegradable materials, based on biopolymers extracted from plant or animal renewable resources [15]. For certain applications, such as packaging and short service life consumer products, bioplastics will become a sustainable alternative. Keratin, due to hidrophobicity, cross-linking ability and due to the abundance of sources, is a promising candidate but the main difficulty is related to the extraction from the keratinous source. Research has been done on the use of superfine wool powder instead of solubilized keratin for the obtaining of biobased thermoplastic materials. Basicly, wool powder is thoroughly mixed with plasticizers and optionally, other syntetic or natural polymers and thr mixture is supposed to hot pressure molding.

Wang [16] mixed wool powder having an average particle size of 1.7 with glycerol plasticizer at 10 % - 50% mass content and subjected the blend to a molding pressure of 1-9 MPa at 100-160°C for 1 – 9 minutes and thermoplastic films with acceptable properties in terms of mechanical strength, tensile strength, swelling capacity, water resistance and ductility were obtained. The wool powder was intimately embeded into a continuous phase in the cross-section and the film surface was smooth. Such biodegradable films can be succesfully used for food and agriculture applications.

Ke and Xu [17] reported the obtaining of films from a blend of wool powder and chitosan, a polysaccharide biopolymer, by solution casting, which exhibited high affinity for a natural cationic dye. Incorporating natural compounds in such films can be the starting point for novel application, in food technology or medicine.

4.6. Wool-based environmentally friendly adsorbents for heavy metals.

Heavy metals are present in wastewaters coming from mining, metallurgical, electroplating, painting, textile and leather industries. They pose serious health hazard problems even if they are present in concentration lower than allowable limits, due to their bioaccumulative behavior. Conventional methods for heavy metals removal including precipitation, chelation, ion exchange are expensive and have several limitations. In recent years, there was an increasing interest in using biobased active solids acting as adsorbents, and biosorption became a viable alternative to the treatment of heavy metal contamination. Keratin fibers coming from different sources (wool, hair, feather, hooves) have proven their binding capacity of different heavy metals (Hg, Pb,Cu, Cr) in trace concentration [18,19]. The adsorption capacity of the keratin fibers is improved by chemical treatment and by reduction of the particle size, by chopping or grinding. Chemical treatment, such as alkaline treatment or treatment with chelating agents is limited to the fiber surface and aims at increasing the density of active sites.

Keratin fibers from chicken feathers, supposed to a alkaline ultrasound treatment proved a high affinity for Pb(II), Hg(II) Cu(II) and Cr(III), both in single and mixed-metal solutions [18]. The maximum uptake onto the keratin fibers mainly depends on the solution pH. Thus, the Pb removal is complete over a pH range of 4.5-5.6, while a 97.6% removal of Hg is attained at pH value of 1.9. Multiple elution and adsorption tests indicated that the keratin adsorbent can be regenerated and used in several treatment cycles.

Binding of. Co(II), Cu(II) and Cd(II) on wool powders of different particle sizes over the pH range 3 – 9 at room temperature and ion concentration ranging from 10^{-3} to 10^{-6} M was investigated [19]. The optimum pH for binding of Cu(II) and Cd(II) was in the range 6–8, while Co(II) absorption

peak was at pH 8. The rate of uptake of Cu(II) for each of the wool powder was significantly faster (~

42 fold) than that of the wool fibre. In comparison with commercial cation exchange resins, the wool powders showed higher (two to nine fold) metal ion loading capacity. The ability to produce large quantities of wool powders and their ease of handling indicate that they have potential for application in separation and recovery of metal ions from industrial effluents and environmental waterways.

5.CONCLUSIONS

Wool is one of the most valuable natural fibers, but during the last decades it has been surpasses by manmade fibers. This pushed down the prices paid for wool and many farmers around the world were forced to treat it as a waste and throw it away. At present, wool is an underrated, underused resource, despite its outsanding properties related to the textile industry.

Sustainable development is the paradigm of the present society and one of its key principles is use and valorization of accesible renewable agroresources, as an alternative to depleting fossil-fuel resources.

In a time when the finding of new resources is vital to mankind survival, a revival of natural fibers regarded as renewable, biodegradable and sustainable resources has been noticed.

Wool is such a resource and efforts have been made to find useful clothing and industrial applications, in order to resolve a waste management issue. Wool and other natural keratinous resources can be transformed into value-added products, through economically feasible manufacturing processes, which imply minimal physical and chemical transformation.

Apart from its versatile uses to consumers and industry, natural fibres are an important source of income for the farmers who produce them. Natural fibre industries employ millions of people worldwide and are of major economic importance in some developing countries. Natural fibers cultivation and valorization have a positive social impact because it assures the development of rural, agricultural-based economy and also have a positive public perception, vs. the exploitation of non-renewable resources.

Use and valorization of wool and other natural fibers into added-value products is a contribution to the environmental, economic and social sustainability.

REFERENCES

[1] F. Petry. (2014, Apr.). Environmental protection and sustainability in the textile industry. Melliand Textilberichte 7-8/2008. Available: http://www.drpetry.de/pdf/Environmental.pdf

[2] C. Wilcox. (2014, Feb.).Wool Journal. June 2013. [Online]. Available: www.sheepusa.org/user_files/file_1235.pdf

[3] R. C. Marshall, D. F. Orwin and J. M. Gillespie, "*Structure and biochemistry of mammalian hard keratin*", Electron. Microsc. Rev., vol. 4, pp. 47–83, Jan. 1991.

[4] T. Wooley, S. Kimms, P. Harrison and R. Harrison, "*Green Building Handbook",* vol.1, London: Spon Press, Taylor & Francis Group, 2005.

[5] J. Zach et al., "*Performance evaluation and research of alternative thermal insulations based on sheep wool",* Energy and Buildings, vol. 49, pp. 246-253, June 2012.

[6] K. Arshad and M. Mujahid. (2014, Mar.). Biodegradation of Textile Materials. Master Thesis, University of Borås. Available: http://bada.hb.se/bitstream/2320/9255/1/2011.7.8.pdf

[7] R. Hempe. (2014, Mar.). Wool waste could be another value-added product. CELS News. [Online]. Available: http://cels.uri.edu/news/nWoolMulch.aspx

[8] R. S. Górecki and M. T. Górecki, "*Utilization of Waste Wool as Substrate Amendment in Pot Cultivation of Tomato, Sweet Pepper, and Eggplant"*, Polish J. of Environ. Stud., Vol. 19, pp. 1083-1087, No. 5, May 2010.

[9] V. D. Zheljazkov, "*Assessment of Wool Waste and Hair Waste as Soil Amendment and Nutrient Source"* Journal of Environmental Quality J.E.Q., vol. 34 No. 6, pp. 2310-2317, June 2005.

[10] I. O. Oladele, J. A.Omotoyimbo and S. H. Ayemidejor, "*Mechanical Properties of Chicken Feather and Cow Hair Fibre Reinforced High Density Polyethylene Composites*", I.J.S.T., vol. 3, pp. 66-72, Jan. 2014.

[11] M. Alzeer and K. J. D. MacKenzie, "*Synthesis and mechanical properties of new fibre-reinforced composites of inorganic polymers with natural wool fibres*", J. Mater. Sci., vol. 47, pp. 6958-6956, Oct. 2012.

[12] M. Prochoń and A. Przepiórkowska. (2014, Apr.). Innovative Application of Biopolymer Keratin as a Filler of Synthetic Acrylonitrile-Butadiene Rubber NBR. Journal of Chemistry (2013). [Online]. Available: http://www.hindawi.com/journals/jchem/2013/787269/

[13] W. Xu et al., "*Development and characterizations of super-fine wool powder*", Powder Technology, vol. 140, pp. 136– 140, June 2004.

[14] G. Wen et al., "*The characterization and chemical reactivity of powdered wool",* Powder Technology, vol. 193, pp. 200-207, July 2009.

[15] Flieger M. et al., "*Biodegradable Plastics from Renewable Sources*", Folia Microbiologica, vol. 48, pp. 27-44, Jan 2003.

[16] X. Wang et al., "*Thermoplastic Film from Superfine Wool Powder"*, FIBRES & TEXTILES in Eastern Europe, vol. 17, pp. 82-86, Feb. 2009.

[17] G.-z. Ke and W-l. Xu, "*Preparation and properties of superfine wool powder/chitosan complex membrane"* J. Text. I., vol. 103, pp. 1183-1188, Nov. 2012.

[18] P. Kar and M. Misra, "*Use of keratin fiber for separation of heavy metals from water",* J. Chem. Technol. Biotechnol., vol. 79, pp. 1313-1319, Nov. 2004.

[19] R. Naik et al., "*Metal Ion Binding Properties of Novel Wool Powders*", J. Appl. Polym. Sci., vol. 115, pp. 1642-1650, Nov. 2010.

RETROFITTING CLOTHING PRODUCTS USING INTERACTIVE DIGITAL ELEMENTS

CAZAC Viorica[1], CUCERENCU Marin[2]

[1] Technical University of Moldova, Faculty of Light Industry, 2045, Kisinau, s. Sergiu Radautanu 4, bl.11 E-Mail1:viorica.scobioala@gmail.com

[2] Technical University of Moldova, Faculty of Light Industry, 2045, Kisinau, s. Sergiu Radautanu 4, bl.11 E-Mail2: marincucerencu@me.com

Corresponding author: Cazac Viorica, E-mail: viorica.scobioala@gmail.com

Abstract: *Interest in information technologies makes also the clothing field to concern about upgrading trough IT implementation not only at the level of organization and management of design processes, planning manufacturing, but also direct using of them with aesthetic implications in visual perception.*
Interactive elements widely used in the III-rd millennium's editions – e-books, electronic magazines, etc. may be applied with success also in clothes.
As starting points for implementation of digital interactive elements on clothing products are analysis of fashion trends 2014-2015 considering recommended colors, aesthetic stylistic peculiarities: forms, lines, contour, decorative elements; materials and aesthetic characteristics: surface, touch, drawing subject, dimensions, assessment of personalization's expectations of a group formed from 15 young girls passionate fans of modern technologies. In order to materialize their expectations, aesthetic and technological solution of interactive digital elements capable to be embedded in clothes was realized with the platform Adobe Digital Publishing Suite.
The survey results confirmed initial hypothesis that interest in upgrading the clothes is high, especially for age of 14-35 years. According to the results, were developed several projects of clothes with interactive elements, attention being paid to conceptual and aesthetic solutions.
Digital interactive elements applied on clothing products ensures a wide range of aesthetic solutions provided by a single product and their compliance with the occasion of wearing, may realize not only aesthetic functions, but also cognitive, informative, protective. Interactive elements may be placed in any zone, both main and small, decorative items. E-dress is one of the guidelines of the future offered to users.

Key words: *Digital interactive elements**,** personalization, aesthetic stylistic peculiarities.*

1. INTRODUCTION

Interest in information technologies makes also the clothing field to concern about upgrading trough implementation of IT not only at the level of organization and management of design processes, planning manufacturing, but also direct using of them with aesthetic implications in visual perception.

Interactive elements widely used in the III-rd millennium's editions – e-books, electronic magazines, etc. may be applied with success also in clothes, excluding the necessity of carrying notebooks, digital tablets. Integrating interactive digital elements in different parts of the clothing can provide multifunctionality of clothing products.

The **study objective** is to identify possibilities of applying digital interactive elements on clothing products.

2. UPGRADING CLOTHING PRODUCTS THROUGH DIGITIZATION

Product development of smart clothing is not only fabrics performances, embedded means such as sensors incorporated for providing and maintaining the temperature of the human body, treating various chronic diseases, etc. Aesthetic aspect, especially for clothing products is as important as their functional properties. Because the objective of this study was not limited to the clothing aesthetic diversification through digital interactive elements, but also to ensure the possibility of information, access to Internet communication media, first it is necessary to identify aesthetic features as the current fashion trends (Fig.1-4).

Fashion trends for the period 2014-2015

Chromaticity [17]

Fig. 1: *Chromatic range recommended for the period 2014-2015*

Offered prints [18]

Geometric prints


Stella Jean


Emma Cook


Tods


Prada


Chanel

Prints with curves


Samuji


Ache Studios


Marc Jacobs


Guy Laroche


Rachel Comey

Plaid prints

On red *On black*


Marc by Marc Jacobs


Missoni


Vivienne Westwood


Marissa Webb


Comme des Garsons

Ornamental print

vegetal ornament *eclectic*


Christophe Lemaire


Osman


Emma Cook


Mara Hoffman


Versus Versace

Prints of flora and fauna

animal print


Balmain


Wren


Tom Ford


Giambattista Vall


Gucci

floral motives

red on black

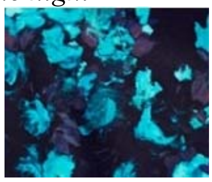

Erin Fetherston


Dolce & Gabana


Honor

flowers in the night


Escada


Sonia by Sonia Kykiel

Macroprints

mountains and trees


Ostwald Helgason


Peter Pilotto


Tracy Reese

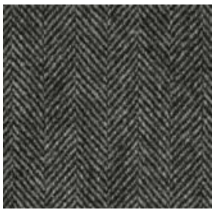
Cartoon characters


|Red Valentino

Moschino

Fig. 2: *Prints recommended for the period 2014-2015.*

The types of materials recommended for the period 2014-2015 [18-19]


Tweed


Mohair and angora


Classic velvet and corduroy


Laces


Fur


Latex type waterproof fabrics


Black leather


Volatiles (chifon-veil)

Fig. 3: *The types of materials recommended for the period 2014-2015.*

Forms of clothing products [17]

Stella Jean | Comme des Garsons | Dolce & Gabana | Rachel Comey | Duru Olowu

Fig. 4: Forms of clothing products.

3. MATERIALS AND METHODS

In order to analyze the personalized expectations a questionnaire was developed which lists topics with reference to the carriers' passions, their predilection to suggest the priority concerns through clothing, young people's attitudes to the possibility of digitization clothing products, placement of interactive elements in product [1-16]. The survey extended only to a group of 15 young people shows a greater interest in clothes with interactive elements. Digital interactive elements were developed using platform Adobe Digital Publishing Suite and embedded in dresses items as additional elements.

4. RESULTS AND INTERPRETATIONS

The survey results confirmed initial hypothesis that interest in upgrading the clothes is high, especially for age of 14-35 years. According to the results, were developed several projects of clothes with interactive elements, attention being paid to conceptual and aesthetic solutions.

Application Adobe Digital Publishing Suite has enabled the development of additional interactive elements shown in Figure 5-7. Interactive elements works like digital tablets. They have stored in its library required information useful to wearer and they are able not only to provide useful information but also to shape the items surface, to boost the running image, to replace an image with another both chromatic and conceptual.

Possibilities offered by the interactive digital elements are manifested by:

- spread of interactive digital content;
- create publications without restrictions and without file size limits;
- create applications for different platforms (Android ™, iOS и QNX);
- monetization payment systems applications stores - sales numbers and special editorial edition subscriptions (Apple App Store, Android Market, BlackBerry App World);
- access to analytical reports information via the Digital Publishing Suite;
- integration with Adobe Online Marketing Suite (Adobe SiteCatalyst ®) based on Omniture ® technology;
- integration with multi-platform advertising (Medialets).

Fig.5: *Digital element specialized in a specific area with embedded 3D element: medicine, fashion, mathematics etc.author:Marin Cucerencu*

Fig.6: *Functional digital element with embedded slideshow element, author: Marin Cucerencu*

Fig.7:*Digital element with embedded video, author: Marin Cucerencu*

5. CONCLUSIONS

- Digital interactive elements applied on clothing products ensures a wide range of aesthetic solutions provided by a single product and their compliance with the occasion of wearing, may realize not only aesthetic functions, but also cognitive, informative, protective.
- Interactive elements may be placed in any zone, both main and small, decorative items.
- E-dress is one of the guidelines of the future offered to users.

REFERENCES

[1] *Using digital publishing suite*, Adobe,USA, (2009)
[2] Dabner, David. *Design grafic*. Grupul Editorial RAO, București, 2005
[3] Рудер, Эмиль. *Типографика*. Книга, 1982 г.
[4] Розенсон И. *Основы теории дизайна*. СПб.: Питер, 2006, 224 с.
[5] Туэмлоу Э. *Графический дизайн. Фирменный стиль, новейшие технологии и креативные идеи*.
[6] William F. Arens, *Contemporary Advertising*, McGraw Hill Higher Education, 12th edition (December 1, 2008)
[7] Drucker, Johanna and McVarish, Emily, *'Graphic Design History: A critical Guide'*. Pearson Education, 2009
[8] Meggs, Philip B., *'A history of graphic design'*. New York: Van Nostrand Reinhold, 1983
[9] Hendel, Richard *On Book Design*. Yale University Press
[10] Jost Hochuli: *Bücher machen. Eine Einführung in die Buchgestaltung, im besonderen in die Buchtypografie*. Agfa Corporation, Wilmington (Mass.) 1989
[11] Wolfgang Kermer: Willi Baumeister - *Typographie und Reklamegestaltung*. Edition Cantz, Stuttgart 1989

[12] Wolfgang Kermer (Hrsg.): Zwischen Buch-Kunst und Buch-Design. Buchgestalter der Akademie und ehemaligen Kunstgewerbeschule in Stuttgart: Werkbeispiele und Texte. Ostfildern-Ruit: Edition Cantz, 1996

[13] Markus Stegmann und René Zey: *Das Designlexikon. Directmedia Publishing*. Berlin 2004

[14] *A History of Graphic Design*. Phillip B. Meggs, New York u. a. 1998

[15] *Engagement & grafik design.* Hrsg.: NGBK / Berlin 2000

[16] Friedrich Friedl, Nicolaus Ott, Bernard Stein (Hrsg.): *Typographie – wann wer wie*. Könemann, 1998

[17] *Модные принты 2014 2015: Осень-Зима* [Online]. Available: http://modabook.net/modnye-printy-2014-2015-osen-zima

[18] *Самые модные ткани 2013-2014* [Online]. Available: http://uumoda.ru/topics/2233/146948/

[19] *Модные тенденции 2014-2015 от Эвелины Хромченко* [Online]. Available: http://2queens.ru/Articles/Dom-Mody-V-etom-sezone/Modnye-tendencii-20142015-ot-Eveliny-Hromchenko.aspx?ID=1844

RESEARCH ON THE BEHAVIOR OF SPINNABLE POLYMER SOLUTIONS IN A HIGH VOLTAGE ELECTROSTATIC FIELD

CIOBOTARU Victor[1], AVRAM Dorin[1], PANTILIMONESCU Florin[2]

[1] *"Gheorghe Asachi" Technical University of Iasi, Romania, Faculty of Textiles & Leather Engineering and Industrial Management, Str. Prof. Dr. Doc. Dimitrie Mangeron, Nr. 29, 700050 Iasi, Romania, E-mail: decanat@tex.tuiasi.ro*

[2] *"Gheorghe Asachi" Technical University of Iasi, Romania, Faculty of Automatic Control and Computer Engineering, Str. Prof. Dr. Doc. Dimitrie Mangeron, Nr. 27, 700050 Iasi, Romania, E-mail: decanat@ac.tuiasi.ro*

Corresponding author: Ciobotaru, Victor, E-mail: victor_clk@yahoo.com

Abstract: *Working parameters are very important to understand the nature of electrospinning. Each of these parameters can affect the fibers morphologies and by proper control of these parameters one can fabricate electrospun fibers with desired morphologies and diameters. Jet charge density is known as one of the important parameters affecting the fiber diameter. To investigate the effect of the applied voltage on jet charge density, one must investigate its effects on the jet electric current and flow rate. There are some difficulties in measuring the jet flow rate. In this work, one method is used to calculate the electrospinning jet flow rate. For exemplification, by using a polyethylene oxide (PEO) solution in water, effects of applied voltage and feed rate on jet charge density is investigated. The jet flow rate is calculated applying different voltages, at different constant feed rates. The jet flow rate is independent of the feed rate and dependent on the applied the voltage. By defining an equation for dependence of jet flow rate on current, a relation between jet volume charge density and jet current can be defined. By measuring the electrospun fiber diameter, surface charge density of the jet can also be estimated. On increasing the voltage, the jet volume charge density decreases whereas the jet surface charge density remains unchanged.*

Key words: *electrospinning, nanofiber, jet flow rate, jet charge density, polyethylene oxide*

1. INTRODUCTION

Electrospinning of polymer solutions is a successful method in producing continuous fibers with nano diameters.

Working parameters are very important to understand not only the nature of electrospinning but also the conversion of polymer solutions into nanofibers through electrospinning. These parameters can be broadly divided into three parts such as solution parameters, process parameters, and ambiental parameters. Each of these parameters can affect the fibers morphologies and by proper control of these parameters one can fabricate electrospun fibers with desired morphologies and diameters.

There are many reports on the effects of the process parameters, such as applied voltage, on electrospun fiber diameter, but they are inconsistent and sometimes antithetical [1],[2],[3],[4]. For example, it was demonstrated that there is not much effect of electric field on the diameter of electrospun polyethylene oxide (PEO) nanofibers [5]. Several groups suggested that higher voltages facilitated the formation of large diameter fiber. For example, there were investigated the effects of voltage on morphologies and fiber diameters distribution with poly (vinyl alcohol) (PVA)/water solutions as model [6]. Several groups suggested that higher voltages can increase the electrostatic repulsive force on the charged jet, favoring the narrowing of fiber diameter. For example, there were investigated the effects of voltage on morphologies and fiber alignment with polysulfone (PSF)/DMAC/acetone as model [7]. In addition to those phenomena, some groups also demonstrated that higher voltage offers the greater probability of beads formation [8][9][10]. Thus, one can say that voltage does influence fiber diameter, but the level of significances varies with the polymer solution concentration and with the distance between the needle tip and the collector [11].

On the other hand, the jet charge density is known as one of the important parameters affecting the fiber diameter [12][13]. It is shown that the fiber diameter decreases when the charge density increases [2].

According to the conservation of mass and conservation of electric charge, the following equation can be writen for an electrospinning jet [12][14]:

$$\frac{I}{Q_j} = \frac{2\sigma}{r} \qquad \textbf{(1)}$$

The ratio of I to Q_j is known as the jet volume charge density (ρ). It is possible to measure the jet electric current during the electrospinning process through putting an electrical resistence in series between the collector and the ground [14][15].

In the work reported here, by measuring the jet current and jet flow rate, the jet charge density is calculated. By using PEO solution in water, effects of applied voltage and feed rate on jet charge density is investigated.

2. EXPERIMENTAL

PEO powder with a molecular weight of 4 x 10^5 g/mol was dissolved in distilled water at ambient temperature for about 12 h. The concentrations were 5, 7, and 10 wt %.

The electrospinning device was assembled in our laboratory. A syringe with a stainless steel needle was used. The needle dimensions were internal diameter of 0.2 mm and length of 3 cm. The needle was connected to the positive electrode of a high voltage power supply. The high voltage power supply consisted of a flyback transformer salvaged from a cathode ray tube monitor and modified for this purpose. The modified transformer could generate output voltages between 10 and 30 kV. The collector was a metal plate connected to ground. The solution was fed at a constant volumetric flow rate using a syringe pump. The syringe pump was designed in our laboratory and consisted of a 24 V Mabuchi C2162-60006 DC motor coupled to a 1:3025 gear, an optical quadrature encoder feedback and an Infineon Hexagon application kit for control. The distance between the needle tip and collector was 15 cm. The jet current was measured as a voltage drop across a 10 MΩ resistor placed in series between the needle and the ground. The voltage drop was sampled with a digital data acquisition with a sampling time of 10 ms. Solutions of 5 wt %, 7 wt % and 10 wt % PEO in water were used at room temperature, with feed rates of 0.5, 1, 1.5, 2, 2.5, 3 mL/h while applying different voltages between 10 and 30 kV. The morphology of the electrospun fibres can be observed using SEM. For each sample, the average diameter of the individual fibers can be measured from multiple magnified SEM images. The result for each sample can be reported as an average value and confidence interval, from several hundred measurements.

3. RESULTS AND DISCUSSIONS

To understand how to measure the jet flow rate, first one must be familiar with the jet regimes and their electrical current curves. In previous works [1], it has been shown that in a horizontally lain electrospinning set up, at a constant feed rate and different applied voltages, two jet regimes can be observed; they are stable jet and fluctuating jet regimes.

A solution of 10 wt % PEO in water was used at a constant feed rate of 0.5 ml/h, while applying different voltages between 10 and 30 kV, and the jet current was measured. Fig. 1 shows a model for jet current vs. time at different voltages. At the voltage of 15.5 kV and above, the process is in the fluctuating regime.

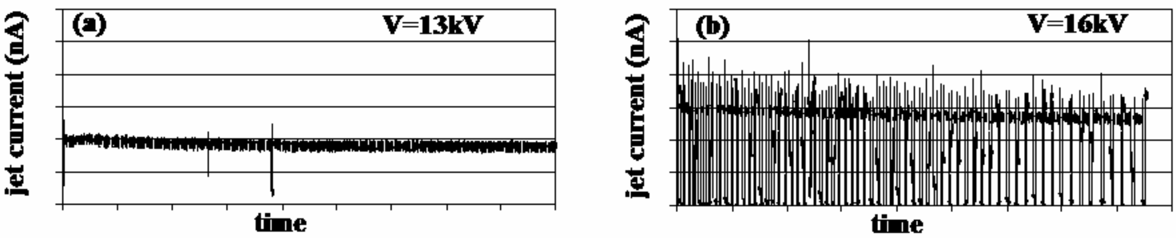


Fig. 1: *Model for jet current vs. time at different applied voltages.*
(a) Model for jet current vs. time for stable jet regime (b) Model for jet current vs. time for fluctuating jet regime

In the stable jet regime the jet flow rate is less than the syringe pump feed rate, so not all the solution transferred by the pump to the needle tip is carried away by the jet to the collector. In this regime the resulted jet is continuous.

In the fluctuating jet regime the jet flow rate is more than the syringe pump feed rate and the whole solution transferred by the pump to the needle tip is carried away by the jet to the collector. In this regime the resulted jet is not continuous.

Between this two regimes there is the so called quasi stable point, in which the jet flow rate is equal to the syringe pump feed rate.

A solution of 10 wt % PEO in water was used at constant feed rates of 0.5, 1, 1.5, 2, 2.5 and 3 ml/h, by applying different voltages between 10 – 30 kV. In each experiment, by increasing the voltage and investigating the current graphs, one can identify the quasi stable points [16].

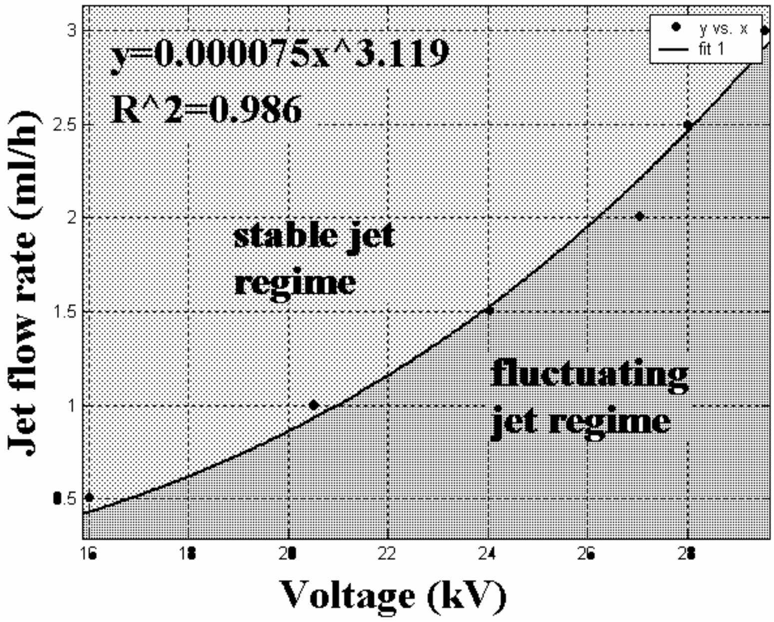


Fig. 2 : *Jet flow rate as a function of the applied voltage at different feed rates. The points on the graph represent the quasi stable points. The curve shows the power-law fitting to the data based on the least squares method. The fitted equation is shown.*

Fig. 2 shows power-law dependence between the jet feed rate and the applied voltage as:

$$Q_j = 0.000075V^{3.119} \tag{2}$$

If one cannot measure de voltage precisely, then a power-law dependence between the jet feed rate and the current must be taken into account, from the calculations above, as in equation (3):

$$Q_j = f(I) \tag{3}$$

Volume charge density is usually defined as:

$$\rho = \frac{I}{Q_j} \tag{4}$$

By calculating the volume charge density and measuring the jet diameter, the surface charge density can also be calculated:

$$\sigma = \frac{\rho r}{2} \tag{5}$$

The jet diameter was estimated by the following equation [15]:

$$r = r_f C^{-0.5} \tag{6}$$

where r_f is the electrospun fiber diameter, and C is the weight fraction of the polymer in the solution.

Fig. 3 shows the applied voltage, jet current, fiber diameter, jet surface and volume charge density, for a solution of 10 wt % PEO in water.

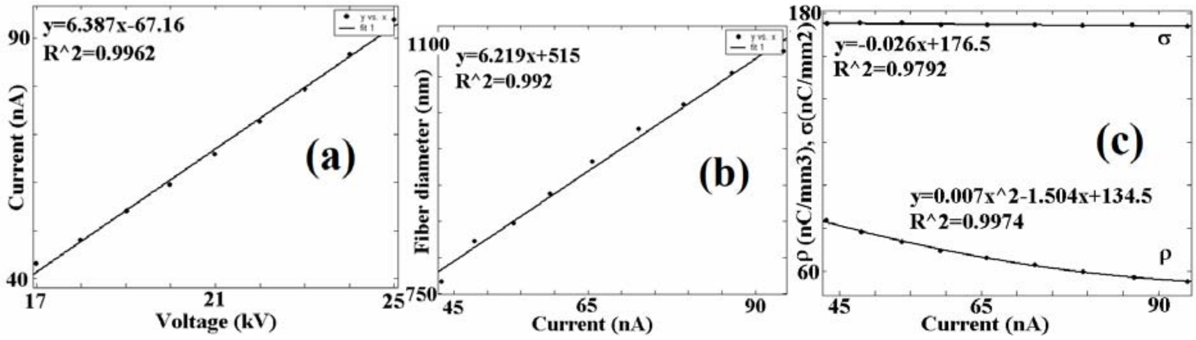


Fig. 3 : *The measured and calculated parameters for a 10 wt % solution of PEO in water.*
(a) Jet current as a function of the applied voltage (b) Fiber diameter as a function of jet current
(c) Volume and surface charge density as a function of jet current

4. CONCLUSIONS

Using polyethylene oxyde solutions in water at different constant feed rates, the jet electrical current is investigated in the real time. Using the real time current graphs, the jet flow is calculated and its variations against applied voltage and jet current are investigated. The jet flow rate is independent of the feed rate and the volume charge increased when increasing the voltage.One equation is defined for dependence of the jet flow rate and the volume charge density on the jet current. Volume charge density of the jet decreased when increasing the applied voltage.

REFERENCES

[1] Fallahi D., M. Rafizadeh, N. Mohammadi and B. Vahidi (2008), *Polym Int* 57, 1363.

[2] Fridrikh S. V., H.H. Yu, M.P. Brenner and G.C. Rutledge (2003), *Phys Rev lett* 90, 1445021.

[3] Li L. and Y.L. Hsieh (2005), *Polymer* 46, 5133.

[4] Megelski S., J.S. Stephens, D.B. Chase, J.F. Rabolt (2002), *Macromolecules* 35, 8456.

[5] Reneker DH, Chun I (1996) Nanometre diameter fibres of polymer, produced by electrospinning. Nanotechnology 7(3):216–223. doi:10.1088/0957-4484/7/3/009

[6] Zhang C, Yuan X, Wu L, Han Y, Sheng J (2005) Study on morphology of electrospun poly(vinyl alcohol) mats. Eur Polym J 41(3):423–432. doi:10.1016/j.eurpolymj.2004.10.027

[7] Yuan X, Zhang Y, Dong C, Sheng J (2004) Morphology of ultrafine polysulfone fibers prepared by electrospinning. Polym Int 53(11):1704–1710. doi:10.1002/pi.1538

[8] Buchko CJ, Chen LC, Shen Y, Martin DC (1999) Processing and microstructural characterization of porous biocompatible protein polymer thin films. Polymer 40(26):7397–7407. doi:10.1016/s0032-3861(98)00866-0

[9] Deitzel JM, Kleinmeyer J, Harris D, Beck Tan NC (2001) The effect of processing variables on the morphology of electrospun nanofibers and textiles. Polymer 42(1):261–272. doi:10.1016/s0032-3861(00)00250-0

[10] Demir MM, Yilgor I, Yilgor E, Erman B (2002) Electrospinning of polyurethane fibers. Polymer 43(11):3303–3309. doi:10.1016/s0032-3861(02)00136-2

[11] Yördem OS, Papila M, Menceloğlu YZ (2008) Effects of electrospinning parameters on polyacrylonitrile nanofiber diameter: An investigation by response surface methodology. Mater Des 29(1):34–44. doi:10.1016/j.matdes.2006.12.013

[12] Shin Y. M., M.M. Hohman, M.P. Brenner and G.C. Rutledge (2001), *Polymer* 42, 9955.

[13] Thompson C. J., G.G. Chase, A.L.Yarin and D.H. Reneker (2007), *Polymer* 48, 6913 .

[15] Halgeson M. E. and N.J. Wagner (2007), *AIChE* 53, 51.

[14] He J. H., L. Xu, Y. Wu and Y. Liu, (2007) *Polym Int* 56, 1323.

[16] Rafizadeh et al, 2008

STUDY OF RASPBERRY EXTRACT APPLICATIONS AS TEXTILE COLORANT ON NATURAL FIBERS

COMAN Diana[1], OANCEA Simona[2], VRÎNCEANU Narcisa[1], FLOREA Marin[1]

[1] *"Lucian Blaga" University of Sibiu, Romania, Department of Industrial Machinery and Equipment, Faculty of Engineering, 550025, 4 Emil Cioran Street, Romania*

[2] *Lucian Blaga" University of Sibiu, Romania, Department of Agricultural Sciences and Food Engineering, Faculty of Agricultural Sciences, Food Industry and Environmental Protection, 550012, 7-9 Dr.Ion Rațiu Street, Romania*

Corresponding author: Coman, Diana, diana.coman@ulbsibiu.ro

Abstract: *The present study deals with the biomordant assisted application of natural extracts obtained from red raspberry (Rubus idaeus L.) fruits onto two different cellulosic supports – flax and bamboo. The study relies on the improvement of multifunctionalities such as colour fastness, washing and rubbing fastness, due to the synergism provided by the co-assistance of both a biomordant, and the complex resulted by inclusion of the pigment molecule, in the cavity of MCT-β-CD; it is well known that natural dye molecule have a good selectivity binding to the hydrophobic monochloro-triazynil-cyclodextrin's (MCT-β-CD) cavity to form inclusion complexes. An investigation system provided the characterization of the composites: FT-IR spectroscopy stressed the main chemical bonds created between MCT-β-CD as host molecule and guest molecule represented by natural colorant molecule; Brunauer-Emmett-Teller (BET) Surface Area Analysis completes the analysis, proving the positive contribution of MCT-β-cyclodextrin grafting. Dyeing fastness and colour modifications were conclusive for this research. Samples of bamboo knitting are less colorful than those of the flax fabric in terms of high absorption capacity and stability / durability of natural dye applied by inclusion within cyclodextrin's inner. The results of analysis revealed improvement of washing and rubbing fastness (1-1.5 points). Colour modifications noticed due to the colorant deposition were quantified from up to 3 points.*

Key words: *flax fabrics, bamboo knitted fabric, natural extract, fastness properties, colour difference*

1. INTRODUCTION

Starting from the idea of promoting eco-textiles' innovation and sustainability, new reliable solutions have been searched for textile industry, by using anthocianin extracts, having the main role in dyeing of textile supports. Unlike the production of synthetic dyes application which requires the use of toxic and hazardous materials as well as conditions like strong acids, alkalis, solvents, high temperatures, and heavy metal catalysts, natural dyes do not produce environmental stresses.

Flax fibers supports were dyed with natural anthocyanin-based pigments, being subsequently underlined the synergic effect given by the co-assistance of both a biomordant, and the complex resulted by inclusion of the pigment molecule, in the cavity of MCT-β-CD. Taking into account the previous studies having the same topic, it is assumed that the binding between anthocyanin molecules and host cyclodextrin is barely fixed, being a dynamic equilibrium. Two main elements could contribute to the binding resistance: the compatibility between the host-guest to form a complex, as well as the specific local interactions between surface atoms [1].

As an alternative of natural dyeing by inclusion, the occurence of a biomordant can constitute another reliable and eco-friendly way in the technology of dyeing of natural fibers supports.

Technically, the novelty of this study, compared with the results previously achieved is the addition of a new support made of bamboo fibers, on one side, and a new extract coming from red rasberries. It is well known that these fibers provide excellent performance to textile items, such as: antibacterial, antifungal, UV protection, IR absorbtion and good water absorbion properties [2,3].

These above-mentioned properties can be potentially completed by the natural pigment used for dyeing by enhancing the coloration [4]

Taking into account the the previous researches regarding the anthocyanin extracted from other fruits [5], this present paper refers to utilizing red raspberry extract, although it contains lower anthocyanin contents compared to other similar extracts from blueberry, bilberry, blackberry or red onion skins.

2. EXPERIMENTAL SECTION

Extraction of anthocyanins was done in 70% ethanol solution from selected samples of red raspberry (*Rubus idaeus* L.). The total anthocyanins content spectrophotometrically determined was found of 31.54 mg $100g^{-1}$ FW (fresh weight). Hydroethanolic anthocyanins extract from red raspberry has been used for the dyeing technologies here investigated.

The pretreatment was made by grafting procedure by padding *(impregnation-squeezing)-drying- curing,* according to the previous dyeing receipes with anthocyanin extracts from bilberry, blackberry or amarena cherry [5]. Both flax and bamboo fibers fabrics were immersed in a solution containing 50 g/l of monochlortriazinyl-β-cyclodextrin.

In this work, 100% flax fiber fabrics and 100% bamboo fiber knitting were dyed with raspberry extract by exhaustion procedure meaning an immersing of the textile supports in dye bath for about 60 minutes at 80°C at 1:30 liquor ratio with 1% solution of anthocianin dye and 1% citric acid (CA).

The descriptions of the studied samples can be specified: F-Reference flax fibres support; F-MCT-ß-CD- Grafted flax support with MCT-ß-CD; sample 1-Non-functionalized flax fiber support dyed by exhaustion procedure with 1% raspberry extract; sample 2- Non-functionalized flax fiber support dyed by exhaustion procedure with 1% raspberry extract and 1% citric acid; sample 3-Functionalized flax fiber support with MCT-β-CD dyed by exhaustion procedure with 1% raspberry extract; sample 4-bamboo knitting support dyed by exhaustion procedure with 1% raspberry extract; sample 5- Bamboo knitting support dyed by exhaustion procedure with 1% raspberry extract and 1% citric acid.

The structure and properties of the raspberry extracted anthocyanin dye-MCT-β-CD-flax and bamboo support composite were studied by nitrogen adsorption-desorption isotherms (BET analysis), FTIR spectroscopy and finally the colorfastness testing measurements completed this study.

For the colour measurement of dyed samples, Datacolor 110 Spectrophotometer, under standard D65/10^0 illumination conditions was used. Washing and rubbing strengths were performed according to specific standards, using Crockmaster 760 laboratory equipment.

3. RESULTS AND DISCUTIONS

In **Fig. 1**, the role played by the biomordant is well stressed by the spectrum ascribed to sample dyed with the assistance of citric acid solution. Thus, the stretching band at 1625 cm^{-1} attributed to the C=O in the dissociated carboxylic acid, makes the difference while compared with the non-dissociated species whose stretching occurred at 1730 cm^{-1} [6].

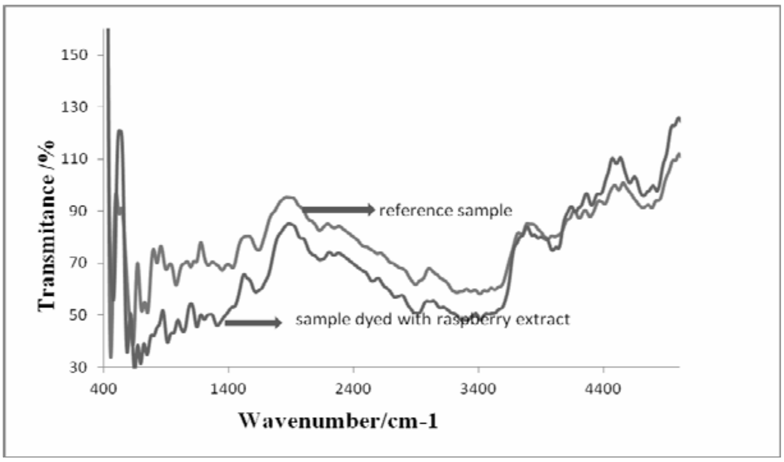


Fig. 1: *FT-IR spectra for flax fiber supports dyed with 1% raspberry natural extract.*

Nitrogen adsorption/desorption isotherms have been used to characterize the textural properties of the studied materials **Fig.2**.

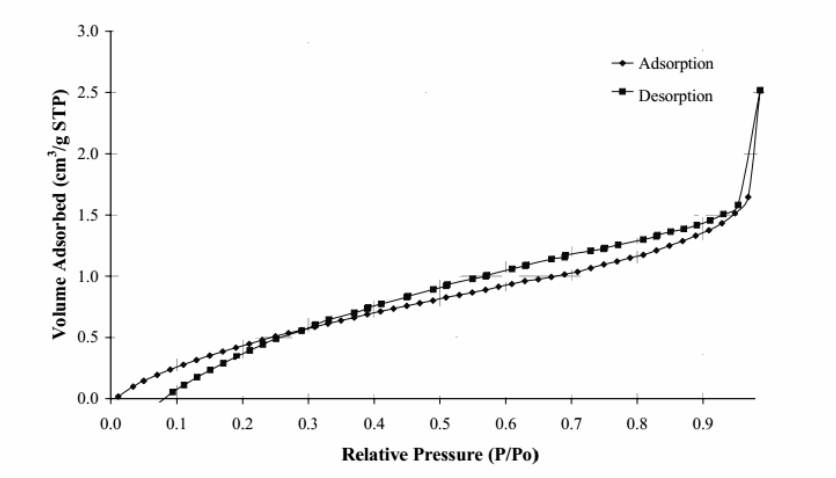


Fig. 2: *The nitrogen adsorption/desorption isotherms of the inclusion compound (MCT-β-cyclodextrin-as host and anthocyanins natural dye as guest molecule).*

BET method requires dehydrating the cellulose fibers at 120°C, under vacuum, having as consequences the elimination of intramolecular water molecules and collapsing of cellulose chains. This explains the small internal surface area of cellulosic fibres, completely inaccessible to the nitrogen molecules. As the result, the adsorption branch overlapses at least one point with the desorption branch. According to the BET isotherm and compared to the previous studies, the inclusion complex is not so well defined.

The colour differences between fruits, flowers and vegetables depend on the nature and concentration of the anthocyanins they contain. The colour changes in case of both flax samples dyed with the assistance of citric acid as biomordant, and for samples dyed by inclusion of the natural extract molecule within the hydrophobic cavity of MCT-β-cyclodextrin, revealed colour differences pretty high, as well as the colour darkening for some of the samples. ΔE* occurs within the acceptable range.

The colour measurements were made having as reference the non-grafted and dyed samples. In the same time, a comparison between flax fabric and bamboo knitting was necessary, in order to set-up the intensity of dyeing with natural pigment, in terms of fibrous composition of the support.

Table 1: *Colour measurements and colour fastness values for flax and bamboo samples dyed with raspberry (Rubus idaeus L) anthocyanin extract*

Textile sample	ΔL*	Δa*	Δb*	ΔC*	ΔH*	ΔE*	Washing fastness	Rubbing fastness
Reference flax sample, dyed Sample 1	- 0.220	- 0.316	- -0. 517	- 0.371	- -0.479	- 0.645	3	3
Flax sample, dyed with the assistance CA Sample 2	-1.250 -0.803	1.058 1.314	1.889 -1.587	0.967 1.138	1.937 -1.717	2.500 2.211	3-4	4
MCT-β-ciclodextrin grafted flax sample, dyed Sample 3	-3.128	1.477	2.317	2.413	1.313	4.163	4-5	5

Reference bamboo knitting, dyed Sample 4	-	-	-	-	-	-	3	3-4
Bamboo knitting sample, dyed with the assistance CA Sample 5	-0.226	0.060	2.958	0.200	2.952	2.967	4-5	5

Following the colour measurements, average colour changes were noticed:

- the sample dyed with mordant is darker and redder and little bluer compared to the sample dyed without the assistance of biomordant;
- the flax fabric is slightly less red and blue compared to bamboo knitting sample;
- the flax fabrics dyed in presence of the biomordant, are darker and redder and little yellower, than the knittings made of bamboo fibres;
- the samples grafted with MCT-β-cyclodextrin and then dyed have the highest colour intensity, as well as improved washing and rubbing strengths.

4. CONCLUSIONS

The results of the present study show the relevance of using the raspberry anthocyanis extract in the cyclodextrin pretreatment version but with the assistance of citric acid as biomordant. Inclusion of raspberry anthocyanins in the cyclodextrin compound was shown from the FTIR analysis, rather than BET analysis, proving the positive contribution of MCT-β-cyclodextrin grafting. The colour changes as well as the fastness are quantificable (2-3 points) for samples pretreated with cyclodextrin, and the bamboo knitting dyed in the presence of citric acid. It is imperative to continue such researches in this direction in order to demonstrate the potential positive impact for the strategy of textile eco-development and the economic benefit of using natural extracts dyes.

Acknowledgement: This work was supported by a grant of the Romanian National Authority for Scientific Research, CNCS – UEFISCDI, project number PN-II-ID-PCE-2011-3-0474.

REFERENCES

[1] A. Sopkova and P. Mezes, "*Combinations of Cyclodextrins with Synthetic and Natural Compounds*", Journal of Inclusion Phenomena and Macrocyclic Chemistry, vol. 33, pp. 109–120, 1999.

[2] S. Wannajun and P. Srihanam, "*Development of Thai Textiles products from bamboo fiber fabrics dyed with natural indigo*", Asian Journal of Textile, vol. 2(3), pp. 44–50, 2012.

[3] W.Yueping, W.Ge, C.Haitao, T. Genlin, L.Zheng, X. Q. Feng, Z. Xiangqi, H. Xiaojun and G. Xushan, "*Structure of bamboo fiber for textiles*", Textile Research Journal, vol 80(4), pp. 334–343, 2010.

[4] G. E. Donlin, "*True colors come through*", in Upholstery Design&Management, ProQuestControl, 2002, pp. 32.

[5] D. Coman, N. Vrînceanu, S. Oancea and M. Stoia, "*A novel approach regarding ecodyeing textile materials with natural extracts*", presented at the XXIII International IFATCC Congress (Congress of the International Federation of Associations of Textile Chemists and Colourists), Budapest, Hungary, 2013.

[6] G. Socrates, *Infrared and Raman Characteristic Group Frequencies*, Wiley, New York, 2001.

SEAMLESS TECHNOLOGY ON CIRCULAR KNITTING MACHINES

CRETU Viorica[1]

[1] *University "Gheorghe Asachi" of Iassy, Romania, Department of Knitting and Clothing Engineering, Faculty of Textiles, Leather and Industrial Management, Postal address1, D. Mangeron, 31, 700050, Iassy, Romania, E-Mail: vcretu@tex.tuiasi.ro*

Corresponding author: Cretu, Viorica, E-mail: vcretu@tex.tuiasi.ro

Abstract: *With industrial progress, the advancements in garment manufacturing have evolved from cut & sew to complete garment knitting, which produces one entire garment without sewing or linking process. Seamless knitting technology is similar to sock manufacture, the specialized circular knitting machines producing 3 dimensional garments with no side seams, with the waistband integrated with body of the garment and with knitted washing instructions and logos. The paper starts by presenting the main advantages of seamless garments but also some limitations because the technology. Because for a seamless garment, which is realised as a knitted tub, is very important to ensure the required final chest size, it was presented the main components involved: the knitting machine, the garment design and the yarns used. The knitting machines, beside the values of diameters and gauges with a great impact on the chest size, are characterised by a very innovative and complex construction. The design of a seamless garment is fundamental different compared to garments produced on a traditional way because the designer must to work backwards from a finished garment to create the knitting programme that will ultimately give the correct finished size. On the end of the paper it was presented some of the applications of the seamless products that cover intimate apparel and other bodywear, outwear, activewear and functional sportswear, upholstery, industrial, automotive and medical textiles.*

Key words: *seamless products, advantages, design, yarns, applications.*

1. INTRODUCTION

Seamless knitting is a relatively new technology, developed from technology used to make socks, when a body panel is ejected immediately after knitting. In traditional "cut make and trim" (CMT) [1] a circular knitting machine knits a continuous tube of fabric, which is subsequently dyed and then slit to make an open width fabric. This fabric is multi-layered on a cutting table and the pattern of the garment would be placed on top and cut around; the individual panels would be cut from the layered fabric. The garment is assembled from the cut pieces. As this type of garment is sewn together every join has a seam. The seamless technology can directly produce nearly finished products/garments, with no side seams, and lessens traditional process of the production. By eliminating the fabric cutting and sewing process, there is an optimisation of the production process, making seamless production a lot faster then conventional. So, this technology can reduce the traditional process of the production costs up to 40% compared to that of traditional knitting [2]. There is also a fewer product failures since most errors, since most of the garment failures are due to seam failure, which translated in better quality pieces.

2. SEAMLESS GARMENTS VERSUS CUT AND SEW GARMENTS

Seamless garments, compared with cut and sew garments, offer a large number of advantages, bur there are also some limitations because of the technology. As advantages [1], [2] there are:

- higher comfort and better fit to consumers by eliminating seams;
- soft handle;
- nearly invisible under clothing;
- no waistband or side seam failures;

- knitted-in crotch in panties giving additional comfort;
- stretch and recovery can be engineered to reduce chaffing;
- waistband is integral with body of the garment;
- washing instructions and logos can be knitted into the waistband (Fig.1), using polypropylene yarns, which give perfect wash fastness under any condition;

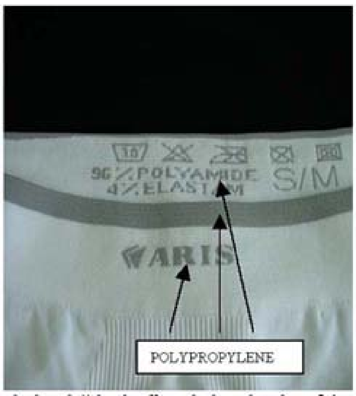


Fig. 1: *Waistband knitted together with logo and washing instructions, using polypropylene yarns*

- reducing on minimum the cutting and sewing processes result in a substantial saving in cost time, higher productivity, fewer machines required, and just-in-time production;
- comparing to traditional production methods, were the fabric is the starting point for most garments, fabric being dyeing, patterns cutting (Fig.2)[3], and then pieces sewing together, on seamless production result almost finished knitted products. The specialised circular knitting machine can makes the entire product in few minutes and save up to 40% of the original fabric that may go as waste or cut-loss in the conventional method;
- automatically knits components like waistband.

Fig. 2: *Conventional method – the patterns for the product are cut out from the fabric*

As limitations, because of the technology, there are:
- garments that can be made by cut and sew methods cannot always be translated exactly into a seamless garment. When designing a seamless garment it must to work backwards from a finished garment to create the knitting programme that will ultimately give the correct finished size. This is difficult because a seamless knitted garment changes size from the minute it is knitted and the degree of shrinkage has to be controlled at all stages.
- a seamless knitting machine produces garment blanks instead of rolls of fabric and corrections are almost impossible after knitting;
- any fabric defect results in garment rejection;
- seamless garments have poor counter appeal, resulting wrinkled when relaxed;
- garments look smaller than indicated size and that required a mannequin presentation in store;
- relaxed size variation is higher than at cut and sews garments.

3. SPECIFIC ELEMENTS REGARDING SEAMLESS TECHNOLOGY

Because the seamless garment is knitted in the form of a tube, first of all is important to ensure the required final chest size, in which are involved the knitting machine (a combination of machine gauge, machine diameter and knitted structures), the garment design and the yarns used.

3.1. Knitting machine

Circular knitting machines used for making seamless garments are based on programmed computer commands that allow a variety of different stitches, for example a jersey knit, a mesh knit, a rib knit or a jacquard knit can be placed side-by-side in a single garment and also can combine different textures and levels of compression.

The main characteristics of seamless circular knitting machines [4] are:

- the capability of individual needle selection, which is programmed electronically by the programmer;
- the knitting on three technical ways – by individual needle-by needle selection;
- stitch formation adjustment by using step-by-step motors, with the possibility of loop widening, tightening and shading on the same course;
- three transfer position from the dial to the cylinder;
- knitting mesh areas anywhere on the garment including diagonally aligned holes and extremely small mesh;
- they allow the production of different stitches such as rib, net, jacquard, piquet, stripes, lace etc., as well as pre-shaped structures such as hidden reinforcement, pockets, collars and hoods;
- knitting double face fabrics using two different yarns – polypropylene yarns on the inner layer, that ensures better protection and maintenance of natural body temperature, and long-staple cotton fabrics on the outside, that keeps the skin perfectly micro-climate controlled, releasing body moisture and keeping the skin dry.

As diameters, the generally aviable values are 12”,13”,14”, 15”, 16”, 17”, 18”, 19” and 20”, and as gauges, aviable are 16, 22, 24, 26, 28, and 32 npi., the most common being 28 gauge. Because machine diameters increase in 1 inch (2.54 cm) that generally increments the chest size, and many buyers require small, medium, large, extra large and sometimes extra extra large products, that imposed to the producer to own five different machine diameters.

3.2. Garment design

The way the seamless garment is designed and how the final size is obtained is fundamental different compared to garments produced on a traditional CMT route. The designer of a seamless garment must to work back from a finished product to arrive at a knitting specification, because an original undyed garment can have dimensions 10-35% larger than the finished garment [1]. The customer must offers a full detailed specification to minimize rework, because any minor change such as leg opening or side length can affect other dimensions and a new sample is required. More, errors to dimensions cannot be corrected at a later stage; therefore a great deal of attention must be given at programming stage to ensure the garment is correct. The cutting lines, which are knitted into the tube, must be modified each time a change of dimension is required by the customer.

A programmer is generally given a finished garment and from this has to predict the measurements at knitting that will give the finished dimensions. The beginnings steps are:

- analyse the yarn types used in the garment.
- check the g/m2 of the fabric.
- measure all relevant dimensions of sample supplied.

From this information the programmer will select an appropriate diameter of knitting machine, based on previous experience with this yarn combination, to give the required chest size. To verify this, a knitted tube in the correct knitting structure would be dyed and from the measurement information on garment shrinkage from knitting, autoclaving and dyeing would be able to predict the appropriate knitting machine diameter.

In the cost of seamless garments, a significant factor is the cutting waste. This waste is negligible compared with cut make and trim (CMT) garments, because in seamless knitting a body blank in the form of a tube is made to the required body width. Waste factors vary depending on the garment, that waste comprises knitting overheads plus full yarn cost. Typical waste values that can be expected are as follows: thong - 54%, panty - 25%, camisole - 9%, T-shirt - 5%. In Figure 3 the chevron line indicates the amount of waste generated in the camisole, the thong and bikini panties, the two last garments showing a pre-dyed cotton gusset knitted in. To reduce waste factors seamless machines are available to manufacture shaped garments utilizing a reciprocating cylinder.

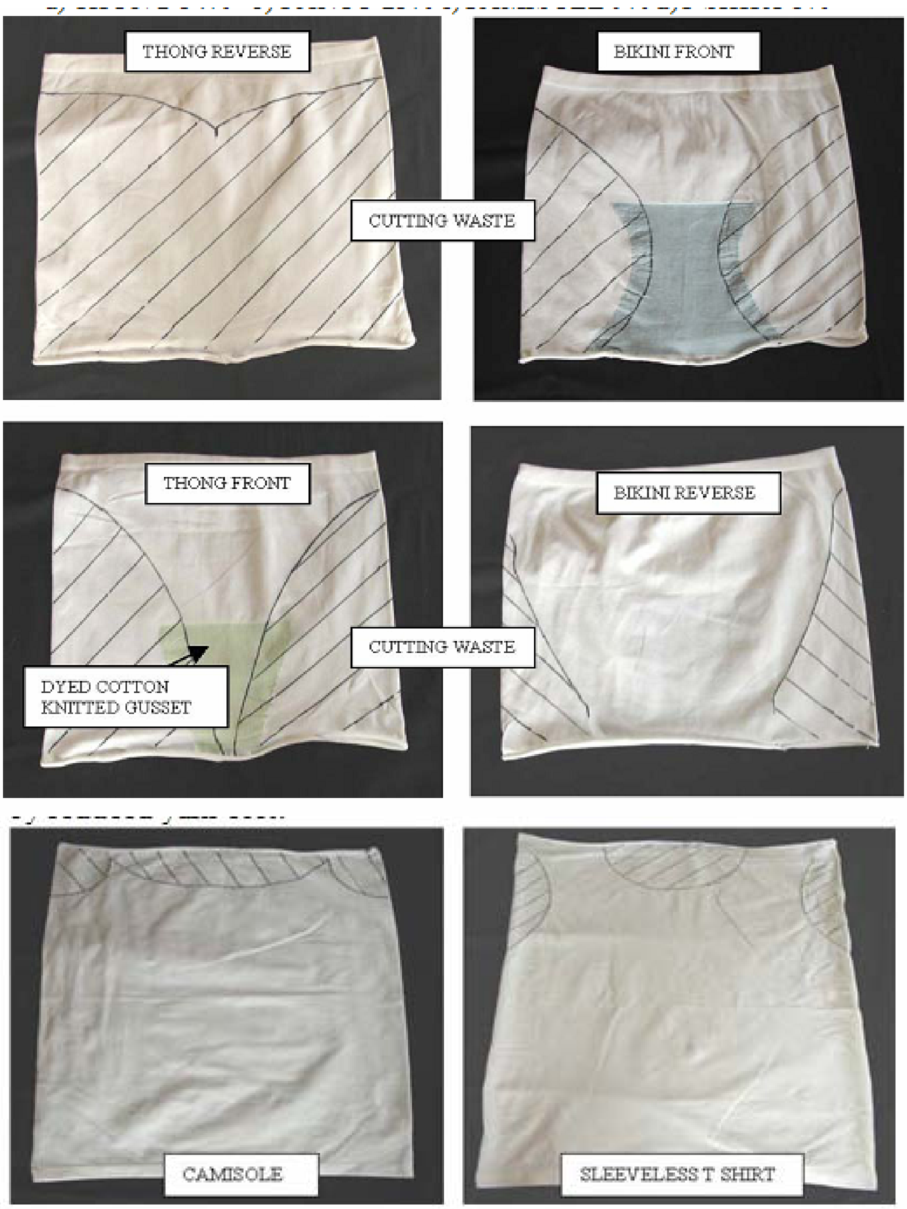


Fig. 3: *The amount of waste generated in the camisole, thong and bikini panties*

3.3. Yarns used in seamless garments

Usually, seamless garments used the plating technique, where two yarns are fed through a needle at the same time: a yarn appears on the side of the fabric in direct contact to the skin, and the other yarn appears on the external side of the fabric. Yarns choice is extremely important in seamless knitting.

The inside yarn. In addition to garment size (a lighter fabric using finer yarns requires an increased machine diameter for the same chest size) and weight per square metre, the fineness of the individual filament largely determines the handle or “feel” of the garment. There are a large variety of yarn counts available to the seamless knitter to give different fabric weights and handle. The diameter of the individual filaments of the yarn determines the handle (softness) of the fabric, most seamless garments being made from microfibres filaments, which gives a soft handle. There are a large variety of yarn counts available to the seamless knitter to give different fabric weights and handle. Special yarns such as cationic dyeable, deep dyeing or melange yarns enable a variety of colour effects during garment dyeing. A trend in developing seamless products is to use more natural fibres such as wool or well-being and comfort yarns such as Cupron and Cocona [4] which is derived from the byproducts of coconuts and is designed to improve wicking by expanding the fibres of the fabric over a large surface area, fibres that offer natural anti-bacterial and anti-odour capabilities, enhanced ventilation, natural UV and skin soothing properties.

The outside yarn is the bare spandex or covered yarns. Spandex or elastane is the key to the comfort and fit of seamless garments. Generally the spandex content of seamless knitted goods lies between 3-20% of the total fibre content. There is a direct relationship between the elastane component and the chest or waist size for a given diameter of knitting machine. A high power elastane will give a smaller chest size and shorter body length for the same number of courses knitted. The effect of using spandex is to "cram" the yarns in the knitted structure, making it tighter with an increased cover factor.

The stretch yarns available to the knitter are (Fig.4):

a) Bare spandex (elastane).

b) Air covered yarns.

c) Single or double covered yarns

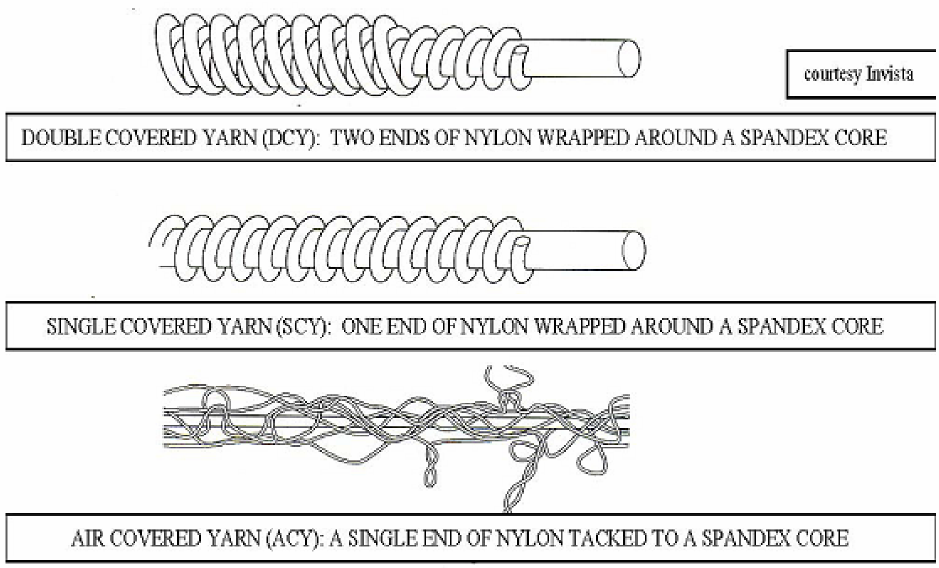


Fig. 4: *Covered yarns*

In one seamless garment can be combined different fibres with different benefits and performance aspects, giving mesh areas, opaque areas, creating ventilation areas, comfort zones and variegated compression in the same garment.

4. APPLICATIONS OF SEAMLESS PRODUCTS

The seamless technology is not only replacing traditional knitting but is also replacing anything stitched or with seams, and cover trends from the very chic, the technically-sporty and the casual, to the more practical and basic needs. Seamless products are being used for a variety of applications [5], [6] as they offer numerous benefits to the user.

Intimate apparel

Intimate apparel produced on seamless machines blend comfort, fit and versatility. They are seam-free, easy-care, silky-smooth garments that feel similar to one's second skin and are designed to be worn under today's fluid, lightweight apparel.

Protective textiles

On the market are available seamless filament-knit gloves and apparel. They are lightweight, flexible and comfortable for workers in the electronics, food-handling, paint, plastics and other high precision business sectors which require high levels of safety in addition to contaminant-free cleanliness.

Sports textiles

Seamless apparel construction focuses on:

- supporting muscles and areas where they need it the most;
- moisture management for evaporation of perspiration
- compression areas that offer both body support and better temperature management
- padding thicknesses for greater body protection while still maintaining the all important moisture and temperature management requirements
- venting to remove heat from specific areas

- thermal pockets strategically placed to trap body heat, again in specific areas
- an engineered fit and micro massaging features by blending of various technical fibres and yarns.

A diverse range of products such as gloves, hats, and socks are some of the more obvious applications. Swimwear also offers exceptional fit through the use of elastic and quick-drying yarns.

Sports bra features heart sensing technology

A new seamless heart-sensing controlling sports bra is offered on the market. It is designed to give greater support during high impact sports. Textile electrodes are knitted into the bra and stretch and move with the wearer, maintaining contact with the skin and sensing the heart's electrical pulses. Dr.Rita Paradiso, Ph.D., Research Director of Smartex, Italy, explains: "Conductivity is the main property being exploited and for our applications, knitted technology is the right one, because we need different domains within the fabric structure with different types of yarns. We have to decide in which places we need to put the conductive yarns and where background yarns are used, because the values of resistance change depending on their position. Of course, we need a garment which fits like a 'second skin' because the bio-electrode is in direct contact with the skin."[3]

Medical textiles

The onset of seamless technology in the medical arena has led to advantages for those times when the body needs it most. By example tubular dressing is a light-weight tubular bandage ideal for dressing retention and for covering the skin in any area of the body. It is manufactured from viscose with very fine elastane threads knitted into the fabric radially and longitudinally to provide a light elasticity. Because of this tubular construction, bandages are particularly suitable for holding dressings in place on difficult areas of the body. The tubular bandages hold dressings securely, without constriction or compression. The light elasticity promotes freedom of movement. An other example is the tubular rib fabrics of small diameters. Due to their compressive effect, they are commonly used to close and secure the sleeves of surgery uniforms, optimising their capacity to close and avoing the dispersion of micro-organisms arising from surgery. Wellness applications, massaging properties and shapewear that offers support pre/post surgery provide the ability for improved recovery. These types of engineered garments offer preventative measures to delay and/or avoid certain medical procedures.

5. CONCLUSIONS

The introduction of the Seamless product has revolutionized the global production process, allowing the knitting of ready-made apparel, very different from cut & sews classical process. The seamless concept spread all over the world with a surprising quickness because it allows to get to the finished garment in a few minutes starting from the yarn and without passing through cutting and sewing operations, it offers savings in terms of production times and cost, and it minimizes yarn consumption. Starting with intimate apparel and other bodywear, today seamless technology has emerged into areas such as fashion, outwear, activewear and functional sportswear, upholstery, industrial, automotive and medical textiles.

REFERENCES

[1] ********* "*Seamless knitting technology and the factors effecting final garment size*", Available http://www.santoni.com

[2] ********** *"Seamless Consortium handbook"*, Available: http://www.seamlessconsort.com

[3] P. Kanakaraj P. and R. R. Ramachadran, *"Seamless garment: Needle selection technique and applications"*, Available:http://www.knittingindusrtry.com

[4] ********** *"Santoni shows brand awareness"*, Knitting Trade Journal, issue 4, 2012, pp.34-35

[5] ********** "*Santoni seamless gets technical in Moscow",* Aviable: http://www.knittingindusrtry.com

[6] B. Hunter , *"Encouraging Success: Santoni Seamless in Sportwear – Casual & Athletic",* Available: http://www.knittingindusrtry.com

RESEARCHES REGARDING USE OF TEXTILE MATERIALS FOR THERMAL INSULATION AT NEGATIVE TEMPERATURES

IOSUB Andrei[1], AVRAM Dorin[2], VERDES Marina[1], HORGA Mihaela[2]

[1] *University of Iasi, Romania, Building Services, Faculty of Civil Engineering and Building Services, 700050, 123456 Iasi, Romania, E-Mail1: decanat@tex.tuiasi.ro*

[2] *University of Iasi, Romania, Industrial Engineering, Faculty of Textiles & Leather Engineering and Industrial Management, Postal address1, 123456 Iasi, Romania*

Corresponding author: Iosub Andrei, E-mail: iosubandrei84@yahoo.com

Abstract: *Using thermal insulation in negative temperature acts to reduce heat flow to the cooled space or to objects that have a temperature below ambient temperature. To achieve economic operation of the space to be cooled insulation thickness and quality is an important factor. In this article we want to compare three products used in thermal insulation at negative temperatures: expanded polystyrene, non-woven and wool coats. The materials will be tested with a mechanical vapor compression refrigerator capable of producing temperatures in the range +4 .. -35 ° C, managed by a programmer Dixel capable of recording values between +40. .. -60 °C. Refrigeration insulation enclosure was made with 100 mm expanded polystyrene. On one side of the enclosure will be a cut of 250 * 250 mm, chosen in a central position where the material will be introduced to be tested. The dimensions of the samples are 250 * 250 * 60 mm.*
To check the insulation properties of materials it will be used a temperature logger capable of recording with two probes temperatures between +125...-40° C. One of the probes will be inserted inside the refrigerator and the second probe will be positioned to the outside of the test material adhered to an aluminum plate, in order to read a average temperature. The difference in thickness of the insulation shall be filled with non-woven material. Hardening the assembly will be made using a 6 mm thick OSB board. The materials will be tested in an identical ambient temperature and humidity.

Key words: *refrigeration cycle, heat flux, air, vapor barrier, thermal conductivity coefficient*

1. INTRODUCTION

According with the the second principle of thermodynamics, heat pass by itself from the body with higher temperature towards the body with lower temperature. Thermal insulation is intended to minimize this process, as a result the insulation does not reduce the total passage but only decreases it.

In practice, two situations may occur:

- thermal insulation, where temperature of the thermodynamic system is higher than the outside ambient temperature, for thermal machinery and equipment;
- refrigeration insulation, where the temperature of the thermodynamic system is smaller than the outside ambient temperature, for refrigeration system; [1]

This paper treats the second situation, refrigeration insulation. The heat can propagate in three distinct ways: conduction, convection and radiation [2].

Heat transfer through insulating materials occurs by conduction, while losing or gaining heat from the environment to insulating material occurs by convection and radiation.

Insulating materials that have a low coefficient of thermal conductivity are those materials having in the composition a large proportion of small air gaps or a certain gas. These gaps must be small enough not to may occur convection and radiation and thus reduce heat transfer [3].

Insulating materials are divided into two categories:

- Natural, such as asbestos, mica, earth;

- Industrial, obtained from industrial processes such as glass wool, rock wool, polystyrene, polyurethane foam, cork tiles, wood fiber plates [4].

Some of the conditions that must fulfill insulating materials that are used in refrigeration technology are:

- Low thermal conductivity;
- Reduced hygroscopicity;
- Reduced vapor permeability;
- High resistance to frost;
- Have no smell;
- Have no nutritive value for insects and rodents;
- Mechanical resistance;
- Long life [5].

The most representative materials used in refrigeration technique are cork, polystyrene, polyurethane foam, R13. Refrigeration insulation also involves using other materials such as: support for attaching the insulation, vapor barrier foil, mechanical shock protection, paint applied with corrosion and aesthetic role.

Whatever the purpose of using cold insulation, a vapor barrier should be installed having the role to limit the entry of water vapor. The phenomenon of migration of water vapor from the environment occurs due to the temperature or humidity difference between the cold surface and environment temperature. Not to be confused condensation with water vapor in the air, there are materials that are water resistant, but not resistant in the passage of water vapor from air. All insulation materials used in refrigeration have some degree of penetration of the water vapor from air, if penetration it is not prevented then this vapors will enter the material, where they condense when dew point temperature is reached or will form ice crystals which will lead, in time, the destruction of insulation. Therefore, vapor barrier plays an important role in the cold insulations. It is applied on the warm side of the insulation and must have a great attention at installation, for not being damaged. For choosing the vapor barrier will keep in mind data provided by producer about permeability of the material used, fire resistance performance of vapor barrier not to affect the entire assembly of refrigeration insulation and a possible scenario for its replacement if it is damage. A possible deterioration of the vapor barrier will lead to poor performance of cold insulation or even the destruction over time.

Condensation can occur when warm insulation surface drops below the dew point temperature of the environment. Condensation on the warm side of the refrigeration insulation, which has installed vapor barrier, does not affect the quality of insulation, but is a phenomenon that should be avoided by a proper calculation of the thickness of the insulation. When sizing the thickness of insulating material must consider the relative humidity of the environment or its approximation as accurately as possible. For selection of insulating material must consider its destination, and it is recommended to consult even the producers [3].

2. GENERAL INFORMATION

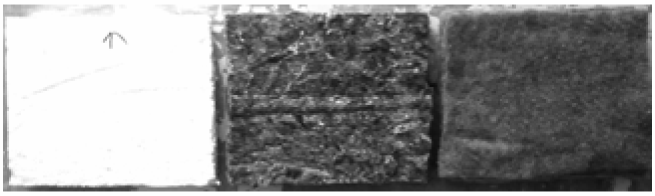
2.1 Experimental aspects

Testing of insulating materials used in this paper will be done with a mechanical vapor compression refrigerator, capable of producing temperatures in the range of +4 ..-35 °C.

This instalation is controlled by a Dixel programmer equipped with PTC 1000 probe, capable of recording temperature values between +40 .. -60 °C. Refrigeration insulation enclosure is made of 100 mm thick polystyrene.

Fig. 1: *Refrigerator used for experiments*

Materials used for experimentation are expanded polystyrene, non-woven material (made of recycling) and layers of wool (turcana).



a) b) c)

Fig. 2: *Insulating materials used in the experiments (a- polystyrene, b-nonwoven material, c-layers of wool)*

Apparent density for each material is 15 kg/m³ for expanded polystyrene, 68 kg/m³ for nonwoven and 33.5 kg/m³ for wool. Samples will measure 250 x 250 x 60 mm.

To conduct the experiments on a side wall, in the central area of the enclosure there is a cutout of the insulation refrigerator with the dimensions 250 * 250 mm.

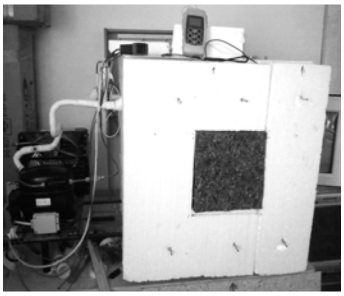
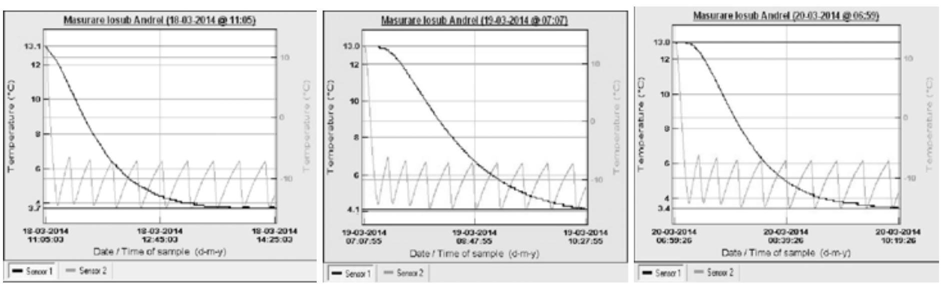


Fig. 3: *Refrigerator used for experiments (test wall)*

Samples of the materials will be inserted into the decoupage. Tracking the temperature fluctuation will be done using a temperature logger equipped with two temperature probes, capable of recording temperatures between +125..-40 °C. One of the probes will be inserted inside the refrigerator bonded to the interior wall, and the second probe will be positioned on the warm side of the insulation materials used in experiments. In order to read a average temperature, the second probe will be bonded to an aluminum plate with the size 150 * 150 mm. On the outside of the tested material will be applied a polyethylene vapor barrier.

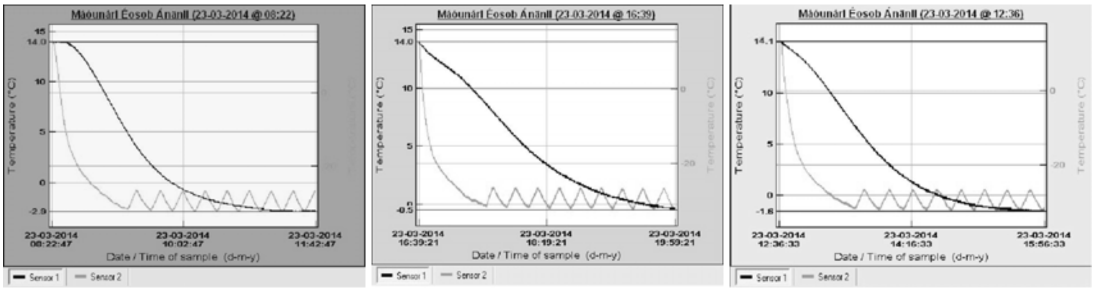
Filling up insulation enclosure to the thick of 100 mm, is made with layers of non-woven material. Hardening the ensemble will be made using a 6 mm thick OSB board, with a 6-bolt mounting system with butterfly nuts for a quickly assembly/disassembly. Experiments will be done at ambient temperature and humidity in order to not apear errors. Test temperatures are -10 and -30 °C, and the duration of the test will be 3 hours and 20 minutes, with recording of the temperature values at 6 sec.

After the tests where finished the data from the Logger was copied and processed by the Logger program in a graphical representation,



a) b) c)

Fig. 4: *Graphical representation of ThermaData Logger t = -10 ° C (a-polystyrene, b-nonwoven material, c-layers of wool)*



a) b) c)

Fig. 5: *Graphical representation of ThermaData Logger t = -30 ° C (a-polystyrene, b-nonwoven material, c-layers of wool)*

and centralized the important data from the graphical representation in Tab.1.

Tab. 1: *Insulating materials testing results*

Ambient temperature 13 ° C			Ambient temperature 14 ° C		
Test temperature -10 ° C			Test temperature -30 ° C		
expanded polystyrene	nonwoven	layers of wool	expanded polystyrene	nonwoven	layers of wool
3.7 °C	4.1°C	3.4°C	-2.9°C	-0.5°C	-1.6°C

3. CONCLUSIONS

According to Fourier, heat flux density is equal to the amount of heat transferred per unit time per unit area [6], resulting that the thermal conductivity is equal to the heat flux crossing unit area of a plate of uniform thickness, when the difference in temperature between the outer surfaces is equal to unit. Following the results obtained at the temperature of -10 °C Fig. 4, and -30 °C Fig. 5 it can be seen in the left values recorded by temperature sensor positioned outside the insulating material and in the right side it can be seen the values recorded by temperature sensor placed in the refrigerated enclosure. In the upper left it can be seen the common temperature that the two sensors start. This value represents the ambient temperature.

In the lower left and right it can be observed the values recorded at the end of the experiment. For the first experiment it can be observed that the recorded temperature of the sensor aplied to the outside of the insulating material of the nonwoven material and the expanded polystyren have a superior temperature than the material made from layers of wool, but in the second experiment the nonwoven material and the wool layers material have a superior temperature than the expanded polystyren meaning that at -10 °C the nonwoven material and the expanded polystyren are better thermo-insulating than the wool layers material and at -30 °C the nonwoven material and wool layers material are better thermo-insulating than the expanded polystyren.

REFERENCES

[1] Facultatea de Inginerie Mecanica si Mecatronica, **“***Indrumar de practica izolator termic si frigorific***”**, Universitatea Politehnica Bucuresti, [Online], pp. 2-9, Available: www.mecanica.pub.ro

[2] D. Stefanescu, **“***Transfer de caldura si masa. Teorie si aplicatii* **“** Ed. Didactica si Pedagogica, Bucuresti, 1983, pp. 6-26

[3] The thermal insulation association of southern Africa, “ *Thermal insulation handbook* “, [Online], pp. 1-30, Available: www.tiaza.org.za

[4] M. Marinescu, Al Chisacof, P. Răducanu, A. Motorga, "*Transfer de căldură şi masa-procese fundamentale*", Ed. POLITEHNICA PRESS, Bucureşti, 2009, pp. 2-40

[5] S. Porneala, M. Balan, **“***Utilizarea frigului artificial. Izolatii si transporturi frigorifice* **“,** Universitatea tehnica din Cluj Napoca, [Online], pp. 1-8, Available: www.termo.utcluj.ro/ufa

[6] V . Athanasovici, **“***Termoenergetică industrială şi termoficare***”,** Ed Tehnică, Bucureşti, 1981, pp. 15-45

INSURANCE OF KNITTED PRODUCTS QUALITY THROUGH THE ANALYSIS AND EVALUATION OF NON-QUALITY DURING ASSEMBLY BY STITCHING

LUTIC Liliana

"Gh. Asachi" Technical University, Iasi, Romania, Knitting and Ready - Made Clothing Department, Faculty of Textile Leather and Industrial Management, 29 Dimitrie Mangeron Street, 700050, Iasi Romania

Coresponding author: Lutic Liliana, E-mail: llutic@tex.tuiasi.ro

Abstract: *In a knitting factory, any acticity oriented toward evaluation, maintanence or improvement of products quality level is based on measuring and examining the product quality characteristics, in order to establish conformity to the quality specifications and/or naming the non-quality characteristics, thus noticing defects or fabrication deficiencies.*
The quality of the stitching operation has a particular influence on the finite product quality and is determined on side by the quality of knitted pieces, and on the other by insuring the correlation between the technological parameters of the stitching operation and the physico-mechanical characteristics of the knittings that are to be assembled through stitching.
Although the product execution processes comprise of manufacturing the elements and distinct subassemblies and their ulterior assembly, they present various difference dictated by the constructive particularities of the machine, as well as fabric characteristics.
Because of the multiple interactions between the material, yarn and working parts of the sawing machine, inadequacies in the technological discipline can result in negative effects on both the knitted and stitching thread as well as the machine. A part of these can be fixed by extra time consuming tasks (yarn breaks, stitching ruffling etc.), while other defects appear during the usage of the product cheapening it (stictch tearing by perforating the knitted on the stitching line, pilling effect, dimensional instability etc.).
This paper systematically presents, the main defects that may occur during the stitching operation of the products made out of circular knitted, as well as the causes that generate them along with preventive or corrective actions.

Key words: *qualiy, knitting, sewing, products, defects, insurance.*

1. INTRODUCTION

In a knitting factory quality insurance presents a management component as well as a technical one. The management component implies the construction of an evolved quality system and involvement of the whole personnel, while the technical componenets implies fitting of high technical level machines.

Along with all the other steps of the product fabrication process, confectioning is the phase in which textile fabric characteristics are improved and new product quality characteristics are obtained. As example:

- Esthetic of technological manufacturing;
- Aspect and behavior of the product;
- Novelty degree of the design;
- Correlation between life style and clothing;
- Dimensional correspondence;
- Dressing and undressing ease;
- Body covering degree;
- Fastening method.

2. GENERAL INFORMATION

Assembly operations, considering their prevalence, decisively influence the quality of the clothing products.

Although the product execution processes comprise of manufacturing the elements and distinct subassemblies and their ulterior assembly, they present various difference dictated by the constructive particularities of the machine, as well as fabric characteristics.

Because of the multiple interactions between the material, yarn and working parts of the sawing machine, inadequacies in the technological discipline can result in negative effects on both the knitted and stitching thread as well as the machine. Part of these defects can be fixed by extra time consuming tasks (yarn breaks, stitching ruffling etc.), while the other part appear during the usage of the product cheapening it (stictch tearing by perforating the knitted on the stitching line, pilling effect, dimensional instability etc.).

In order to prevent these deficiencies, a good understanding of knitted proprieties and behavior during the manufacturing process is needed, thus creating the premises of product quality supervision.

2.1 Agents that influence the quality of stitching assembly

During knitted stitching, the working regime and a series of functional and technological parameteres have to be directly correlated with the physico-mechanical characteristics of the knitted that is to be assembled.

The agents that influence the quality of the sawing operation through representative characteristics are presented in table 1:

Table 1: *Influencing factors for the quality of the sawing operation*

No.	Quality influence factors	Groups of representative quality characteristics
1.	Type and characteristics of the textile	- structural characteristics (density, thickness); - physico-mechanical characteristics; - manufacturing characteristics;
2.	Seam type and structure	- number of stitchng threads; - stitching direction; - stitching type (visible/hidden); - interwining of the threads;
3.	Working parts characteristics	- needle type and characteristics (shape, count and surface preparation) [1, 4]; - transporter type (shape, height, and preparation of transporter teeth; amplitude differences in the transporter plates) [2,3]; - pressing pin type (shape, surface preparation);
4.	Seam thread type and characteristics	- fibrous composition; - torsion value and direction; - count; - designation (closing, covering, overlock) - elasticity; - physico-mechanical characteristics;
5.	Technical documentation characteristics	- technical and technological files; - assortement card; - standard design; - fabric samples;
6.	Caracteristicile asamblării Assembly characteristics	- number of layers; - layer height (thickness); - stitching direction; - stitching width;
7.	Stitching technological paramenters	- yarn tension; - seam pitch; - stitching speed;
8.	Human factor	- objective characteristics (education level); - subjective characteristics (motivation, fatigue level);

Fabrics quality destined for textile products confection, can be expressed through their manufacturing and fashioning capacity (transfer from plane to spacial shape).

The main characteristics of the materials that influence quality are: thickness, elasticity degree, compaction degree, mass, dimensional stability, fibrous compositions, electrostatic charge.

Depending on these fabric characteristics their designation is chosen, machine type and technological parameter of the termic adhesion operation, stitching and finishing operations.

The choice of material in close connection with:

- ✓ product type (underclothes, exterior wear, night clothes, sports wear etc.);
- ✓ position of the product compared to the body (with support on the shoulders, with support on the waistline);
- ✓ place in case of multiple layers of clothing (base material, backing, lining etc.).

Not correlating the fabric characteristics with technological and functional stitching parameters, will lead to inconformities or defects in the stitched joints.

In table 2, a series of fabric characteristics that influence the esthetic of the stitching are presented, as well as concrete solutions.

Table 2: *Factors that influence the esthetic of the stitching*

Material characteristics	Fabric groups on which the influence is significant	Influenced quality indicator	Quality insurance method
Thickness	All textiles	Esthetic: - raise the seam - the uniformity of the seam	Adjusting the presser foot pressure Adjusting the hight of transporter teeth over the needle plate Adjusting the sewing tension
Density	Knitted or weave	Esthetic: - wrinkled seam - raise the seam	Correlating the needle count with the fabric structure Choosing the stitching type in correlation to the fabric structure
Elasticity	Knitted or fabrics made out of high elasticity threads	Esthetic: - wrinkled seam	Choosing a stitching thread with a similar fibrous composition to the knitted yarns Choosing the correct type of stitching
Friction coefficient	Silk-like knitted, knitted made out of synthetic yarns	Esthetic	Correct adjustement of the seam pitch Correct adjustement of the sewing tension Correct choice of the stitching thread Appropriate constructive design of the stencils
Electrostatic charge	Fabrics with high content of synthetic yarns	Esthetic: - uneven transport caused by fabric adherence to the working pieces of the sawing machine	Antistatic treatment of the material Air ionization in the production departement

3. DE-CA-RE FILE FOR THE SAWING OPERATION OF PRODUCTS MADE OUT OF CIRCULAR KNITTED

Studies and practical experience proved that from the standing point of their importance and frequency, defects that may occur during the sawing operation of the knitted are various. Some of them are presented in table 3, as De-Ca-Re files:

Table 3: *Correlation defect-causes-preventive actions or remedies*

Defects during the stiching process	Causes	Preventive actions or remedies
1. Perforation of the knitted on the seam line followed or not by stitch unwinding[1, 5]	**Yarn breaking in the stitch when pierced by the needle determined by:**	Utilising round headed needles, of corresponding count to the knitted
	-low sliding capacity of the stitch yarn, at the needle penetration moment	Respecting the environment conditions in the confection section (for a 65% air humidity, material humidity is approximately 7.2%)
	- utilising a wrong needle, as counting, form or surface state, with the knitted structure	Brushup of external needle surface Correct dimension of the needle plate eyelet (reccomended eyelet of about 1,6 -1,8 mm)
	- needle heating because the high stitching speed	Respecting the admitted stitching speed Cooling of the needle (needle treatment with lubricants)
2. Interrupted seam	**Breaking of the sewing thread and formation of breaked seam pitches because:**	Insuring the correct yarn- needle track
	- uncompliance to the yarn track	
	- non-correlation between sewing thread and stitching type with the knitted characteristics	Choosing the thread and stitching type in correlation with the knitted characteristics
	- surface wear of the yarn conductive organs	Polishing or replacement of worn out or flawed parts
	- melting or breaking of the stitching thread because of high temperature of the needle at high stitching speeds	Reduction of the stitching speed
	-inadequate adjustement of thread tension	Optimal adjustement of sewing tension
3. Inadequate look of the stitching and interweaving (relative displacement of the layers)	**Irregular feed of the material layers because of:** - amplitude differences in the motion of the plates with transporter teeth	Correct adjustement of the plates with transporter teeth
	-utilisation of the wrong presser foot	Using a Teflon or special presser foot
	- incorrect adjustement of the pressure exerted by the presser foot in correlation with the knitted characteristics	Correct pressure adjustement of the presser foot according to the knitted characteristics
	- elongation of the knitted material during stitching	
4. Incorrect interlacing of the threads (in a simple seam)	Inadequate tension of the yarn (tension too low)	Respecting the technological parameters of the sewing
	Out of sync movement of the stitching formation organs (needle, greifer, transpoter)	Correct movement adjustement of the stitching formation organs
5. Knitted wrinklin during sewing	Stitching yarn overly stressed Inadequacy of the seam pitch with the knitted characteristics	Respecting the technological parameters (yarn tension, and seam pitch in correlation with the knitted structure)
	Amplitude difference of the conveyor teeth plates	Correct adjustemenet of the conveyor
	Wearing of the conveyor	Replacement of the flawed sewing organs
6. Raising of the knitted stitch on the seam line	Using the incorrect count needles or inadequate to the knitted thickness	Insuring the correlation between the needle count and the knitted count
	Uneven needle suface or conveyor teeth surface	Smoothing of the external needle surface

Defects during the stiching process	Causes	Preventive actions or remedies
7. Melting of the yarns of the knitted on the seam line (in the case of syntethic fiber knittings)	Excessive heating of the needle because of the high stitching speed	Keeping the maximum admitted speed
8. Deflection from the stitching line	Techonological indiscipline	Respecting the technological discipline
9. Inclination of one the piece during stitching	Irregular stitching Wrong pairing of pieces (different characteristics and dimensions of pieces)	
10. Different nuance between the piece of the same product	Knitting defect on the surface of pieces of the product (stripes on stitches or rows, irregular density etc.) Dyeing or imprinting defects and wrong pairing of the pieces when forming packages (at the assortment of components after the sawing operation)	Caring out an adequate reception of the knitted, anterior to the sawing operation
11. Differences between the simetrical pieces of the same product (sides, sleeves, pockets, welts etc.)	Contraction of the pieces after sawing because of uneven tensing of the spread layers	Respecting the spreading and sawing conditions
	Technological indiscipline at sawing: - unemployment of sawing stencils and /or control stencils in the making	Keeping the technological discipline during product confection
12. Not keeping the simetrical gradient and shoulder length in the same product	Technological discipline Not keeping the technological indicators during the confection process	Keeping the technological indicators during the confection process
13. Pocket asimetry	Indisciplină tehnologică Technological indiscipline	
14. Stitching skew from the outline		
15. Pattern asimetry on the paired pieces (sides, pockets, flaps)	Sawing defect Technological indiscipline during making	
16. Buttonholes incorrectly done	Inadequate adjustement of the machine	Adjusting the mechanisms of the sawing machine
17. Incorrect placement of the buttons in comparison to the buttonholes	Technological indiscipline	Keeping the technological discipline
18. Inconcordance between Button dimensions and buttonholes lenghts		
19. Misplaced buttonholes compared to pieces sides and uneven spaces between them		
20. Oil smears and/or dirth	Incorrect maintanence of the sawing machines associated with technological indiscipline	

4. CONCLUSIONS

The quality of the stitching operation has a particular influence on the product and is determined by a multitude of factors, punctually presented in this paper.

Contructive particularities of the machines, technological parameters of the stitching operation, knitted characteristics, behavior during the processing, as well as the correlations between these factors are of crucial importance. Only knowing these can we prevent stitching deficiencies, creating at the same time the premise for supervising process quality.

This paper systematically presents the main shortcomings observed during the stitching operation of knitted products, the causes and their prevention method or their remedies.

REFERENCES

[1] L.Lutic, "*Contributions to the Design and Quality Evaluation of Weft Knitted Fabrics"*, Doctoral thesis, Iaşi, România, 2005.

[2] R.Nester, "*Vergleichende Untersuchungen der Fehlerberucksichtigungs – Verfahren in der textilen Konfection*", Textiltechnick, 1997, pag. 137 - 140.

[3] G.Y.Feltaous, T. Mourcy, "*Kotott kelmek varrhatosaga*" Textile Research Departement, National Research Centre, Cairo.

[4] A. V. Kukin, "*Textilnoe materialovenie*", Moscova, 1992, p.30 - 199.

[5] R. Oinuma, *"Comparison of end breakage rate due to splices and knots in plainweft knitting zone"*, Journal ot the Textile Machinery Society of Japan, v.37, nr.3, p.73

DYEING OF KNITTED MICRO-VISCOSE IN THE PRESENCE OF ULTRASOUND WITH DIFFERENT FREQUENCIES

MITIC Jelena[1], STOJANOVIC D. Nenad[1], SMELCEROVIC Miodrag[1], UROSEVIC Snezana[2], DJORDJEVIC Dragan[3]

[1] *Higher Textile School, Serbia, Textile department, Vilema Pusmana 17, 16000 Leskovac, Serbia, E-mail: msmelcerovic@yahoo.com*

[2] *University of Belgrade, Serbia, Technical Faculty, Bor, Serbia, Vojske Jugoslavije 12, 19210 Bor, Serbia, E-mail: surosevic@tf.bor.ac.rs*

[3] *University of Nis, Serbia, Textile department, Faculty of Technology, Bulevar oslobodjenja 124, 16000 Leskovac, Serbia, E-mail: drdrag64@yahoo.com*

Corresponding author: Djordjevic, Dragan, E-mail: drdrag64@yahoo.com

Abstract: *In dyeing process, the object is to transport or diffuse dyes and chemicals into the fibre. Various novel processes, including ultrasound, are being introduced and studied as more environmentally friendly alternatives. Encouraging results have been reported for the use of ultrasound energy in dyeing processes of micro-viscose. The recent studies revealed major ultrasound applications advances: savings of processing time, energy, chemicals, as well as environmental protection. Influence of various ultrasound frequencies (40, 200 and 400 kHz) on dyeing of micro-viscose knitted fabrics, by a reactive dye has been reported in this work. A method of reflection spectrophotometry has been employed to record reemission curves of the colored compounds. A software packet has been employed to calculate CIELab colored coordinates. Then, a comparison has been made with samples colored by conventional procedure according to CIELab76 and CMC (2:1) criteria. The use ultrasound in textile dyeing processing offers many potential advantages. The results prove better dye exhaustion by ultrasound and consequently the better fixing. The exhaustion for the bifunctional dye (containing two vinylsulphone groups) reaches 71.75 % without ultrasound, and 83.69 % with 400 kHz ultrasound. The 40 kHz, 150 W ultrasound causes a cavitation of higher intensity, compared to 200 and 400 kHz ultrasounds. In this particular case, destruction of cavitation bubbles is very intensive. That is why a large amount of cavitation energy is being transformed into a heat, yielding the additional bath heating. The ultrasounds with higher frequencies (200 and 400 kHz) cannot use such a strong power. The applied powering this case reaches 0.6 W. The cavitation bubbles are now smaller the cavitation disintegration is not so strong, and the energy loss is much smaller, i.e. a smaller amount of energy has been transformed into a heat. An ultrasound of an equal power, but of higher frequency contributes to the somewhat higher exhaustion and fixing. The ultrasound dyeing produces much obscured colours, compared the standard. The differences are evident and not negligible. The comparison of the samples treated ultrasound of different frequencies during dyeing revealed the higher coulours intensities with the increase of ultrasound frequencies of the equal power (200 and 400 kHz). However, the increase is not so expressed.*

Key words: *knitwear, dyeing, micro-viscose, ultrasound, CIELab.*

1. INTRODUCTION

Exhaustion dyeing of textiles proceeds through migration of dye molecules from the bath to the fiber surface, then a slower diffusion process takes place into the fiber. Ultrasound applied to dyeing processes enables dye dispersion breaking up the molecular aggregates and contributes to agitation enhancement of the bath with a consequent thickness reduction of liquid boundary layer surrounding the fibers. Sometimes ultrasound can induce fiber swelling which increases the dye diffusion rate inside the fiber. The fundamental benefit commonly ascribed to ultrasound is a mass transfer improvement, which can be otherwise achieved by higher temperatures, longer times and introduction of auxiliary chemicals [1-3].

The effect of ultrasonic energy on dyeing processes was already widely investigated on cotton, wool, silk, acrylic, nylon, polyester with good effects in all cases. In fact, it was observed that the action of ultrasound (600 W, 20 kHz) enables to increases dye diffusion coefficient of 30 % allowing a dyeing time reduction of 20 % at the same temperature. In the case of polyester dyeing with disperse dyes the ultrasound benefit is still more relevant due to advantages like ultrasonic waves helping in breaking up the dye aggregates, stabilizing the dispersion and accelerating the diffusion rate of the dye inside the fiber [4-10].

The presented papers point to the fact that ultrasound has a great potential for practical application, considering its contributions with enhanced productivity, easier processing control and reduced pollution of waste waters.

Taking into consideration that ultrasonic vibrations create compression and refraction in water, i.e. areas of high and low pressure, as a corollary of refraction there occur bubbles, which swell until, during the stage of compression, they abruptly disintegrate causing shock in the mass. This phenomenon of creation and disintegration of bubbles (known as cavitation) is generally responsible for most of the ultrasonic physical and chemical effects observed in solid-liquid and liquid-liquid systems. Thus, ultrasonic energy has been applied in textile industry, as well, for the most part in soaking processes, and textile washing and cleaning.

2. EXPERIMENTAL PART

2.1. Material

The basic characteristics of the used material have been presented on Table 1.

Table 1: *Basic characteristic of undyed fabric interlock 100 % micro viscose*

Machine - knitted Fabric Interlock	
Tt_{yarn}	20 tex
Tt_{fiber}	1,0 dtex
Mass of a square meter	205 gm^{-2}
Illuminant - Whiteness, Berger	83 %

The Drimarene Black R-3B (Clariant International Ltd., Switzerland) is used dye, and it belong to the group of diazo dyes. The gross formula of this dye is $C_{26}H_{21}N_5S_6O_{19}Na_4$, and its molecular mass 991.82 g/mol. The structural formula of this dye has been presented on Figure 1.

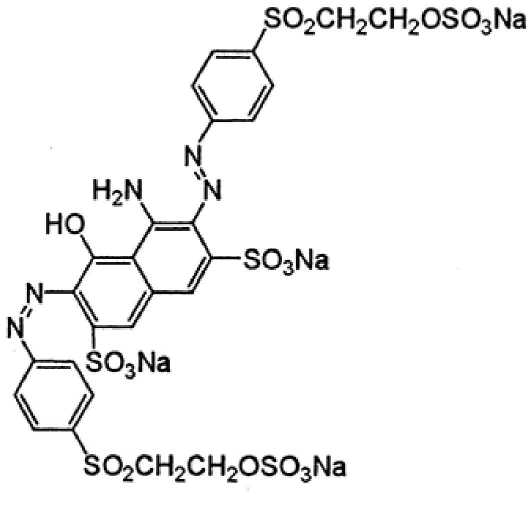


Fig. 1: *Structural formula of used dye*

2.2. Procedure

Dyeing was done in ultrasonic reactor on ultrasound frequencies of 200 and 400 kHz. The applied energy is 0.6 W. The ultrasonic reactor was made some parts like generator, transducer and reaction vessel.

It has been dyed by dye (c = 2.0 % o.w.t) without ultrasound action (conventional method) and under the effect of various frequencies of ultrasound, respectively:

I Conventional method (without ultrasound);

II With ultrasound λ = 40 kHz;

III With ultrasound λ = 200 kHz;

IV With ultrasound λ = 400 kHz;

In the experiment viscose microfibre knitwear has been dyed according to the on-line procedure, isothermally at 40°C, for the period of 100 min., at pH 10,4 (pH adjusted with Na_2CO_3) and with 60 g/L NaCl (dye and chemical were added on the very beginning of the process). Dyeing bath ratio is R=1:50. Mechanical mixing was applied during conventional (ultrasonic dyeing performed without mechanical mixing).

Washing of dyed samples was made at the end of treatment: warm rinsing, 15 min on 90°C with 2 g/L Hostapol CV, 10 min neutralization on 40°C (1.5 ml/L CH_3COOH 30 %) and cold rinsing.

2.3. Measurement methods

The color computer that measured the reflectance of the dyed fabrics was a HunterLab ColorQuest XE diffuse/80 with adequate software.

The measurement parameters are:
- Color calculation model: CIELab, CIE (2:1);
- Light source: Daylight D65;
- Standard observer: 10°;
- Number of measurement points of samples was 5;

Samples are, after dyeing but before washing (scouring) divided into two halves. One-half is washed and the other is dried without washing. Dyed samples are measured before and after washing on reflection spectrophotometer and then some parameters were calculated [11].

$$\%E = \frac{A_0 - A_T}{A_0} X100 \quad \textbf{(1)}$$

Where E, A_0 and A_r are, respectively, the bath exhaustion percentage, the absorbance of the bath before and after dyeing.

$$\%F = \frac{(K/S)_2}{(K/S)_1} X100 \quad \textbf{(2)}$$

$$\%T = \frac{\%F * \%E}{100} \quad \textbf{(3)}$$

Where *%F* is the percentage fixation of the dye, which exhausted, $(K/S)_1$ and $(K/S)_2$ represent the colour strength of the dyeing before and after stripping of any unfixed colour, *%T* is the overall percentage fixation.

3. RESULTS AND DISCUSION

Rate of exhaustion curves for dye on cellulose fabrics whew obtained by measuring the dye bath concentration at 10 min (Fig. 2). Intervals between 0 and 100 min during the dyeing process. The amount of dye in the residual bath was measured on Philips model PU UV/visible spectrophotometer at wavelength of absorption maximum (λ = 585 nm).

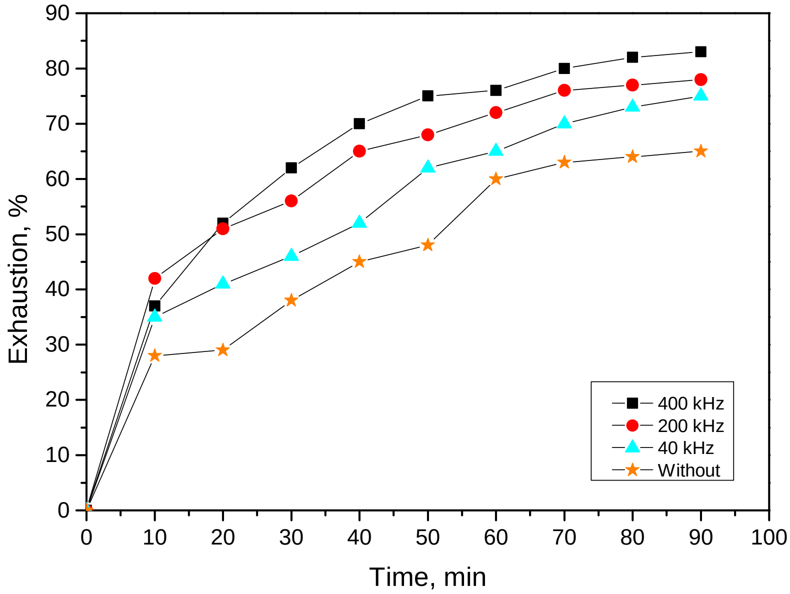


Fig. 2: *Exhaustion diagram for used dye*

Table 2: *Some results of performed measurements during dyeing*

Dyeing method	%E	%F	%T
without US	71.75	95.80	68.74
40 kHz	78.90	99.11	78.20
200 kHz	80.05	98.14	78.56
400 kHz	83.69	98.56	82.48

The use ultrasound in textile dyeing processing offers many potential advantages. Previous researching has shown that the use of ultrasonic provides saving of processing time, energy, chemicals and improvement of production quality. The results prove better dye exhaustion by ultrasound and consequently the better fixing (Fig. 3). The exhaustion for the bifunctional dye (containing two vinylsulphone groups) reaches 71.75 % without ultrasound, and 83.69 % with 400 kHz ultrasound. The 40 kHz, 150 W ultrasound causes a cavitation of higher intensity, compared to 200 and 400 kHz ultrasounds. In this particular case, destruction of cavitation bubbles is very intensive. That is why a large amount of cavitation energy is being transformed into a heat, yielding the additional bath heating. The ultrasounds with higher frequencies (200 and 400 kHz) cannot use such a strong power. The applied powering this case reaches 0.6 W. The cavitation bubbles are now smaller the cavitation disintegration is not so strong, and the energy loss is much smaller, i.e. a smaller amount of energy has been transformed into a heat. An ultrasound of an equal power, but of higher frequency contributes to the somewhat higher exhaustion and fixing.

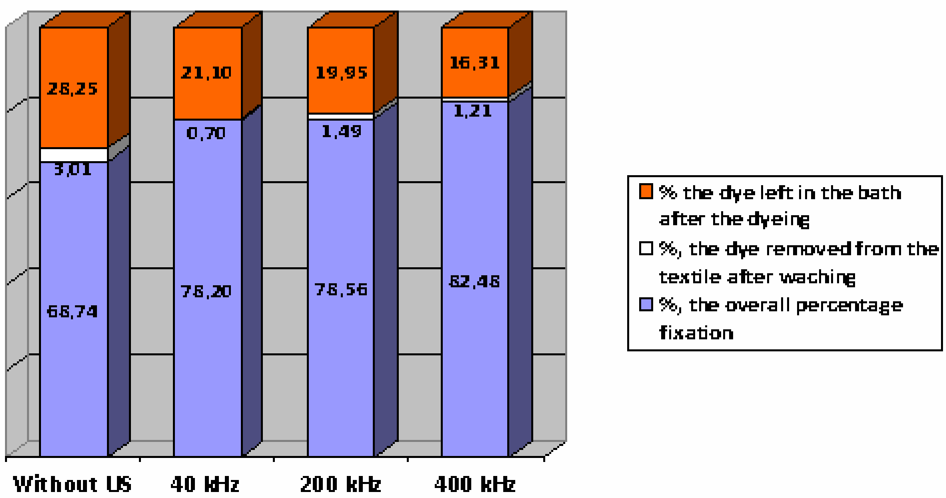


Fig. 3: *Histogram of the dye distribution between the textile substrate and the dyeing bath*

Based on the recorded reemission curves of dyed samples, computed spectral K/S values (Fig. 4) dye differences are defined according to CIELAB76 and CMC (2:1) criteria. Dyeing gained by a conventional method is used as a standard sample.

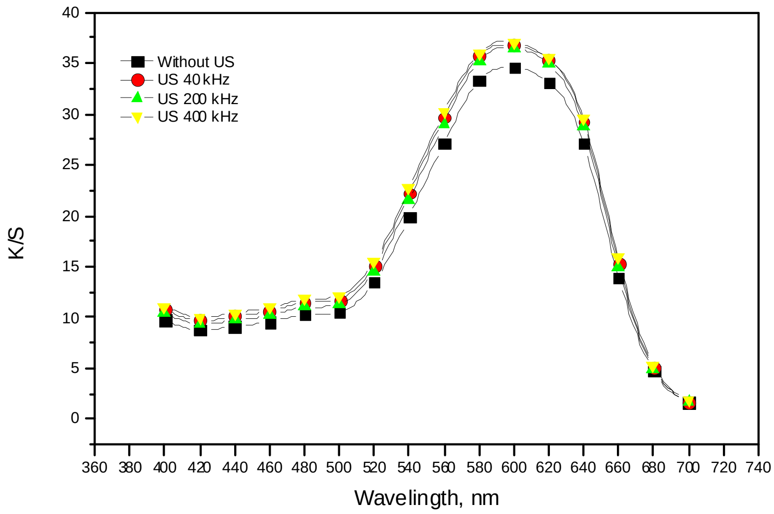


***Fig. 4:** K/S values for used dye*

The ultrasound dyeing produces much obscured colours, compared the standard, table 3. The differences are evident and not negligible. The comparison of the samples treated ultrasound of different frequencies during dyeing revealed the higher coulours intensities with the increase of ultrasound frequencies of the equal power (200 and 400 kHz). However, the increase is not so expressed.

***Table 3:** Colour differences of the dyed samples*
(Standard: without US, at D65 color coordinates: L=17.9; a=-3.5; b=-13.2)

COLOUR DIFFERENCES Illuminant D65 - 10°								
CELAB 76					CMC (2:1) pass<1.4<reject			
Batch	DE*	DL*	Da*	Db*	DE*	DL*	DC*	DH*
40 kHz	2.7	2.6 Darker	0.7	0.3	1.5	1.8 Darker	0.7 Weaker	0.3 Bluer
200 kHz	2.5	2.4 Darker	0.7	0.6	1.8	1.5 Darker	0.6 Weaker	0.3 Bluer
400 kHz	3.1	3.1 Darker	0.5	0.1	2.0	2.0 Darker	0.2 Weaker	0.4 Bluer

4. CONCLUSION

Ultrasonic dyeing of cellulosic fabric by means of reactive dyes has good prospects, taking into consideration the considerable dye saving for achieving a tint of equal depth in respect to conventional procedures. Moreover, it contributes largely of dye exhaustion from the tank, so that waste water pollution is considerably lower, which makes this procedure ecologically very significant.

The 40 kHz ultrasound contributes to the significant increase of the exhaustion degree as well as of the dye fixing. The increase of the ultrasound frequency accompanied the smaller power produces a higher intensity colouring (the higher depth) but overall the differences are negligible.

REFERENCES

[1] D. Sun, Q. Guo and X. Liu, (2010) Investigation into dyeing acceleration efficiency of ultrasound energy, Ultrasonics, 50, pp. 441–446.

[2] H. Wang, F. Zhaoa and J.X. Lin, (2010) Studies on the ultrasonic-assisted dyeing of poly(trimethylene terephthalate) fabric, Color. Technol., 126 pp. 243-248.

[3] V.S. Moholkar and M.M. Warmoeskerken, (2004) Investigations in mass transfer enhancement in textiles with ultrasound, Chem. Eng. Sci. 59, pp. 299–311.

[4] P.S. Vankar, R. Shanker and J. Srivastava, (2007) Ultrasonic dyeing of cotton fabric with aqueous extract of Eclipta alba, Dyes Pigm. 72, pp. 33–37.

[5] S.J. McNeil and R.A. McCall, (2011) Ultrasound for wool dyeing and finishing, Ultrason. Sonochem. 18, pp. 401–406.

[6] S.R. Shukla and M.R. Mathur, (1995) Low-temperature ultrasonic dyeing of silk, J. Soc. Dyers Colour. 111, pp. 342–345.

[7] M.M. Kamel, H.M. Helmy, H.M. Mashaly and H.H. Kafafy, (2010) Ultrasonic assisted dyeing: dyeing of acrylic fabrics C.I. Astrazon Basic Red 5BL 200%, Ultrason. Sonochem. 17, pp. 92–97.

[8] M.M. Kamel, R.M. El-Shishtawy, H.L. Hanna and N.S.E. Ahmed, (2003) Ultrasonic-assisted dyeing: I. Nylon dyeability with reactive dyes, Polym. Int. 52, pp. 373–380.

[9] A.N. Saligram, S.R. Shukla and M. Mathur, (1993) Dyeing of polyester fibres using ultrasound, J. Soc. Dyers Colour. 109, pp. 263–266.

[10] M. Vouters, P. Rumeau, P. Tierce and S. Costes, (2004) Ultrasounds: an industrial solution to optimise costs, environmental requests and quality for textile finishing, Ultrason. Sonochem. 11, pp. 33–38.

[11] A. Soleimani-Gorgani and J.A. Taylor, (2006) Dyeing of nylon with reactive dyes. Part 1. The effect of changes in dye structure on the dyeing of nylon with reactive dyes, Dyes and Pigments, 68, pp. 109-117.

NANOCOATING PROCESS FOR TEXTILES APPLICATIONS AND WOOD PROTECTION

NICULESCU Claudia[1], DUMITRESCU Iuliana[1], GHITULEASA Carmen[1], MOCIOIU Ana-Maria[1], POPESCU Alina[1], PITICESCU Roxana[2], PETRICEANU Mirela[2], BOGDANESCU Cristian[2], SOBETKII Arcadie[3]

[1] *National R&D Institute for Textiles and Leather, 16, Lucretiu Patrascanu, 030508 Bucharest, Romania; E-mail: certex@certex.ro*

[2] *INCDMNR-IMNR, 102, B-dul Biruintei, 077145 Pantelimon Ilfov Bucharest, Romania, E-mail: imnr@imnr.ro*

[3] *SC MGM STAR CONSTRUCT SRL, 7 Pincota, 022773 Bucharest, Romania, E-mail: office@mgmstar.ro*

Corresponding author: Niculescu Claudia, E-mail: claudia.niculescu@certex.ro

Abstract: *This paper presents the research results obtained in ERA NET MANUCOAT project, coordinated by INCDTP in collaboration with the following partners: INCDMNR-IMNR, SC MGM STAR CONSTRUCT SRL – Romania and IRIS-Spain.*
The objective of the research was to develop and obtain textile and wood surfaces with self-cleaning, photo catalytic, antibacterial and antifungal properties.
An innovative method of manufacturing nanoparticles by hydrothermal process in a single step without any further heat treatment and controlled stoichiometry, tested spray coating technology (sputtering) were developed. Full characterization of nanostructured powders in terms of chemical, physical, structural, thermal and technological characteristics was performed.The most important features to be considered in the treatment of wood by sputtering in order to deposit thin layers of TiO_2 NPs or TiO2/Ag as the humidity should be below 12% and the maximum roughness P150, depending on the species of wood.
Future works envisage optimizing the existing sputtering systems for pilot stage, in order to make nanoparticles deposits on large areas of textile and wood. The results of the research are photocatalytic textiles for surgical gowns, operative fields, hospital bed sheets and curtains and drapes for public spaces.

Key words: *TiO_2 nanoparticles, sputtering coating, photocatalytic textiles, antibacterial/antifungal, durable wood*

1. INTRODUCTION

In the global competition environment textile companies will always try to obtain a significant market share through product quality improvement and new technologies or products development. Also, consumers demand high performance textiles for both casual wear and for technical textiles.

Textiles with antimicrobial, antifungal efficacy and photocatalytic properties are required by fields such as medicine, defense, sports and leisure, for covers and draperies for public spaces and passenger compartments.

At its turn, wood is an excellent material for building, furniture, art objects but in natural state it is unfortunately not resistant to weather, insects and fire. Structures, surfaces and wood objects must be long lasting in order to be attractive to customers and to compete with other materials.

Photocatalytic activity, non-toxicity, high availability, biocompatibility, and low price make TiO2 nanoparticles particularly attractive for manufacturing textiles and wood products with high performances. When nano TiO_2 are irradiated with light of higher energy than its band gap, electrons and holes pairs are generated on its surface. Holes produced during an oxidative reaction can react with water and generate hydroxyl radicals and electrons. Anions of superoxide radical are created during reduction with oxygen. Active oxygen species and hydroxyl radicals can oxidize organic compounds to carbon dioxide and water as shown in the following reaction [1].

$$C_nO_mH_{(2n-2m+2)} + \bullet OH + O^{-}_2 \rightarrow nCO_2 + (n-m+1)H_2O \quad \textbf{(1)}$$

Different methods for fabric treatment with nanoparticles are known and were studied: padding, ultrasonic treatment, plasma and electro-spray and sputtering.

This paper presents the lab experiments of TiO_2 nanoparticles deposition on textiles and wood by physical methods, sputtering.

2. EXPERIMENTAL PART

2.1. Technology for obtaining TiO_2 nanoparticles

The characteristics of TiO_2 nanoparticles depend mainly on the method applied for their synthesis. The size, shape, crystalline structure and specific surface determine the electrical, chemical, optical properties and the photocatalytic activity of TiO_2 nanoparticles.

The innovative technology for obtaining nanostructured powders of TiO_2 and TiO_2 doped with Ag was developed by IMNR at laboratory level. Hydrothermal synthesis in one step, at high pressures (1000-3000 atm) and low temperatures starting from soluble inorganic salts of titanium and silver, is used to prepare silver doped nanostructured anatase. Hydrothermal process approach represents an alternative to the sol-gel, ball milling or spray pyrolysis processes used to prepare doped TiO_2. Hydrothermal synthesis presents some advantages, namely: it is an environmentally friendly procedure, it enables the formation of nanostructured anatase phase (>95%) and the dopant level can be controlled [2] [3].

The nanostructured powders were characterised in terms of chemical, physical, structural, thermal characteristics and photo catalytic properties, toxicity and antibacterial properties.

2.2 Textile substrates

The selection of textile substrates takes into account the following requirements: breaking and tear strength, elongation, abrasion resistance, thermal resistance, surface and volume resistivity, air permeability, water-vapour resistance, water permeability, the user and last but not least the cost. The textile materials were selected for areas of application where the functional effects, photo catalytic, antibacterial and antifungal properties are the most requested: hospitals, public spaces, clothes, home interior. We analysed nine textile substrates with different fibre compositions in terms of the characteristics mentioned above. The selected textiles were: Rafia-fabric from textured yarns, 100% polyester with crepe weave, for covers and curtains used in public spaces; Mihaela-fabric from shiny three lobe yarns and microfilaments yarns, 100% polyester with satin weave, for surgical gowns and drapes; Ivona-fabric made of 100% cotton, with combined pattern weave (vertical stripes), for hospital and home bed linen; Fabric code 154-5069 made of 55% polyester + 45% wool, for women dress. The selected textiles were used as substrates for the deposition of nanostructured layers which give them photocatalytic, antimicrobial and antifungal properties [4].

2.3 Wood substrates

For the selection of the wood substrates to be used during the project, the partners had intense discussions to ensure the compatibility of the substrates with the different set-ups of the project and their industrial relevance. Three wood types were selected to be analysed in the project: oak, beech and cherry. The oak was chosen for its intensive use for interior works and furniture. High density and high tannin content give this wood resistance against fungi, but its aspect is strongly affected by UV radiation and aging. TiO_2 nanoparticles surface treatment removes these disadvantages. Beech is one of the most common species of deciduous wood for interior applications. Its low porosity prevents protective treatment by impregnation, making it difficult to use for outdoor applications. Surface activation and treatment with TiO_2 nanoparticles provide the opportunity for its use in outdoor applications. Cherry wood was selected for its use in the manufacturing of art objects.

The most important characteristics to be considered in the treatment of wood by plasma or sputtering in order to deposit thin layers of TiO_2 or TiO_2/Ag nanoparticles are:

- Humidity, must be below 12%; first tests will be done with samples with humidity between 10-15% (depending on species);
- Roughness depends on wood species, ideally P150 grit ISO / FEPA.

Rugosity and humidity are the only parameters usually provided by wood manufacturers.

2.4. Sputtering technology

Experimental deposition of nanostructured thin layers was performed by sputtering [5] [6]. Sputtering technology is a physical method deposition which involves removing the source material deposition at a temperature much lower than evaporation. The experiments for the deposition of TiO_2

and Ag/TiO_2 nanoparticles on small size substrates of textiles and wood were performed on VU-2 M vacuum equipment. Basically, the method involves placing the substrate and material deposition in a vacuum chamber in the presence of an inert gas. TiO_2 and TiO_2/Ag nanoparticles powders was pressed into 2 g pills. Then it was sintered in high vacuum equipment VU-2M, equipped with 2 inch sputtering, e-gun and resistive sources, glow discharge plasma cleaning system, carousel and thickness monitoring. Sintering was tested by electron beam heating and resistive method. It was concluded that resistive method is preferable because the electron beam pulverizes the material. The equipment has rotation and monitoring system of deposition rate and thickness control. Before the deposition process, textile and wood substrates were treated in Argon-Oxygen plasma to purify the surface. Sputtering deposition system performs simultaneously two functions: surface activation and deposition of TiO_2 nanoparticles or TiO_2/Ag. The deposition rate and thickness was monitored by Inficon XTC quartz controller with parameters set for TiO_2 (density of 4.26 g / cc and Z-ratio of 0.4). The sputtering deposition cannot be included in the continuous wood and textile production process, being used in a discontinuous –offline process (in comparison with the plasma treatment method that can be used in a continuous – online process).The sputtering experimental works were performed at laboratory scale on small textile and wood areas. Textile substrates have been covered with 5 and 10 nm TiO_2 and with 5 and 10 nm Ag/TiO_2 by RF sputtering.

3. RESULTS AND DISCUSSIONS

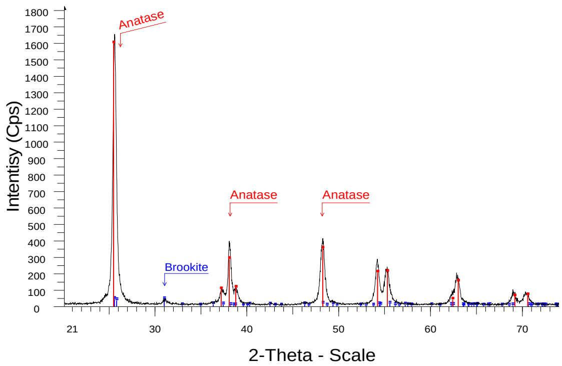
3.1. Technical characteristics of nanoparticles obtained by hydrothermal technology

Chemical components of NPs obtained at lab scale are presented in table 1:

***Table 1**: Chemical components of NPs*

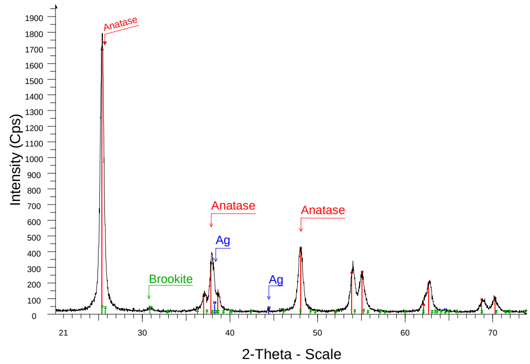
Sample code	Components %	
	Ti	Ag
MCTi	59.5	-
MCTiAg	58.4	0.52

XRD spectrum for lab nanoparticle samples is presented in figures 1 and 2.



Compound Name	Formula	S-Q(%)
Anatase	TiO_2	98.3
Brookite	TiO_2	1.7
Silver	Ag	0.0

***Fig.1**: XRD spectrum for MCTi samples.*



Compound Name	Formula	S-Q(%)
Anatase	TiO_2	93.5
Brookite	TiO_2	6.0
Silver	Ag	0.5

***Fig.2**: XRD spectrum for MCTiAg* samples

The best photocatalytic activity (100%) of the MCTiAg sample was measured at 75 min. For the MCTi sample the best photocatalytic activity (97.071%) was measured at 150 min.

3.2. Characteristics of textiles and wood samples nanocoating by sputtering

The textile and wood samples coated with TiO_2 and TiO_2 /Ag were analysed in terms of morphology and elemental composition of the deposited layers and the functional effects namely: hydrophobicity / hydrophilicity, photocatalytic effect, surface and volume electric resistant, antibacterial and antifungal effect.

3.2.1 The morphology of the textile materials and structure of the deposited layers have been analysed by scanning electron microscopy, (Quanta 200, FEI, Netherlands), figure 3.

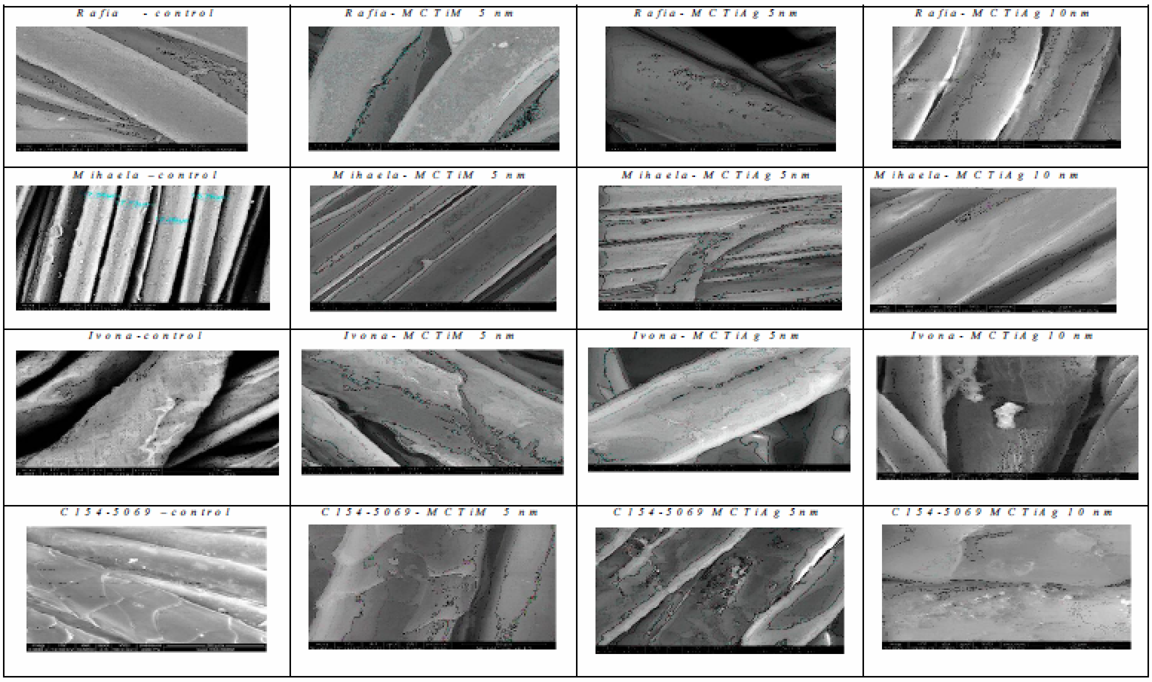


Fig.3: *The morphology of the textile materials and structure of the deposited layers*

The sputtering coatings of Rafia do not significantly modify the surface characteristics of the PET fibres. In the case of Mihaela only a few nanoparticles are seen on the fibres covered with 5nm TiO_2 layer (MCTi) while the fibre coated with a thicker layer (10nm) is very smooth and uniform. The difference could come from the smoother, finer fibres (76.3 den, 108 µm diameter) used in the warp of Mihaela sample compared to Rafia sample (168.4den, 179 µm diameter). In the case of Ivona sample with 10nm sputtering, the layers seem more uniform, covering the fibres better. After the deposition of TiO_2 and Ag/TiO_2, on code 154-5069 fabric, both the polyester and wool fibres composing the sample are covered with a thin layer of metal oxide, creating a smoother surface.

3.2.2 The identification of the metals deposited on samples

The EDX unit connected to the SEM microscope was used to determine the chemical contents of elements presented in the surface of coated fabrics.

EDX spectra for Rafia indicate the presence of TiO_2 and Ag/TiO_2 on the material. The dominant elements are carbon attributed to polyester fibres and oxygen attributed to polyester fibres and titanium oxide. The sample presents a higher Ag/Ti ratio for coatings with 10nm (Ag/TiO_2 = 0.21) than for those with 5nm (Ag/TiO_2 = 0.3). This behaviour is largely due to hydrophobicity and polyester fibres structure which allow uniform deposition of oxide films. For coated Mihaela material, the ratio Ag/Ti is 0.27 for 5 nm coatings and it increases to 0.42 for deposits thicker than 10nm. For the Ivona sample covered with 10nm Ag/TiO_2 spectra were performed for particles present on the surface of the material. Due to the presence of other elements and especially of large amounts of carbon and oxygen from the substrate, practically Ag/Ti ratio has relatively high error margins. EDX spectra for fabric code 154-5069 confirm the deposition of TiO_2 and Ag/TiO_2. The amount of silver and titanium increases as the layer thickness grows.

3.2.3 Hydrophobicity/hydrophilicity of the nanocoated samples are analysed by measuring their contact angle, using the VCA Optima equipment and distilled water as test liquid.

The materials' wetting capacity modifications induced by sputtering show the results:

- Rafia sample is initially hydrophilic, due to fibres type and to large interspaces between yarns and after sputtering nanocoating it becomes hydrophobic (about 124^0).
- Mihaela sample is initially hydrophobic (88^0) and after sputtering nanocoating it becomes hydrophilic due to polar groups: =C=O, -O-C= O, -COH, -COOH, -CH2OH and better adherence of TiO_2.
- Ivona sample is strongly hydrophilic (0^0), both initially and after deposition, the water drops being instantaneously absorbed by the materials.
- Fabric Code 154-5069 is initially and after deposition highly hydrophobic (about 130^0).

3.2.4 Evaluation of the photocatalytic activity

Evaluation of photocatalytic effect was performed by two methods:

- Photodegradation of methyl orange solution with different concentrations (0.01, 0.005, 0.002 g /L) and exposure to UV radiation under stirring (λ = 254nm and 365nm);
- Measurement of the colorimetric coordinates of the initial samples and of the stained samples after exposure to artificial light. The samples coated with 5nm layer of TiO_2 and Ag/TiO_2 were spotted with 3 drops of 0.02g/L Methylene Blue(MB), 0.02g/L Methyl Orange(MO), coffee (C). The spotted samples have been exposed to artificial light according to standard ISO 105- B02:2013 in Apollo light fastness tester provided with Xenon lamp, simulating sunlight, wavelength: 300-700nm, the lamp irradiation: 42W/m^2, humidity 45%, light exposure temperature:50^{0}C. UV-VIS spectra of solution 0.002g/L MO + Ivona coated with 5nm MCTiAg and 10nm MCTiAg exposed to UV radiation (365nm) are presented in figure 4 a) and 4b).

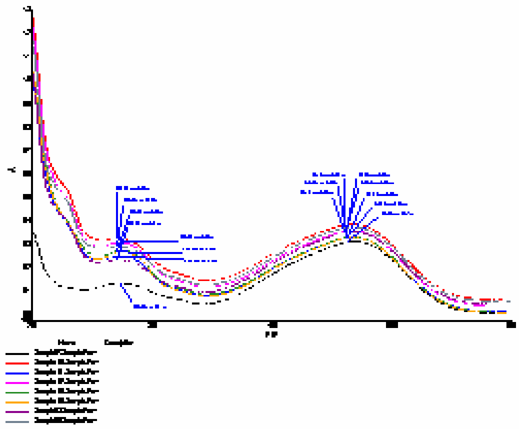


Fig.4 a): *UV-VIS spectra of solution*0.002g/L *MO + Ivona coated with 5nm MCTiAg*

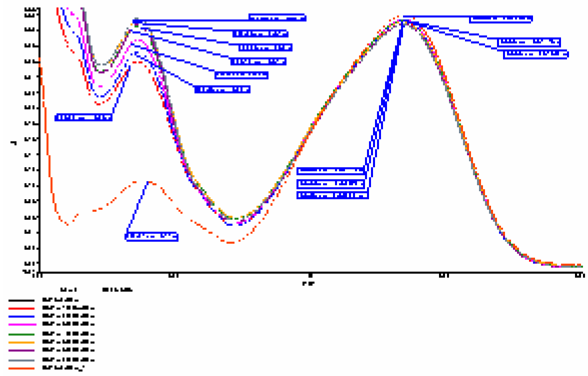


Fig.4 b): *UV-VIS spectra of solution*0.002g/L *MO + Ivona coated with 10nm MCTiAg*

Photodegradation efficiency after 4 hours is 15.38% for 5nm MCTiAg and 4.06% for 10 nm MCTiAg.

The second method for the evaluation of colours of stained samples after exposure to artificial light uses the spectrophotometer Hunterlab with 0/45 degrees geometry. Spotless original material was the reference.

Table 2: *Colour difference for stained samples after exposure to light*

Sample/Stained with	Initial				MCTiAg 5 nm			
	dL*	da*	db*	dE*	dL*	da*	db*	dE*
Rafia/ C	1.4	-0.43	0.67	1.61	1.36	0.77	1.14	1.93
Rafia/ MO	3.54	-0.65	-0.18	3.61	4.19	-0.62	-2.04	4.7
Rafia/ AM	2.39	-0.5	-0.02	2.44	2.53	-0.24	-1.41	2.91
Mihaela/C	-4.45	-1.84	16.37	17.07	-2.38	-2.94	13.67	14.18
Mihaela/MO	-0.69	-2.06	7.1	7.42	-1.31	-2.85	10.23	10.7
Mihaela/AM	-1.1	-1.89	5.79	6.19	-1.09	-2.79	8.87	9.36
Ivona/C	-9.5	-0.96	25.99	27.69	-9.47	-1.62	28.18	29.77
Ivona/MO	-2.6	-2.22	19.06	19.36	-2.83	-2.33	18.73	19.08
Ivona/AM	-10.38	-4.94	8.26	14.15	-7.22	-4	10.35	13.24
Code 145-5069/ C	1	-1.59	-2.09	2.81	0.95	-1.29	-2.08	2.63
Code 145-5069/ MO	1.09	-1.4	-2.64	3.18	2.82	-4.61	-5.38	7.63
Code 145-5069/ AM	1.08	-1.63	-2.58	3.23	1.58	-3.84	-4.4	6.05

Total colour difference (DE *) is almost double for all treated stained materials compared with the original material stained and exposed for 67 hours to artificial light, except for the sample code 154-5069.

3.2.3. Antibacterial and antifungal effect

Antibacterial effect was tested at E.Coli and E. Aureus in conformity with SR EN ISO 20645:2005 and antifungal effect was tested at Candida albicans and Trichophyton interdigitale in conformity with ASTM E2149-01 and ISO 20743:2007. The samples tested were Mihaela and Ivona for medical sector.Mihaela sample treated with MTTiAg 5 nm and 10nm presented a satisfactory antibacterial effect. Ivona sample treated with MTTiAg 5 nm presents antibacterial efficiency at limit.

Textile samples treated with Ag/TiO2 presented excellent results when tested against Candida albicans. All treated samples have a 100% reduction of microbial population, when compared to untreated control samples. The reduction rates were lowered on the same textile tested against strain of Trichophyton interdigitale, ranging from 47%, lowest reduction;

Materials treated only with TiO_2 didn't exhibit significant reduction in microbial population, compared to untreated control samples.

3.3. Characteristics of the wood samples' nanocoating by sputtering

Changes induced by nanocoating of wood samples were determined by measuring the contact angles using the same method and the same equipment as for textiles.

After nanocoating with TiO_2 by sputtering, 5 nm and 10 nm all 3 types of wood presented the contact angle higher by about 16^0 than initial samples.

After nanocoating with TiO_2/Ag, 5 nm and 10 nm all 3 types of wood presented the contact angle higher by about 30^0 than initial samples.

4. CONCLUSIONS

- All natural and synthetic fibres can be treated with TiO_2 or TiO_2/Ag nanoparticles by sputtering with technology conditions appropriate for each type of material;

-Powder TiO_2/Ag nanoparticle samples containing anatase phase in 93%;

- Powders componence is as follows: 59.5% titanium in TiO_2 and 58.4: titanium 0.52% silver for TiO_2/Ag ;

- The sample of MCTiAg presented the highest photocatalytic activity (100%) and was measured at 75 min;

- Sputtering deposition method has the advantage of two functions simultaneously, activation of the substrate surface in plasma and deposition of nanoparticles;

- Photocatalitic efficiency for 100% cotton sample after 4 hours is 15.38% for 5nm MCTiAg and 4.06%. for 10 nm MCTiAg;

- Textile samples treated with Ag/TiO_2 presented excellent results when tested against Candida albicans (100% reduction of microbial population) and 47% against Trichophyton interdigitale;

- Sample made of 100% cotton treated with Ag/TiO_2 5 nm and 10nm presented a satisfactory antibacterial effect and sample 100% polyester treated with MTTiAg 5 nm presents antibacterial efficiency at limit.

The results of technical characteristics of nanopowders and nanocoated textiles and wood will allow optimisation of the TiO_2 and Ag/TiO_2 synthesis at pilot scale.

The results of samples' characteristics obtained by lab scale sputtering technology provide important information for the optimization of the existing sputtering systems at MGM STAR CONSTRUCT for pilot stage.

REFERENCES

[1] M. Montazer, S. Morshedi, "*Nano photo scouring and nano photo bleaching of raw cellulosic fabric using nano TiO_2*", 2012 ELSEVIER, [Online]. Available: www.elsevier.com/locate/ijbiomac

[2] Qingfeng Sun&al, "*TiO_2 Photocatalyst with Cellular Structure*" via Facile Wood-Template Method, Intern. Journal of Photoenergy (2013)

[3] US 2013/0079520A1, Pub date:28 Mar.2013 "*Method of synthesizing anatase TiO_2 nanosheets*"

[4] Maja Radeti´, *"Functionalization of textile materials with TiO2 nanoparticlesMaja"* [Online] Available: www.elsevier.com/locate/jphotochemrev

[5] L. M. Franco A., G. Zambrano, M. E Gómez, Enrique Camps, L. Escobar-Alarcón, "*Photocatalytic activity of nitrogen-doped and undoped titanium dioxide sputtered thin films*"- Superficies y Vacío 25(3) 161-165, septiembre de 2012, Sociedad Mexicana de Ciencia y Tecnología de Superficies y Materiales

[6] Seon-Hong Lee*, Eiji Yamasue, Hideyuki Okumura and Keiichi N. Ishihara, *"Preparation of N-Doped TiOx Films as Photocatalyst Using Reactive Sputtering with Dry Air"*- Materials Transactions, Vol. 50, No. 7 (2009) pp. 1805 to 1811, The Japan Institute of Metals

[7] Petr Lukes, COST Action 540 " Phonasum" , Scientific Report-3rd Meeting of Working Group 2, Prague 2008

LONGITUDINALLY STRIPED FABRIC DESIGN WITH A MODIFIED WEIGHT

OANA Dorina[1], OANA Ioan-Pavel[2]

[1, 2] University of Oradea, Romania, Department of Engineering and Industrial Management in Textiles and Leatherwork, Faculty of Energy Engineering and Industrial Management, B.Şt Delavrancea Str., no.4, 410087, Oradea, Bihor, Romania

Corresponding author: Oana, Ioan-Pavel, E-mail: oanaioanpavel@yahoo.com

Abstract: *There are cases when the mass of woven fabrics requiring amendment intervening in the internal structure of the fabric, the reason most often for economic reasons, but also for the diversification by look.*
The internal structure of striped fabric obtained by combining groups wire ties, densities and / or different fineness creates a specific case on change of fabric weight.
Each stripe is a woven fabric whose features differ, in some cases significantly to the bars side by side. This is the reason why the change of mass of such a woven fabrics, it is not so simple as in the case of fabric with a uniform structure.
Changing the whole of the fabric weight can be done by changing the mass of each partial woven fabrics.The proposed method for mass modification consists in identifying and determining the partial structural fabric components and their mass change. To change the mass densities chosen method which involves designing a woven fabrics with weft yarn density, so the fabric assembly reference model resulted in a new woven fabric with a mass change After studying the structural features of these fabrics, and methods used to design woven fabrics with weight change , it has been found that there are other ways to solve this problem they known by has can achieve the same results but the simplest way.

Key words: *woven fabrics, structure, longitudinal stripes, features, density, fineness*

1. INTRODUCTION

Thus, the following describes a new method and algorithm of the design striped fabric obtained by combining by ties, densities and / or different fineness re both by content and by design are fully original and is something new in this domain.[1-4]

Next we will show a concrete example applied to a woven fabric whose characteristics are known. It take over the benchmark fabric density and length of the yarn systems and other characteristics required for calculation of the ratio by related components and the fabric weight.
It is proposed to change its mass by increasing the e=10%

The calculation of the re-design of the fabric to the mass change was made by applying the algorithm and the method described to obtain the results as shown in:

2. FABRIC CHARACTERISTICS BENCHMARK

- width: - stripes: L1=79,4
  L2 = 57,2 cm
  L3 = 10,4 cm
  $l_f{}' = \sum Li = 147cm$
  - edges : lm =30 cm
  - finite: lf = 150 cm

2.1. The density of yarn length:

- warp; from the fund Ttui Ttu1= 20tex

Ttu2=Ttu3= 10x2 Tex

From edges: Ttum = Ttu1 = 20 tex

- weft: Ttb = 16,67 tex

2.2.Yarn density:

- warp; Pu1= 200yarns/10cm
  Pu2= 300 yarns /10cm
  Pu3= 500 yarns /10cm
- weft; Pb = 250 yarns /10cm

2.3.Yarn contraction;

- warp in stripesi; au1= 9,8%
  au2= 6,9%
  au3=5,9%
- the weft stripesi; ab1= 13,5%
  ab2= 11,6%
  ab3=9,8%
- medium abmed=12,5%

2.4 Loss or gain of weight;

pf=4%

2.5. Mass calculation of the fabric:

$$Mf = \left[\sum_{i=1}^{m} \frac{Li \cdot Pui \cdot Ttui}{100(100 - 9{,}8)} + \frac{Pb \cdot Ttb \cdot l'_f}{100(100 - abmed)} \right] \cdot \frac{100 \pm pf}{100} \quad \textbf{(1)}$$

$$Mf = \frac{79{,}4 \cdot 200 \cdot 20}{100(100 - 9{,}8)} + \frac{57{,}2 \cdot 300 \cdot 20}{100(100 - 6{,}9)} + \frac{10{,}4 \cdot 400 \cdot 20}{100(100 - 5{,}9)} + \frac{250 \cdot 16{,}67 \cdot 147}{100(100 - 12{,}5)} \cdot \frac{100 - 4}{100}$$

$$Mf = 144{,}6 g / m$$

2.6. Calculation of the bonded fabric weight

2.6.1.Weft plain

$$Mf = \frac{l'_f}{100} \left[\frac{Pui \cdot Ttui}{100 - au1} + \frac{Pb \cdot Ttb}{100 - ab1} \right] \cdot \frac{100 \pm pf}{100}$$

(2)

$$Mf = \frac{147}{100} \left[\frac{200 \cdot 20}{100 - 9{,}8} + \frac{250 \cdot 16{,}67}{100 - 13{,}5} \right] \cdot 100 \frac{100 - 4}{} = 130{,}6 g / m$$

Modified mass calculation

$$M' f1 = Mf1 \cdot \frac{100 + e}{100}$$

(3)

$$M' f1 = 130{,}6 \cdot \frac{100 + 10}{100} = 143{,}7 g / m$$

Calculation of density

$$P_1 = \frac{P_{u1}}{P_b}$$

(4)

$$P_1 = \frac{P_{u1}}{P_b}$$

Calculation of the warp yarn density stripe thickness

$$P'u1 = \left[\frac{100 \cdot M'f1}{l'_f \left(\frac{Ttui}{100 - au1} + \frac{Ttb}{p1(100 - ab1)} \right)} \right] \cdot \frac{100}{100 - pf} \quad \textbf{(5)}$$

$$P'u1 = \left[\frac{100 \cdot 143,7}{147 \left(\frac{20}{100 - 9,8} + \frac{16,67}{0,8(100 - 13,5)} \right)} \right] \cdot \frac{100}{100 - 4} = 220\ fire/10cm$$

Calculation of density by weft yarn

$$Pb1 = \frac{Pu1}{P1}$$

(6)

$$Pb1 = \frac{220}{0,8} = 275\ fire/10\,cm$$

2.6.2 The twill D 2/1

$$Mf2 = \frac{l'_f}{100} \left[\frac{Pu2 \cdot Ttu2}{100 - au1} + \frac{Pb \cdot Ttb}{100 - ab2} \right] \cdot \frac{100 \pm pf}{100}$$

(7)

$$Mf = \frac{147}{100} \left[\frac{300 \cdot 20}{100 - 6,9} + \frac{250 \cdot 16,67}{100 - 11,6} \right] \cdot \frac{100 - 4}{100} = 157,5g/m$$

Modified mass calculation

$$M'f2 = Mf2 \cdot \frac{100 + e}{100}$$

(8)

$$M'f2 = 157,5 \cdot \frac{100 + 10}{100} = 173,2g/m$$

Calculation of density

$$P2 = \frac{Pu2}{Pb}$$

(9)

$$P2 = \frac{300}{250} = 1,2$$

Calculation of the warp yarn density stripe thickness

$$P'u2 = \left[\frac{100 \cdot M'f2}{l'_f\left(\frac{Ttu\,2}{100 - au\,2} + \frac{Ttb}{p1(100 - ab\,2)}\right)}\right]\cdot\frac{100}{100 - pf} \tag{10}$$

$$P'u1 = \left[\frac{100 \cdot 173,2}{147\left(\frac{20}{100 - 6,9} + 1,2\,\frac{16,67}{0,8(100 - 11,6)}\right)}\right]\cdot\frac{100}{100 - 4} = 330\ fire/10\,cm$$

Calculation of density by weft yarn

$$Pb2 = \frac{Pu2}{P2} \tag{11}$$

$$Pb2 = \frac{330}{1,2} = 275\ fire/10\,cm$$

2.6.3 Bond rips D 2/12

$$Mf\,3 = \frac{l'_f}{100}\left[\frac{Pu\,3 \cdot Ttu\,3}{100 - au\,3} + \frac{Pb \cdot Ttb}{100 - ab\,3}\right]\cdot\frac{100 \pm pf}{100} \tag{12}$$

$$Mf\,3 = \frac{147}{100}\left[\frac{400 \cdot 20}{100 - 5,9} + \frac{250 \cdot 16,67}{100 - 11,6}\right]\cdot\frac{100 - 4}{100} = 186,5\,g/m$$

Modified mass calculation

$$M'f3 = Mf\,3 \cdot \frac{100 + e}{100} \tag{13}$$

$$M'f3 = 186,5 \cdot \frac{100 + 1}{100} = 205,15\,g/m$$

Calculation of density

$$P3 = \frac{Pu\,3}{Pb} \qquad P3 = \frac{400}{250} = 1,6 \tag{14}$$

Calculation of the warp yarn density stripe thickness

$$P'u3 = \left[\frac{100 \cdot M'f3}{l'_f\left(\frac{Ttu\,3}{100 - au\,3} + \frac{Ttb}{p1(100 - ab\,3)}\right)}\right]\cdot\frac{100}{100 - pf} \tag{15}$$

$$P'u1 = \left[\frac{100 \cdot 205,15}{147\left(\frac{20}{100 - 5,9} + \frac{16,67}{1,6(100 - 11,6)}\right)}\right]\cdot\frac{100}{100 - 4} = 440\ fire/10\,cm$$

Calculation of density by weft yarn

$$Pb3 = \frac{Pu3}{P3} \tag{16}$$

$$Pb3 = \frac{440}{1,6} = 275\, fire/10cm$$

The Compliance Test for the weft system

$$\frac{Pu_1'}{Pu\ 1} = \frac{Pu_2'}{Pu\ 2} = \frac{Pu_3'}{Pu\ 3} \tag{17}$$

$$\frac{220}{200} + \frac{330}{300} + \frac{440}{400} = 1,1$$

The Compliance Test for the weft system

$$Pb1 = Pb2 = Pb3 = 275\, fire/10cm \tag{18}$$

The Compliance test for the mass

$$Mf = \frac{l_f'}{100}\left[\frac{Lui \cdot Pui \cdot Ttui}{100 - au1} + \frac{PbPb \cdot Ttb}{100 - ab1}\right] \cdot \frac{100 \pm pf}{100}$$

$$Mf = 159,4 g/m \tag{19}$$

$$Mf = \frac{100 \cdot Mf}{100 \pm e} = \frac{100 \cdot 159,4}{100 + 10} 144,9\ g/m$$

Calculating the number of reports related to the width lf

$$NR = \frac{l_f'}{Lru} = \frac{147}{5,6} = 26,25\, cm \tag{20}$$

Calculating the width of the stripes for liaison

$$li = \sum_{i=1}^{n} l_{ij} \rightarrow l1 = l11 + l12 = 2 + 1 = 3cm$$

$$l2 = l21 + l22 = 0,72 + 1,45 = 2,17\ cm \tag{21}$$

$$l3 = l31 = 0,45\ cm$$

$$Lru = 5,62\ cm$$

Calculation of the total width of the bonded stripes

$$
\begin{aligned}
& Li = li \cdot Nr + r \\
& L1 = 3 \cdot 26 + 0{,}45 = 78{,}45 \\
& L2 = 2{,}17 \cdot 26 = 56 \\
& L3 = 0{,}45 \cdot 26 = 11{,}81 \\
& \sum Li = 147 \ cm
\end{aligned} \tag{22}
$$

3. CONCLUSIONS

Changing the whole of the fabric weight can be done by changing the mass of each partial woven fabrics.The proposed method for mass modification consists in identifying and determining the partial structural fabric components and their mass change.[5-6] To change the mass densities chosen method which involves designing a woven fabrics with weft yarn density, so the fabric assembly reference model resulted in a new woven fabric with a mass change.

REFERENCES

[1] D. Chinciu, „*Bazele proiectării ţesăturilor*"Ediţia a II-a, Editura Mega-Mix, Iaşi 2003

[2] D. Chinciu, G.C. Chinciu „*Proiectarea ţesăturilor*", vol I, Editura Mega-Mix, Iaşi,2003

[3] D. Chinciu, G.C. Chinciu „*Proiectarea ţesăturilor*", vol II, Editura Mega-Mix, Iaşi,2003

[4]D. Chinciu, „*Geometria structurii ţesăturilor*",Aplicaţii, Editura BIT, Colecţia CARTEX nr.3, Iaşi,1996

[4]D. Chinciu, D. Oana, „*Proiectarea ţesăturilor cu dungi obţinute prin asocierea dee dungi*", Ed.Mega Mix, Iaşi,2004

[5] l.Cioară,"*Structura ţesăturilor*", Editura Performantica, Iaşi, 2001

[6] D. Oana, „*Proiectarea ţesăturilor cu dungi longitudinale*", Editura Universităţii din Oradea, 2005

PRACTICAL CONTRIBUTIONS TO THE STUDY OF RESISTANCE ASSEMBLIES MADE WITH WARP KNITS

OANA Ioan-Pavel [1], OANA Dorina[2]

[1,2] University of Oradea, Romania, Department of Engineering and Industrial Management in Textiles and Leatherwork, Faculty of Energy Engineering and Industrial Management, B.Şt Delavrancea Str., nr.o, 410087, Oradea, Bihor, Romania

Corresponding author: Oana, Ioan-Pavel, E-mail: oanaioanpavel@yahoo.com

Abstract: *Based on the principle that a body to be obtained by sewing the material to provide resistance and the like in the stitching assembly, the experimental study of which developed resistance is compared with the resistance materials to effectively assembled by the assembly line. The experimental values resistance for assemblies were obtained in the testing for resistance to sliding stitch ASTM D 434 using Tinius Olsen HK5T test type machine.*

The assembly strength was determined for warp knitted fabric and satin charmeuse, made of poly-filamentary wires and mono-filament polyester and polyamide. Resistance assembling is one of the major determinants of the quality of the stitching. It is defined as "the tensile strength or friction." Tenacity stitching seam rupture is the force recorded at its weakest point. Seam abrasion resistance is the number of cycles required friction mesh destruction of seam.

It can be said that the strength of the used assembly, the seam 301 is achieved by, in most of the cases, lower resistance knitted studied. In these cases, the primary findings presented, it is clear that the assembly is not appropriate in terms of reliability and maintainability of the product. Such a situation requires a first step to change the type (class) of stitch used. Another way to remedy the deficiencies could be using a sewing thread with a lower finesse or strength in grain, especially in the upper loop of wire used in the study-specific.

Key words: *fabrics, structure, assembly, knitted fabric, satin, material*

1. INTRODUCTION

The main factors affecting the strength of assembly are:

♦ **Factors linked to seam**

• **stitch type** - assembly generally made with a stretch stitch type chain is stronger than an assembly made of a rigid seam, of a simple stitching type.

• **stitch density** - a density greater resistance favors, but too high values lead to the destruction of the material and implicitly to decreased resistance assembly

• **thread tension** - tension is preferable to stronger wire being careful not to produce seam wrinkling

♦ **Factors linked to sewing**

• **wire resistance** - from the point of view of resistance wire, loop resistance has a greater influence on resistance than the resistance in grain assembly.[1-2]

A resistance of assembling must be equal to that of the material assembled so as to achieve a balanced that will withstand the stresses to which the product will be subjected during wear. For this reason the choice of qualitative and quantitative factors should be weighted influence, to prevent an over strengthening is not required assembly. [3]

2. PRESENTING COMPARATIVE EXPERIMENTAL VALUES RESISTANCE FOR ASSEMBLING

The experimental value resistances for assemblies were obtained in the testing for resistance to sliding stitch ASTM D 434 using Tinius Olsen machine type test HK5T. The average values obtained are summarized practical data for all four types of knitted studied in Table 1, together with strength and elongation at break for knits with and without assembling.[4-5]

Tabel 1. *The experimental values determined for the resistance assembling*

Code knit	sample test with assembly		free sample test assembly		resistance assembly[N]
	breakout force[N]	elongation at break[mm]	breakout force[N]	elongation at break[mm]	
P275 30	273,75	28,13	522,22	37,86	280,45
P275 45	281,175	34,5	582,15	43,85	282,16
P275 60	300,70	44,16	620,62	54,41	309,78
P275 90	265,59	21,93	615,81	35,35	246,6
P26 30	361,18	35,75	390,21	35,39	367,37
P26 45	229,28	35,37	341,81	43,13	312,5
P26 60	353,38	40,30	529,71	41	366,63
P26 90	291,98	27,46	527,69	30,16	329,27
R25 30	274,26	45,51	355,60	50,88	279,5
R25 45	237,70	46,01	439,48	53,02	262
R25 60	171,85	40,92	682,84	67,99	177,23
R25 90	151,55	38,115	477,25	57,26	155,94
R2030	152,78	50,53	179,70	45,89	280,73
R20 45	139,47	50,91	193,98	46,25	143,5
R20 60	143,69	53,58	188,08	54,51	146,24
R20 90	162,43	51,12	199,01	47,14	167,13

For charmeuse fabric of polyester filament yarn of poly-P275, relatively uniform resistance varies with the angle of assembly test. The maximum value is recorded for the angle of 60 °, while the minimum value finding angle of 90 °.

Figure 1 illustrates the change in resistance compared with the resistance of assembly due to the fabric-free assembling [5].

The chart shown highlights of the assembly similar behavior for the four-way test. At the same time it can be seen that the fabric strength is much superior to the resistance of assembly, the double knitted fabric resistance values, regardless of the direction of testing. This indicates that the assembly is too little resistance compared to fabric. Consequently, as was found during testing and assembling fails first, at relatively lower values.

The things are somewhat different in the case of satin fabric of polyester filament yarn of poly-P26. In this case, test direction of 30 ° and 45° were similar values were obtained for resistance of the assembly and the resistance of the fabric, which suggests that these assembling are equilibrate. For angles 60 and 90 ° can vary substantially between the two values, raising again the question of insufficient resistance against the fabric assembly.[6] From the point of view of the resistance variation with angle assembly arrangement of fabric in assembly, one can observe a uniform behavior at the request of stretching the range exceeding 50N. It can therefore be concluded that the directions of 30 ° and 45 ° are optimal for the realization of a balanced assembling.[6]

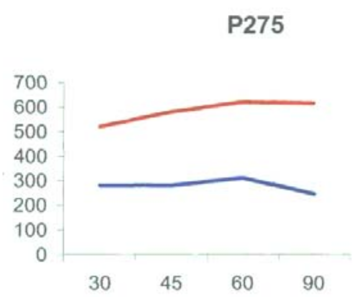


Fig. 1: *Assembled with the angle of change in resistance test Knitting P275*

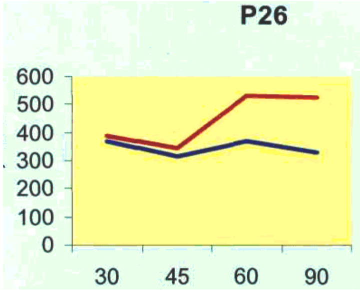


Fig.2: *Variation of the angle resistance test assembly for fabric P26*

Figure 3 shows a graph of resistance for comparison assembly in the case of knitted fabrics made of polyester yarn. From the graph it appears that the two resistant knits in different assembly, satin fabric is superior in this regard. The largest differences are found for the directions of 30° and 90°, about 25% of the top. For the other two directions are not those great differences of 9.5% and 15.5%.

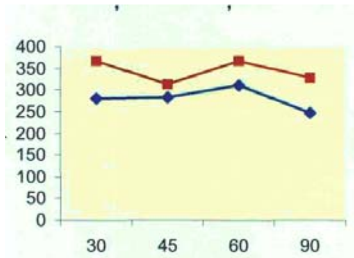


Fig. 3: *Graph versus change in resistance assembly for knitted fabrics made of polyester yarn*

Charmeuse fabric of yarns of polyamide 25 is characterized by a steady decrease in resistance assembly on the four-way test. This decrease is more pronounced for the last two lines of the arrangement of fabric in assembly, leading to the resistance assembly angle of 90° to about half the value corresponding to the angle of 30°. From the comparison chart shown in Figure 4 that the best situation in which assembly and fabric have similar resistance is the direction of 30°. Otherwise, the assembly is significantly less resistant than the material.[5-6]

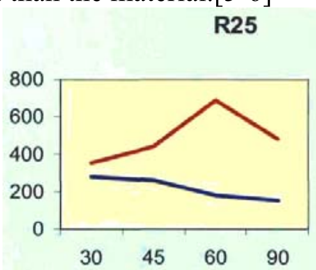


Fig. 4: *Variation of the angle resistance test assembly for fabric R25*

Satin fabric of yarns of polyamide 20 is the only one that presents a distinct situation from the other knits. Do not forget that this is the only fabric made from mono-filament yarn, which in addition have and greatest finesse. Figure 5 shows the variation of the angle resistance test assembly for this type of fabric. It can be seen that for the 30° direction is greater the assembling resistance than the resistance of the knitting fabric in an amount of 280N, while the strength of the fabric is approximately 180N. This indicates that the assembly is too strong in that case. It should also be emphasized again during testing of the assembly behavior of satin fabric R20, it was found breaking and jerking knitted and then an assembling.

The rest of the test lines of assembling strength is much lower, approximately half of the maximum value recorded for the 30° direction. The differences from the fabric resistance are not so large and R20 is preferably the fabric assembly in the direction of 45°, 60° and 90°. Moreover, the behavior of assembling directions 45° and 60° is the same, the values are almost equal.

Fig. 5: *Variation of resistance test assembling angle fabric R20*

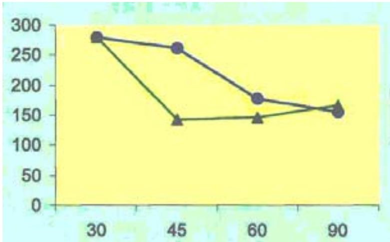


Fig.6: *Graph compared to resistance variation for knitted fabrics made from yarn assembling PA*

A comparison graph of the assembling resistance to the knitted threads of polyamide from Figure 6 shows that the knits have a similar behavior to the directions of 30° and 90°, while the other two angles are distinct differences in test value. If the angle test angle of 60° the two values are closer to assembling resisntace, the difference being about 17% for the test the angle of of 45° if the difference reaches 45%. It can be concluded that the assembly is obtained for best R25 fabric [7].

3. CONCLUSIONS

As a general conclusion, we can say that the resistance assembling used, made by stitching 301 is one of the cases, being at a lower resistance by the studied knittings. In these cases, the primary findings presented, it is clear that the assembly is not appropriate in terms of reliability and maintainability of the product. Such a situation requires a first step to change the type (class) of used stitch. Another way to remedy the deficiencies could be using a sewing thread with a lower finesse or strength in grain, especially in the upper loop of wire used in the specific study[5-7].

There are also knits that assembly directions are balanced in terms of resistance. These directions are given priority in the design of product lines for sectioning, which can be the basis for the development of new approaches style products, and reinterpreting the existing problems in order to optimize the seam and the product reliability and maintainability

REFERENCES

[1] Lutic, L. – "*Contribuţii la proiectarea şi evaluarea calităţii tricoturilor, la tricotarea pe direcţie transversală",* teza de doctorat, U.T. Iaşi, 2005

[2] Mitu, S. – "*Bazele tehnologiei confecţiilor textile",* vol. 1, Rotaprint, laşi, 1996

[3] Comandar, C. – "*Structura şi proiectarea tricoturilor- Tricoturi din bătătură",* Editura Cermi, laşi, 2000

[4]. Creţu, M. – "*Proiectarea si tehnologia confecţiilor din tricoturi",* Editura Gh. Asachi, laşi, 2000

[5] Oana Ioan Pavel, Oana Dorina– "*Contributii practice la studiul asamblărilor realizate cu structuri textile"* – Editura Universităţii din Oradea, 2008

[6] Moisescu, E. - *Control tehnic de calitate,* Editura Gh. Asachi, laşi

[7] Florea, A. – "*Controlul calităţii produselor",* Editura "Gh. Asachi" laşi, 2001

ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

SIMPLE METHODS FOR INCREASING THE PRODUCTIVITY IN A WORKSHOP OF TEXTILE GARMENTS

PORAV Viorica

University of Oradea, Romania, Department of Engineering and Industrial Management in Textiles and Leatherwork, Faculty of Energy Engineering and Industrial Management, University Street no. 1, 410087, Oradea, Romania, E-Mail: textile@uoradea.ro

Corresponding author: PORAV Viorica, E-mail: viorica.porav@gmail.com

Abstract: *This paper is based mainly on experience and is the result of optimization analysis of work operations in departments that make clothing products, with maximum 200 workers and financially unable to invest in expensive technical equipment. The analysis takes the problem of increasing productivity for some work operations, such as the operation of the realisation of loops, cutting them to the required size, forming packages, for their application to the top of the pants. The analysis performed was concerned not only with increasing productivity but also to create better working conditions for workers. Of course, through a thorough analysis can be improved and other working methods. Ergonomic workplace organization, centralization of operations or handling study due to their repetitiveness, can result in significant savings of time working. Equally it may affect the operations times for making garments and methods of employment with cut marks and accessories needed, or how to discharge processed workpiece. This paper outlines some options for improving the performance of companies producing textiles, in idea of increasing labor productivity and product quality. Even if a firm producing textiles, has sufficient financial resources for modern equipment, the studies conducted by experts, can brings improvements in working time and this without high costs.*

Key words: *loop, work operations, loop machines, screen printing, patterns*

1. INTRODUCTION

Of course, manufacturers have designed sewing machines that are getting more efficient, but at the same time becoming more expensive.[1-2]

The economic crisis led to the bankruptcy of a large number of textile factories, and in their place appeared little workshops that make clothing, with a small number of workers and poor technical equipment.

2. ANALYSIS OF THE OPERATION OF MAKING LOOPS

In this workshop an analysis was made to optimize work processes. The workshop is equipped classically, have 100 employees that manufacture about 400 sports pants and can not afford to make investments to buy modern machines with increased efficiency and low latency.

Among the analysed process steps and operations, was the realization of the loops, which has been submitted to the analysis due to delays in the supply of other operations. It was analyzed in detail, regarding the organization of the workplace, supply and exhaust system, performance of the machine that executed loops, and worker`s rhythm of work. [3]

2.1. Existent situation

Work is being done on a trimming and loops making machine, with a coating seam and strengthening material inside.[4]

The orders of work are small and have many colors. The time scale was checked, taking into account the frequency of thread color or fabric guide changes.

After sewing a package of loops, the worker prepared for cutting them to the size required, putting a bandage on her fingers! The first conclusion about the delay in supply of loops was the worker discomfort caused by the prolongued handling of scissors, in a layered material.[5]

***Fig.1**: Trimming and loops making machine*

***Fig. 2**: Driving device and the strip of reinforcement material*

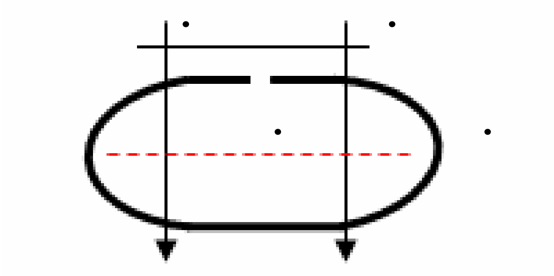


***Fig. 3.** Loop. Transversal section representation*

2.2. The improved situation. Version 1

Without any additional investment, a sewing and trimming machine was set close the loops machine. After sewing the loops, they will be cut with this sewing machine (without needle), guided by different indicator points of cutting length. Evacuation of cut eyelets is done by sliding them into a collection box.[5]

***Table 1**. Comparative results*

EXISTENT SITUATION				IMPROVED SITUATION./ VERSION 1			
Work operation Trimming, making loops and putting them in packages.	Average time type of operation performed for 60 loops (10 pants)	Average time for cutting with scissors and putting loops in packages	**Total 1.**	Average time of operation performed for 60 loops (10 pants)	Average time for cutting loops with the sewing machine.	**Total 2.**	**Difference**
	1,65 min.	2,20 min.	**3,85 min.**	1,65 min.	1,20 min.	**2,85 min.**	**1,00 min**.

Result 1. TIME REDUCTION = 1,00 min / trouser

2.3. The improved situation. Version 2

The loops are applied on top of trousers, with a sewing and correction machine which will cut the bag pockets excess mterial.

At the top of the trousers will be projected through a slit, a bright light stripe marking where to find the free end of the loop. The worker receives the belt loops uncut. He fixes the end of the belt loops where the light indicates and fixes it at the top of the trousers, at the same time executing the cut of the loop. This process is repeated until all loops are fastened on the trousers. Belt loops are fed from a roll that was wrapped simultaneously with the execution of loops.[5]

Compared to Version 1, the average time for the cutting loops with cutting machine located in the vicinity of the machine that makes loops was eliminated, and also the time for packaging loops, which according to situation no. 1. is 1.2 minutes, with cutting loops being realised during the fixing operation(coupling of operations).[5]

***Table 2**. Comparative results.*

EXISTENT SITUATION				IMPROVED SITUATION./ VERSION 2		Difference
Work operation	Average time type of operation performed for 60 loops (10 pants)	Average time for cutting with scissors and putting loops in packages	**Total 1.**	Average time type of operation performed for 60 loops (10 pants)	**Total 2.**	
Trimming, making loops and putting them in packages	1,65 min.	2,20 min.	**3,85 min.**	1,65 min.	**1,65 min.**	**2,20 min.**

Result 2. TIME REDUCTION = 2,20 min . / trouser

3. ANALYSIS OF MARKING THE PLACE OF APPLIED POCKETS ON THE BACK OF PANTS

3.1. Current situation

The place of back pants pockets, is marked using cardboard auxiliary templates. These have the contour of pocket cut out, allowing it to be outlined with chalk. The template is positioned on the back of the trousers, matching the cuts/bytes with the bites of the back pant cut .[2,4]

Average time for marking the contour of pockets:

Nt = 0,50 min. / 2 pocket .

3.2. The improved situation

A screen printing with the outline of the shape of the pocket and perforated will be used. The screen is a hard surface, on which different shapes are cut. In the clothing industry, it is used to perform highly repetitive enrollments. Classical method consists in placing the screen above the fabric and spraying him with chalk dust. Chalk dust enters the perforations giving the textile material these contours.[5]

The improved situation will do the opposite. There is a need for a container which contains the powder of chalk, who is connected to compressed air and is covered with a fine screen, with the size of screen printing. The screen sits on the fine screen and is positioned according to the markers.

Over the screen sits the back of trousers, fabric face down, matching the nicks and positioning marks. At the push of a button, air drives the chalk dust through the screen. It enters through the perforation templates, marking simultaneously all around the pocket on the back of the trousers.

Results

After counting, the average time for marking the site of application of the two pockets is:

Nt = 0,20 min .

Compared to the original method there is a reduction of 0,30 min / trouser .[5]

4. CONCLUSIONS

Even if the financial situation of the company does not allow investments, a careful analysis of phases of work, finding weaknesses and finding inexpensive solutions can increase production efficiency.

REFERENCES

[1] Asociaţia Inginerilor din România, "*Manualul Inginerului Textilist"*, Vol. II, ISBN 973-8466-10-5, 973-8466-96-2, Ed AGIR, Bucuresti, Romania, 2003.

[2] Mitu S, Stan, Mihaela S. Mitu, "*Bazele Tehnologiei Confecţiilor"*, Vol. I si II, Ed. Performantica, Iasi, Romania, 2005.

[3] Nicolaiov Pulferia, *"Proiectarea proceselor tehnologice pentru confecţii din ţesături"*, ISBN 973-9378-45-5, Ed CERMI, Iasi, Romania, 1999

[4] Papaghiuc Viorica , Irina Ionescu , Adela Florea, *"Proiectarea sistemelor de fabricaţie pentru produse de îmbrăcăminte"*, ISBN 973-7994-81-7 , Ed Performanca, Iasi, Romania, 2004.

[5] Personal bookmarks

RESEARCH REGARDING DIFFERENT APPLICATIONS OF SILVER IN TEXTILE

PRALEA Jeni [1], ȘOLTUZ Elena [2]

[1] *University of Arts George Enescu Iasi, Romania, Department of Design, Faculty of Visual Arts and Design, Postal address189 Sarariei, 700451 Iasi, Romania, E-Mail: fapdd@arteiasi.ro*

[2] *University of Arts George Enescu Iasi, Romania, Department of Design, Faculty of Visual Arts and Design, Postal address189 Sarariei, 700451 Iasi, Romania, E-Mail: fapdd@arteiasi.ro*

Corresponding author: Elena, Soltuz, E-mail: soltuzelena@yahoo.com

Abstract: *Experimental research presented in this paper are based on septic properties of silver. The experiment creates premises for developing of project concepts, products and inscriptions (applications of graphic signs), ionization treatments with silver ions, which ensures the quality of the septic product in an ecological way (no preservatives and no toxic chemicals), characterised by a modern design. Thus developing concepts of textile products, the development of accessories needed for manufacturing textile products that ensure the property of being septic, development of eco-friendly products without thermochemical treatments, are applications that the designer can achieve based on the properties of silver. The paper presents both technological capabilities and properties of silver to be able to be used in the field of textiles, as well as the creativity of designers to generate ideas for new applications of this material in the field of industrial products in the textile, garments. The importance of the designer's involvement in creating septic and ecological products, which respecst the environment represent the focus of this work. The deformability properties of silver are the inspiration for designer even when it shows major deformities, caused as a result of tests of endurance. Surface modifications of this material can cause identification of applications of this precious metal, turning in esthetic product, scrap, samples, test specimens subjected to various tests.*

Key words: *design, silver, septic, eclogical, textile product..*

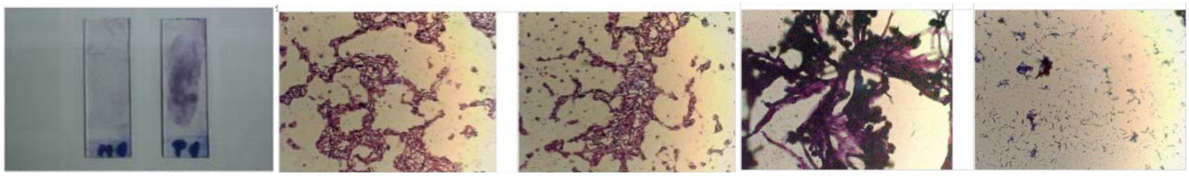
1. INTRODUCTION

The use of silver or silver alloy in textiles and accessories, requires knowledge of the reaction of the metal processing by cold plastic deformation [1]. The textile industry, produces a wide range of textile fabrics in a range of thicknesses, degrees of fineness, composition, structure. Regardless of the type of material you are going to apply to the accessories, they must be safe and the must lasting during use. The attachment must be free of processing traces, which would affect the aesthetics of the product, to be easily mounted and used to provide safty, to be easy but sturdy, and ergonomic. The textile industry in its development requires solutions to provide proper hygienic conditions, safety and comfort, without contaminating the environment. For stopping the process of contamination of the environment, will be undertaken in new procedures and approaches, which are safe and with low toxicity to skin. Metallic ions of silver with bactericide action, are related to "inorganic supports", so that the release of agents in the environment is done gradually, steadily and sustainably. The efficacy of antiseptic qualities of silver ions, have a fast, strong action and are non-toxic and non invesive for environment [2]. The experiments presented in **Fig.1**, has proven that these elements provide the ability to annihilate bacteries. There are two systems of actiona of bactericide:

- Due to the removal of silver ions in water or moist air, the catalytic action of ions takes place by destroying the plasma membrane of bacteria cells, through the potential difference between the external and internal side of the cells.
- Penetration of the silver ions of the plasma membrane of the bacterial cell, destroying the cytoplasm. The use of silver ions from these products is recommended to prevent the transmition of diseases and infections through textile materials. [3]

Silver can be used in textiles industrie or fashion, or in technologies that involves the treatment of fabrics due to its antiseptic properties, as well as in the field of accessories, thanks to its aesthetic and technological properties.

a. b. c.



d. e.

***Fig.1**: Phases of the experiment regarding the influence of silver for preserving food in packages that contain silver elements: a. Food samples, b. Packaging with silver elements and food samples, c. Macromorfological aspect of the colonies developed, d. Coloured microscopic blades, e. Micromorfological aspect of the colony from samples-mycenaean filaments with spores(1000x)[2]*

2. GENERAL INFORMATION

2.1 Silver properties

Fine silver **(Ag999,6 $^{0}/_{00}$)**, precious metal, is used due to its resistance against corrosive agents: in the chemical industry for the manufacture of receptacles; in electro technical industry is used because of its high conductivity, in the manufacture of electrical contacts; in the construction of machines is used due to antifriction properties, particularly in the manufacture of aircraft bearings. Silver alloys are non-ferrous alloys which are obtained on the basis of fine silver. Silver alloys are forming alloys with different metals in the amount imposed for producing the desired alloy, in order to obtain certain properties. Silver alloys keep the essential qualities of metal and the alloying elements contribute to the improvement of some features (e.g., increasing hardness) and changing aesthetic properties (color). Silver-based alloys can be obtained only by alloying with copper, gold, zinc, etc., but do not form alloys with iron (because some metals do not dissolve in the molten state, Ag-Fe being one of them).

The most important physical and mechanical properties, of silver are [4, 5, 6, 7]:

- Reflects the rays of the Moon, is opaque, the reflected light appears white silver;
- The mark made by silver can be white-silver, yellow, grey to black;
- From the contact with air is covered with a dark film, an oxide layer that makes reflects the ageing process, an effect that can be used for aesthetic purposes and that prevents oxidation in depth of silver;
- Polished, has a beautiful glow due to the high power to reflect light;
- The capacity of reflecting in aer is 95,5% for green and is 93% for red;
- The index of refraction is 0,181;
- Is isotropic;
- Silver Hardness is 2.5 (on Mohs scale);
- Specific weight is 10,4923 g/cm3;
- Melting point is 960,50 ° C;
- Boiling point is 21700^0 C;
- Vaporization temperature 2212^{0}C;
- It is very plastic A_5=48-50 %;
- Is soft (softer than copper and harder than gold) being easily scratched with a sharp object, is light, malleable, ductile, stainless steel;
- Does not combine with oxygen, but it dissolves large amounts of oxygen in the molten state (up to 22 times its volume), which is removed after solidified by throwing metal sprays, which is why silver just can't pour out;
- Presents the highest thermal and electrical conductivity of elements;

- Doesn't clive and often forms angular particles;
- Crystallization system is cubic (4/m³/m 2);
- Rarely presents itself in the form of crystals, often in the form of twisted fibers, dendrites, irregular plates, sometimes curved plates, nuggets, compact masses, foils, etc.;
- When there are crystals they are have the form of dodecaedru; the coefficient of linear expansion is 1.92 x 10-5 at 40□;
- Is diamagnetic;
- Almost all combinations of this metal are non-toxic;
- Allows the passage of light in foil with thickness of min. 0, 003mm;
- From one gram of silver can be obtained a thread length of 2,6 m by pulling it;
- A silver wire with a diameter of 1 mm can support a weight of 16.5 Kg;
- Cristalisation can be of a cubic or octahedron type;
- Separation of silver takes place through: fusion, extraction;
- Can form alloy with Cu, resulting in a light alloy workpiece coloured white (malleable);
- Can form alloy with Hg, resulting in an alloy with a strong glow (in the form of foil results in being the reflective surface of the mirror);
- Can form alloy Ni and Cu, resulting in a alloy used for making coins (by hammering);
- The titles used are: for jewelry $750^0/_{00}$; $800^0/_{00}$; $875^0/_{00}$; $916^0/_{00}$; $925\ ^0/_{00}$; for medals and vase $800^0/_{00}$; $900^0/_{00}$; $925^0/_{00}$;
- Nitric Acid affects silver until it is dissolved even in cold condition, and sulfuric acid affects silver in warm state;
- When the silver has a high title ($925^0/_{00}$), and it interacts with a reactive solution of potassium bichromate (saturated solution in nitric acid 45%), it results a precipitate of intense red color called "dove's blood";
- An alloy imitating Ag is mailsort (also known as the silversmith, alpaca), containing 60%Cu +20%Ni +20%Zn or crisocal (Cu alloyed with Zinc);
- Ag is the whitest metal and is distinguished from white gold and platinum by the peculiar brilliance, platinum has bluish shimmer, and gold is slightly greenish white.

Fine silver (according to STAS 3321-93) has the mark Ag 999,6 with a content of 99,96%.

2.2 Silver machinability

Researches in the field of accessories, shows that there are certain preferential technologies used in their processing. Experimental research presented in **Fig.2** and **Fig.3** shows that the processing of silver and silver alloy does not require large deformation forces. The forces required for the processing of silver are lower than those required for silver alloy. Although ductile and malleable, silver and silver alloy are changing they're proprieties due to plastic deformation, requiring the application of heat treatment like annealing and recrystallization. Tools used for the processing the silver accessories must be thoroughly finished because the macro and microgeometrice defects of the tools is printed on the finished part, turning it into the scrap or requiring additional labor to remove these defects. Depending on the piece, it can have a certain finish hardness, imposed by technology, machine, tool, the degree of hardening, and the heat treatment. The major priority for design is for the finishing of the product. The difference between glossy and mate surfaces, the fine lines on the surface, and other effects, (from simple to complex ones), contributes to increasing the aesthetic value of the accessory. Experimental researches carried out on silver, have demonstrated that the designer can use, due to the aesthetic properties of the material, both the finished products and scrap resulting from the manufacturing process of this noble material.

Such pieces and debris resulting from mechanical and technological tests, represents a challenge for the designer in the establishment of ecological benchmarks (reuse, recovery, redesign, rethinking). Thus, attempts to traction, rolling and structural changes and microgeometrics specimens can be exploited through aesthetic and function by the designer. In **Fig.4** are examples of the technological scrap that can be used by the designer for creating accessories, or other applications with septic and decorative purposes.

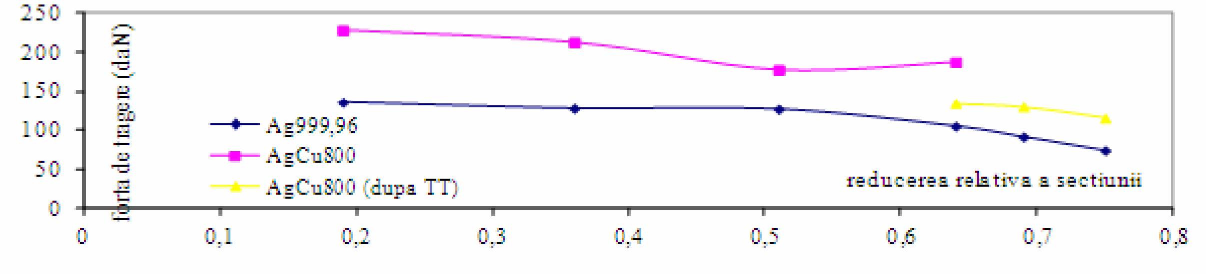


***Fig.2**: The law of variation of wireing process of silver and silver alloy (AgCu800)[4]*

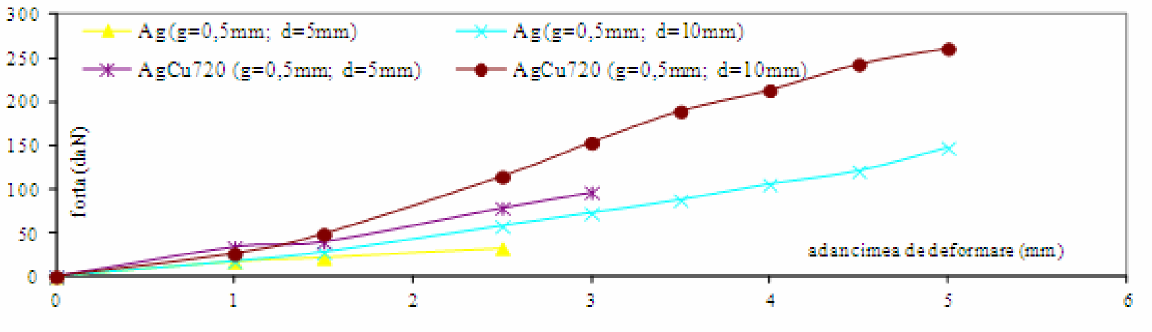


Fig.3: *The strength of distortion at warping silver and silver alloy [4]*

***Fig.4:** Technological silver and silver alloys planks and scrap that can be creatively applied ty the designer to create products with aesthetic value and septic properties*

3. EXPERIMENTAL RESEARCH OF SILVER IN TEXTILE DESIGN

3.1. Experimental data and proposals for accessories

The experiment carried out by using two type samples, packages of different samples of agri-food products with and without silver, showed that silver has a positive effect on the samples used by slowing the processes of dehydration and development of microorganisms cultures. Having inhibitory effect on dehydration, growth and multiplication of micro-organisms, these results allow to develop design concepts for: keeping food, accessories and items of clothing with septic properties, exemplified in **Fig.5.**

***Fig. 5:** Staples and silver buttons, esthetic and functional role, septic*

3.2. Experimental data concerning the application of silver ions on the labeling of textiles

The experiment carried out using silver nitrate concentration of 1%, used as a method of working samples of different materials, different textures, finishes and colors, which have been applied by inserting glyphs using paintbrushes. Being a light sensitive solution, silver nitrate acted differently, **Fig. 6**, on those samples. Coloring the fabric with silver has the purpose to make the material septic helping people with high sensitivity to allergies, and giving the fabric an esthetic design, that can be custom made.

Fig. 6: *Inscriptions made by applying the solution of silver nitrate on different types of textile fabrics, giving them functional, esthetic and septic purposes.*

3.3 Experimental data and proposals for eco-concepts

The technological scrap arising from attempts to wiring, casting, rolling, laminating silver presented in **Fig. 4**, represents a challenge for the designer, in the sense of creating eco-concepts.

Fig. 7: *Decorative applications of silver items resulted from debris and technological samples presented in Fig. 4*

Half-finished products and the technological scrap pieces of silver are a reliable source of generating ideas for accessories that can be used in the fashion design whit the purpose to protect sensitive people against microorganisms and allergies. The use of this scrap pieces shows that silver does not present the "pulling out of use”stage in its life cycle. Being a noble metal it supports unlimited number of cycles in the recovery. In **Fig. 7**, are presented concepts of eco products. These products can be declared as eco because they use creatively materials recovered, recycled or coming through from technological tests (results shown in **Fig. 2, Fig. 3** and **Fig. 4**). The products shown are aesthetic and functional. These ecoconcepts have septic properties due to the use of silver, and they also have a decorative value.

4. CONCLUSIONS

Aesthetic, technological and septic properties of silver can determine the development of design concepts which shows positive impact on human health. Applications of silver are based on its ability to be recoverable, reusable and nontoxic for the environment. Theoretical and experimental research has led to the following conclusions:

- accessories made of silver can be used for functional, aesthetic and septic purposes;
- use of accessories from silver can have a preventive or curative purpose for people who need a septic environment;
- use of silver ions in embossing and treating of textiles, is an organic, septic method, welcomed in the cases of products made for children or adults with allergy issues or otherwise, and which prevents the use of chemical substances;
- use of silver ions in the labelling of textile products and treatment can be performed by anyone, the application of a layer of silver nitrate, allowing customization of textiles or garments;
- modelling silver does not impose strong deformation forces, which allows its use in creating objects/accessories in a wide variety of shapes, sizes, finishes and alloys (with silver), through a wide range of techniques and technologies (from of manufacturing technologies up to the industrial scale of productivity).

REFERENCES

[1] Pralea, J., „*Tehnologii vechi şi noi în prelucrarea metalelor*", revista "Artele vizuale la sfârşit de mileniu", publicată de Centrul de cercetare "Estetică şi creaţie artistică" ISBN 973-85170-6-0, Editura Artes 2002 Iaşi

[2] E. Soltuz, J. Pralea, S. Buraga, "*Experimental research on the advantages of using silver in the field of food packaging",*ModTech International Conference - New face of TMCR, 2010, Available: http://www.arteiasi.ro/ecodesign/index.html

[3] Nimitan, E., Dunca, S., Comanescu, O., Comanescu, S., "*Microbiological methods and techniques*", University's Al. I. Cuza, Printing House, Iassy, 1998

[4] Pralea, J., "*Argintul, Proprietăţi – prelucrabilitate*", Editura Artes ISBN 973-85170-2-8 IAŞI – 2004

[5] Bordeaux A. „ *L'or et l'argint*", Librairie Plon-Nourriet, Paris,1962

[6] Borel F. „S*plendour of ethnic jewellery*", Thames & Hudson, 1994

[7] Brepohl Erhard „*Theorie und praxis des golschmiedes*", VEB Fachbuchverlag, Leipzig, 1980

ESD GARMENTS

SCARLAT Răzvan[1], CĂRPUŞ Eftalea[1], ENE Alexandra[1], MIHAI Carmen[1], VISILEANU Emilia[1], DONCIU Codrin[2]

[1]*National Research and Development Institute for Textiles and Leather, Bucharest, Romania, Postal address: Lucretiu Patrascanu st. no 16, 030508, Bucharest, Romania, E-mail: razvan.scarlat@certex.ro*

[2] *Electrical Engineering Faculty of Iasi, Iasi, Romania, Prof. Dimitrie Mangeron st. no. 21-22, 700050, Iasi, Romania, E-mail: cdonciu@ee.tuiasi.ro*

Corresponding author: Razvan Scarlat, E-mail: razvan.scarlat@certex.ro

Abstract: *Protective equipment represents an alternative for the sustainable development of companies and for human health protection. The insertion of "invisible functionalities" in textile structures, the use of functional elements as part of the whole garment are just a few tools which define "freedom" of creation in the field of textiles. The electrical, chemical and mechanical properties of conductive textiles are crucial for intelligent textiles. ESD garments are used to protect sensitive devices from electrostatic discharges that can occur from the normal clothing of the human operators. ESD garments on the market don't solve all the problems raised by accidental electrostatic discharges. This is because the fabric, from which the garment is made, must fulfil at the same time two contradictory conditions: high resistivity, to limit the charging process and energy transfer in case of an eventual discharge, and high conductivity, to facilitate the dissipation process of charges, thus limiting the accumulation of charge on the fabric. To obtain an ESD garment with superior qualities, the present paper proposes the development of a bilayer structure using the integral knitting technique. The outer layer, which comes in contact with the working environment, is mainly dissipative (DL) which ensures the protection against short circuit and limitation of electrostatic energy transfer into the working environment, while the inner layer, which comes in contact with the human operator, is mainly conductive (CL), providing the controlled drainage of accumulated electrostatic charge.*

Key words: *electrical discharge, knitting, protective clothing*

1. INTRODUCTION

Electrostatic discharges are caused when a sufficiently amount of charge accumulated through different mechanisms (friction, induction or corona charging) [1-3] is suddenly released on a nearby object. The magnitude of these discharges depends on a number of parameters, such as: air gap between the charged object and the one to which the discharge will be made, humidity, resistivity of charged object, etc. [4-6]. Controlling these parameters can help minimize the risk of an electrostatic discharge.

When human operators are met on the production line of devices sensible to electrostatic discharge, a different protection measure is taken into consideration, namely ESD garments, which reduce the risk of an ESD from the operator's normal clothing to the sensitive device. ESD garments on the market don't solve all the problems raised by accidental electrostatic discharges. This is because the fabric, from which the garment is made, must fulfil at the same time two contradictory conditions: high resistivity, to limit the charging process and energy transfer in case of an eventual discharge, and high conductivity, to facilitate the dissipation process of charges, thus limiting the accumulation of charge on the fabric The protective garments must also have shielding properties, to prevent the electrostatic fields generated under the garment to induce charge to nearby objects [7] and good anti-static properties, so that they won't generate electric charge when making contact with other materials [8].

To satisfy the conditions for ESD garments (high resistivity and high conductivity), a bilayer structure of the fabric was developed. The bilayer structure offers both high resistivity and high conductivity, required for the ESD garments, while the integral knitting technique ensures the electrical conductivity throughout the fabric. An additional requirement for the inner layer is to ensure the user's comfort.

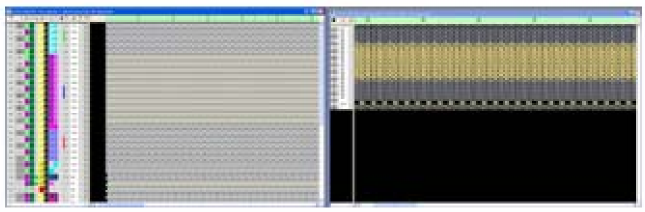
2. EXPERIMENTAL PART

Two-layer knit variants were made with plaited structures, with parallel evolution of two or more yarns with strictly determined relative position as a result of their submission at different angles (plaiting yarn V at an angle smaller than ground yarn F). The most used knitted structures are jersey and rib structure. In case of jersey structure, the plaiting yarn V appears on the foreground on the front and the ground yarn F, on the foreground on the back of the fabric. In case of rib structure due to alternating of front-back wales - both the plaiting yarn (at front aspect stitches) and the ground yarn (at rear aspect stitches) will be present on the foreground, on each side of the fabric.

Both types of fabric were made on STOLL knitting machines, from SC Tanex SRL, with a possibility to have a differentiated adjustment of yarn tension so as to ensure the correct plaiting of the fabric (Table 1 and 2).

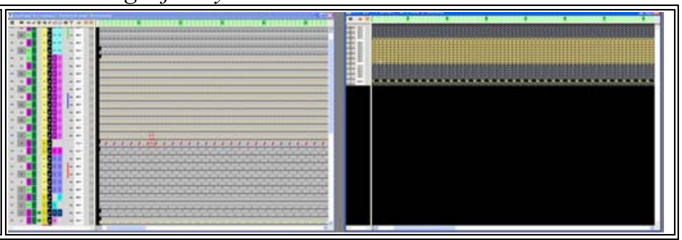
1. Rib1x1

Table 1: *Rib structure*

MSEC	Value	Description	
MSEC 3	0.55	Transfer speed	
MSEC 4	0.60	Knitting speed	

2. Single jersey

Table 2: *Single jersey structure*

MSEC	Value	Description	
			

Yarn used:

- ground yarn: Nm 50/3, 100% cotton;
- ground yarn: Nm 30/2, 100% wool;
- plaiting yarn: conductive yarn type 2: 75% cotton + 25% epitropic yarn (Nm 34/1 carbon coated polyester);
- plaiting yarn: conductive yarn type 3: Nega-Stat P210, 112 dtex 12 f, polyester filament with trilobal core and carbon outer layer;
- plaiting yarn - conductive type 4, Nega-Stat P190, 155 dtex, 24f, polyester filament with trilobal carbon inner core;
- plaiting yarn - conductive type 5, nylon filament superficially saturated with carbon particles.

Table 3: *Samples resulted after experiments*

Sample No.	Structure	F1/Front	F2/Rear	Conductive yarn percentage
1	plaited jersey	one cotton yarn + one yarn type 2	one cotton yarn + three yarns type 4	6%
2	plaited rib	one cotton yarn + one yarn type 2	one cotton yarn+two yarns type 3	5%
3	plaited jersey	one cotton yarn + one yarn type 2	one cotton yarn +two yarns type 3	5%
4	plaited rib	one cotton yarn + one yarn type 2	one cotton yarn + three yarns type 3	6%
5	plaited jersey	one cotton yarn + one yarn type 2	one cotton yarn +one yarns type 3	4%
6	plaited jersey	one cotton yarn + one yarn type 2	one cotton yarn +two yarns type 4	6%

7	plaited jersey	one cotton yarn + one yarn type 2	one cotton yarn +one yarns type 4	5%
8	plaited rib	one cotton yarn + one yarn type 2	one cotton yarn +one yarns type 4	4,5%
9	plaited rib	one cotton yarn + one yarn type 2	one cotton yarn +two yarns type 4	6%
10	plaited jersey	one cotton yarn + one yarn type 2	one cotton yarn +one yarn type 5	4,5%
11	plaited jersey	one cotton yarn + one yarn type 2	one cotton yarn +two yarns type 5	6%
12	plaited jersey	one cotton yarn + one yarn type 2	one cotton yarn + three yarns type 5	7,5%
13	plaited rib	one cotton yarn + one yarn type 2	one cotton yarn + three yarns type 5	7,5%
14	plaited rib	one cotton yarn + one yarn type 2	one cotton yarn +two yarns type 5	6%
15	plaited rib	one cotton yarn + one yarn type 2	one cotton yarn +one yarn type 5	4,5%
16	plaited rib	one wool yarn + one yarn type 2	one wool yarn +one yarn type 5	4,5%
17	plaited rib	one wool yarn + one yarn type 2	one wool yarn +two yarns type 5	6%
18	plaited rib	one wool yarn + one yarn type 2	one wool yarn +two yarns type 5	7,5%
19	plaited jersey	one wool yarn + one yarn type 2	one wool yarn + three yarns type 5	7,5%
20	plaited jersey	one wool yarn + one yarn type 2	one wool yarn +two yarns type 5	6%
21	plaited jersey	one wool yarn + one yarn type 2	one wool yarn +one yarn type 5	4,5%

3. RESULTS

In order to characterize the 21 knitted fabric samples (table 3), complete sets of tests were conducted for the following parameters: weight [g/m^2], thickness: density (wales/10cm, rows/10cm), thickness (mm), air permeability (l/m^2/s), water vapour permeability (%), thermal conductivity (mW/mK), thermal resistance (m^{2}KW), shielding factor (S), discharge time (s) (Table 4a and 4b).

Table 4a: *Characteristics of knitted samples*

Sample no.	Bilayer structure	Type of yarns combination	F1 yarns combination	F2 yarns combination	Weight [g/m2]	Density		Thichness, [mm]
						rows/10cm	wales/10cm	
5	Plaited jersey	Cotton yarns combination	1 cotton yarn +1 yarn type 2	one cotton yarn +one yarn type 3	470	43	92	1,58
3				one cotton yarn +two yarns type 3	495	41	90	1,63
7				one cotton yarn +one yarn type 4	487	44	86	1,63
6				one cotton yarn +two yarns type 4	508	44	79	1,69
1				one cotton yarn +three yarns type 4	525	43	84	1,62
10				one cotton yarn +one yarn type 5	597	47	81	1,62
11				one cotton yarn +two yarns type 5	589	47	82	1,66
12				one cotton yarn +three yarns type 5	634	47	75	1,74
21		Wool yarns combination	1 wool yarn +1 yarn type 2	one wool yarn +one yarn type 5	521	47	71	1,65
20				one wool yarn +two yarns type 5	562	47	69	1,65
19				one wool	603	46	69	1,66

				yarn +three yarns type 5				
2	Plaited rib	Cotton yarns combination	1 cotton yarn +1 yarn type 2	one cotton yarn +two yarns type 3	728	38	60	3,41
4				one cotton yarn +three yarns type 3	825	37	63	3,34
8				one cotton yarn +one yarn type 4	705	37	61	3,52
9				one cotton yarn +two yarn type 4	834	37	65	3,32
15				one cotton yarn +one yarn type 5	785	37	61	3,39
14				one cotton yarn +two yarn type 5	828	36	59	3,58
13				one cotton yarn +three yarn type 5	878	36	59	3,61
16		Wool yarns combination	1 wool yarn +1 yarn type 2	one wool yarn +one yarn type 5	766	36	57	3,33
17				one wool yarn +two yarn type 5	802	34	60	3,53
18				one wool yarn +two yarn type 5	846	33	59	3,57

Table 4b: *Characteristics of knitted samples*

Sample no.	Air permeability l/m2/s	Water Vapor permeability %	Thermal resistence m2K/W	Thermal conductivity, mW/m·K	Shielding factor [S]	Discharging time t1/2 (F1)	Discharging time t1/2 (F2)	Conductive yarn percent %
5	593,4	39,1	0,03913	40,25	0,84	0,0227	0,0228	4%
3	646	41,6	0,03901	41,65	0,92	0,0251	0,0228	5%
7	484,6	42,5	0,03354	48,65	0,82	0,0274	0,0246	5%
6	475,8	40,9	0,03447	49,05	0,83	0,025	0,0232	6%
1	539	38,3	0,03869	41,85	0,9	0,0249	0,0268	6%
10	374,4	36,2	0,03269	49,55	0,72	0,0258	0,0273	4,5%
11	395	35,9	0,04444	37,35	0,70	0,0252	0,0258	6%
12	401,4	34	0,03395	51,25	0,81	0,0235	0,0263	7,5%
21	643	34,2	0,04291	37,45	0,80	0,0253	0,0282	4,5%
20	601	34,8	0,04099	40,25	0,73	0,0227	0,024	6%
19	647,6	30,06	0,03567	46,55	0,80	0,0251	0,0255	7,5%
2	667,8	37,6	0,04950	69,05	0,82	0,0245	0,0245	5%
4	581,2	40,8	0,04805	69,45	0,82	0,027	0,0238	6%
8	654,8	38,1	0,05052	69,75	0,78	0,026	0,0268	4,5%
9	495,8	35,8	0,04664	71,15	0,90	0,0234	0,0241	6%
15	454,2	30,1	0,05481	61,85	0,81	0,0238	0,0274	4,5%
14	576,6	28,5	0,05732	62,45	0,83	0,0255	0,0248	6%
13	609,8	32,4	0,05726	63,05	0,7	0,0241	0,0228	7,5%
16	593,6	29,3	0,07881	42,25	0,86	0,0252	0,0244	4,5%
17	800,8	29,5	0,07801	45,25	0,80	0,0236	0,0269	6%
18	872,2	28,6	0,07786	45,85	0,82	0,0227	0,0241	7,5%

When using a rib structure, voluminousness of the fabric will be higher due to the spatial arrangement of the stitch elements, due to an increased amount of incorporated air into the knitted structure. These aspects favour on the one hand a very high thermal comfort and on the other hand an effective air flow, respectively perspiration vapours between body and environment.

From way in which statistical events are distributed can be mention the following aspects:

- electrostatic shielding factor hasn't significant differences for the analyzed samples, sample 9 from rib structure group and sample 3 from jersey structure group shows the best possible attenuation of the electrical load (fig. 1);

- the presence of the yarn type 2 on the front face 1 determine the performance improvement by using the yarns 3, 4 and 5 for all knitting configuration, knitting structure does not significantly influence the ability of electrostatic discharge (fig. 2);

- the limits of variation for water vapor permeability is between 28.5% and 42.5%, statistical events that agglomerates into optimal zone indicate the presence of the cotton yarn, in patent structure (fig. 3).

- air permeability causes sensations of warm and cool of clothing products, the best value being obtained by the samples 10, 11, 12 (374 - 400 l/m^2/s), characterized by the presence of cotton yarn and conductive yarn element from nylon filament surface saturated with carbon particles (fig.4).

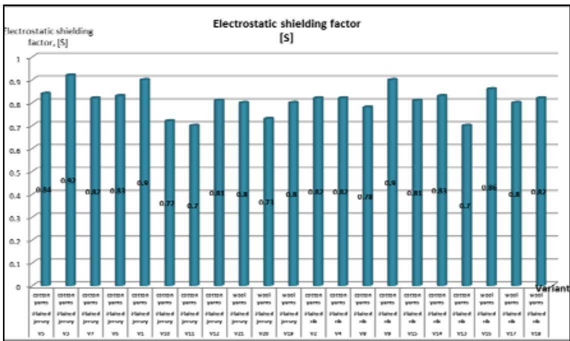


Fig. 1: *Electrostatic shielding factor*

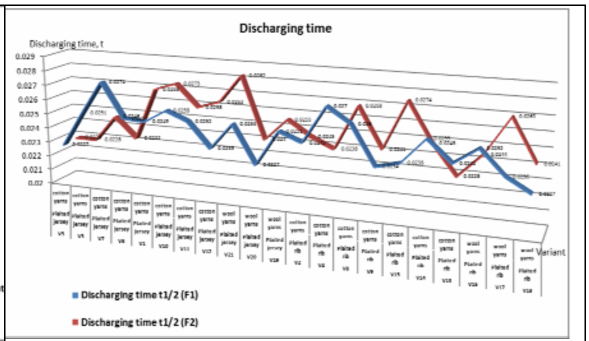


Fig. 2: *Discharging time*

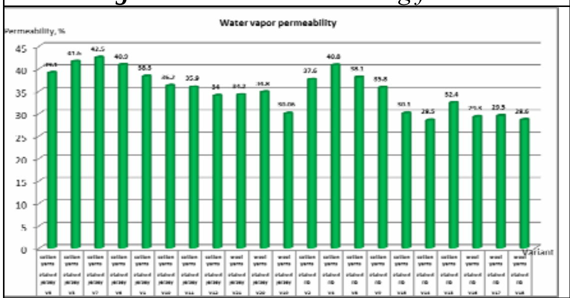


Fig. 3: *Water vapor permeability*

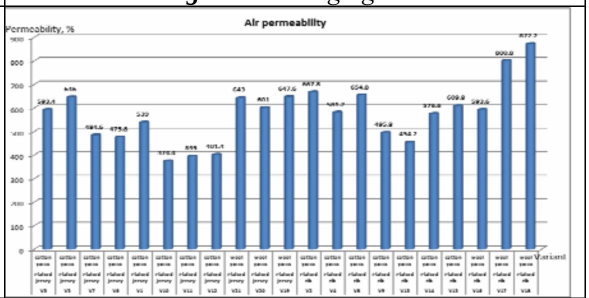


Fig. 4: *Air permeability*

4. CONCLUSIONS

A number of 21 samples made by integral knitting technique with different types of conductive fibres, which can be used in ESD applications, were tested for their ESD properties. The dielectric properties of the same samples were analyzed to see if there is a correspondence between them and ESD properties. Analysing the results, it was found that bilayer structure satisfy the two conditions for the ESD garments (high resistivity and high conductivity).

ACKNOWLEDGMENT

This work was supported by a grant of the Romanian National Authority for Scientific Research, CNDI–UEFISCDI, project PCCA 179 - 2012 "*Haine ESD realizate din fibre cu miez conductor tricotate bistrat*"

REFERENCES

[1] G. Schmeer-Lioe, Anwendungsorientierte Prufung des elektrostatischen Verhaltens vonTextilien, Technische Textilien 43 (2000) 182.

[2] J.N. Chubb, Comments on methods for charge decay measurement, J. Electrostat. 62 (2004) 73-80.

[3] M. Cieslak, S. Wrobel, Assessment of Textiles Based on Three Test Methods of Charge DecayTime, 7th International Symposium EL-TEX 2006 (2006) 16-17.

[4] F. Marchini, Advanced Applications of Mettalized Fibres for Electrostatic Discharge and Radiation Shielding, J. Ind. Text. 20 (1991) 153-166.

[5] N. Wilson, The Nature and Incendiary Behaviour of Spark Discharges from Textile Sufraces, J.Electrostat. 16 (1985) 231-245.

[6] J.L. Davidson, T.J. Williams, A.G. Bailey and G.L. Hearn, Characterisation of electrostatic discharges from insulating surfaces, J. Electrostat 51-52 (2001) 374-480.

[7] A.S. Ardeleanu, A. Verejan and C. Donciu, Study Regarding the Knitting Parameters in 3D Textiles Shields Implementation, Acta Electrotehnica 51 (2010) 128-131.

[8] G. Baumgartner, Consideration for developing ESD garment specifications, ESD TR 05-00 Report, ESD Association (2000).

TEXTILE STRUCTURES FOR AERONAUTICS (PART I)

SOLER Miquel

Centre de Recerca i Transferència de Tecnologia Tèxtil de Canet de Mar, Barcelona, Catalonia (Spain), Plaça de la Industria, 08360 Canet de Mar (Barcelona)

Coreseponding author : Soler Miquel, E-Mail1: solerlm@diba.cat

Abstract: *Three-dimensional (3D) textile structures with better delamination resistance and damage impact tolerance to be applied in composites for structural components is one of the main goals of the aeronautical industry. Textile Research Centre in Canet de Mar has been working since 2008 in this field. Our staff has been designing, developing and producing different textile structures using different production methods and machinery to improve three-dimensional textile structures as fibre reinforcement for composites. This paper describes different tests done in our textile labs from unidirectional structures to woven, knitted or braided 3 D textile structures. Advantages and disadvantages of each textile structure are summarized.*
The first part of this paper deals with the introduction of our Textile Research Centre in the field of composites and carbon fibre as a main material to produce three – dimensional textile structures. The use of composite materials in aerospace structures has increased over the past decades. Our contribution related to this field consists of the development of three- dimensional textile structures and even the adaptation and improvement of machinery to do it possible. Carbon fibre provides advantages as volumetric fraction and minimum fault occurrence. However carbon fibre has also disadvantages as uncomfortable handling delamination and high cost of material and processing.

Key words: *3D, composites, carbon fibre, fabric, aeronautics*

1. INTRODUCTION

Three-dimensional (3D) textile structures with better delamination resistance and damage impact tolerance to be applied in composites for structural components is one of the main goals of the aeronautical industry.

This paper aims to describe the different conventional fabrics making processes and evaluate advantages and disadvantages of each one related to aeronautical industry.

The first time the Textile Research Centre in Canet de Mar got in touch the field of composites for aeronautical industry it was six years ago when a company asked us to produce a cross-shaped 3D textile structure. The challenge was brought to the Research Staff, telling them the structure was a fitting or beam for aeronautics. Next morning, several 3D textile structures were on the table to be assessed. Figure 1 was the closest one to the requirements expressed by the aeronautical company. Our quick and right reply showed that company our capability to think, design and produce textile structures as well as new answers that fit the needs of aeronautical sector.

However, after this first contact we studied the requirements the textile structures have to fulfil and then we realized the complexity and difficulty it has this field [1]. It was the starting point of our collaboration in the field of textile structures for aeronautical sector as a part of composite structures.

Fig. 1. *Cross-shaped 3D fabric*
Source: CRTTT – Escola de Teixits

2. PURPOSE OF COMPOSITES

Cost increases and the reduction of fossil fuel reserves leads to design more efficient and lighter aircrafts. New designs have also in mind the simplification of the production process as well as the requirements of reliability and safety of aircrafts. The main goal is to achieve lighter weight structural components (carbon fibre or other fibres) to replace metal elements with complex geometry as fittings or frames.

Fig. 2 *Redesigning of aircrafts*

3. WHAT A COMPOSITE MATERIAL IS

Composite material is a material made from two or more constituent materials with improved characteristics from the individual components. The individual components remain separate and distinct within the finished structure. Composite materials are made up of two constituent materials: matrix (resin) and fibres /reinforcement (textile structures) [2]. From two constituent materials composite materials for aeronautical can be designed.

It can be generally thought composite materials have been recently invented. However, as shown in table 1 [3], composite materials were used from the beginning of world. Composites can be found either in the nature or in the human body. Besides, from the early times to present days composites have also been invented by humans. However, the fundamental principle of all of them is the same.

Table 1. *Compound materials [3]*

SOURCE	MATERIAL		MATRIX	FIBRES/REINFORCMENT
Nature	Wood		Natural resins	Cellulose fibres
Human Body	Bones		Bone calcium	Collagen fibres
Human Invention	Ancient Times	Adobe	Mud	Straw
		Reinforced plaster	Plaster	Horsehair
	Modernity	Reinforced concrete	Concrete	Reinforced steel
		Asbestos cement	Cement's mortar	Asbestos
		Fibrous mortars and concretes	Mortar	Steel, glass, polymeric, carbon, vegetable fibres
			Concrete	
		Reinforced plaster	Plaster	Glass, polymeric, vegetable fibres
		Polymeric mortars	Resin	Sand
		Composites	**Resin**	Glass, polymeric, carbon, aramid

Looking at the table it can be observed the main innovations in the field of composites are related to building industry in order to design and build more resilient and secure structures. First references to a different industry are related to marine industry, Glasspar, a boat-building company started in 1947 when it began building small fibreglass boat hulls in his fibreglass shop in Costa Mesa, California.

4. WHY CARBON FIBRE?

Carbon Fibre [4] is used because its strength is almost three times higher than steel, and its density 4.5 times lower. Other Carbon Fibre properties include corrosion and fire resistance, chemical inertness and electrical conductivity. It keeps its shape to temperature changes. The above properties make Carbon Fiber perfectly suitable to needs and requirements of aeronautical industry

Table 2 shows the main features of Carbon Fibres and comparison with other fibres

Table 2. *Textile Fibres*

Material	Density [g/cm^3]	Elongation at break[%]	Tensile stress [MPa]
GLASS FIBRE			
E-Glass S-Glass	2,54 2,49	4,8 5,0	3.450 4.300
CARBON FIBRE			
HS HM	1,74-1,76 1,78-1,96	1.8 1,9	4.500 6.000
BORON FIBRE	2,70	0,8	3.100
ARAMID FIBRE			
Kevlar 49 Kevlar 149	1,45 1,47	2,8 1,9	3.620 3.450

5. PROPERTIES OF CARBON FIRE USED IN OUR TESTS AND PREFORMS

Carbon Fibre classification is related to the number of filaments it has each type of yarn. Table 3 shows classification of different types of Carbon Fibre according to the number (k) it has each bobbin.

The relationship is as follows, 1k corresponds to 1,000 filaments of Carbon Fibre. The most common type of fibre used in our tests is 12k, that is to say, 12,000 filaments in laminar form. The use of a type of fibre is a matter of price. 1k, 2k and 3k Carbon Fibre prices are higher than other types. Therefore, the use of them will have an extra cost.

Carbon Fibre is not compatible with resin. This means the fibre has to be prepared previously in order not to reject the resin. There is a sizing process consisting in coating the fibre to make it compatible with the type of resin to be used. We have used epoxi resin for our essays.

The best condition when handling Carbon Fibre is completely flat and stretched as the main drawback is corrugation.

Table 3. *Technical properties of the main Carbon Fibre filament yarns [5]*

Number of filaments 1k=1,000	Nominal linear density	Twist	Tensile Strength [MPa]	Tensile Modulus [GPa]	Elongation at break [%]	Ø [µm] Filament diameter	Density [g/cm^3]	Sizing	% Size level
1k	67 tex	15 S	3.950	238	1,7	7,0	1,76	EPOXI	2,5
2k	140 tex	2 de 15 S 300 Z	3.700				0,14 g/m		
3k	200 tex		3.950	238	1,7	7,0	1,76	EPOXI	1,3
6k	400 tex		3.950	238	1,7	7,0	1,76	EPOXI	1,3
12k	800 tex		4.500	240	1,8	7.0	1,77	EPOXI	1,3
12k	1.420 tex		2.750	215	1,2	7,5[1]	2,70	PU[2]	1,3

6. LAMINAR CARBON FIBRE STRUCTURES FROM UNDIRECTIONAL TOW

Design and fabrication of multilayered laminar structures [6] obtained from unidirectional tows and then cured in an autoclave are the reference material for any structural analysis. It consists of obtaining an isotropic carbon fibre structure able to resist strength from different angles along the axis of coordinates.

Figure 3 shows the distribution of different layers of Carbon Fibre according to the right orientation of each layer in order to obtain an isotropic design of the interlaminar structure. It can be seen it is a 7 layers structure following the configuration 0º, +45º, -45º, 90º, -45º, +45º, 0º

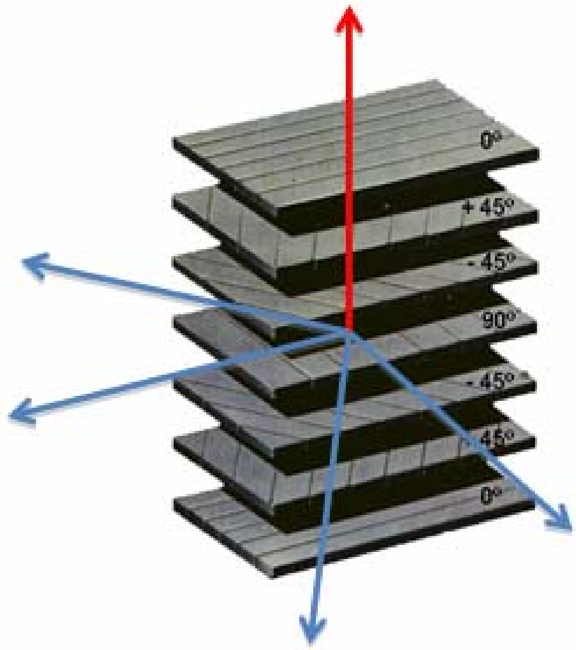


Fig. 3. *Carbon fibre 7 laminar layered structure and fibre orientation of each layer*

6.1. Advantages

- Maximum volumetric fraction
- Minimum fault occurrence: holes or fibre misalignment.

6.2. Disadvantages

- Uncomfortable handling. When placing unidirectional carbon fibre tows according to the structural design, crimps and wrinkles easily happen to appear. This drawback is known as low drapeability.
- Delamination happens when Z strength is applied on the structures. A structure as shown in figure 3 has a high resistance except when this is applied following Z direction. Therefore, it ha a low cross or transversal resistance. When delamination occurs, the fibre would break down as the pages of a book open.
- High cost of material and processing

7. CONCLUSIONS

The manufacture of complex three dimensional textile structures it is still in its starting stage with a high cost due to the amount of labour involved in the process.

Composites are the nowadays solution in the redesign process of aircraft in order to make them more efficient and with a lower consumption.

Carbon fibre is the most suitable material in the manufacturing of composites for the aeronautical sector. It has got higher tensile strength than other fibres.

Delamination is a disadvantage for carbon fibre laminar structures.

REFERENCES:

[1] Michael C. Y. Niu *Composite Airframe Structures* Hong Kong Conmilt Press Ltd. 1992.

[2] Luís Aguirre "*Refuerzos"* pp 1-21 in *Materiales Compuestos*

[3] M. Olivares Santiago, C. Galán Marín, J. Roa Femández COMPOSITES: CHARACTERISTICS AND APPLICATIONS IN BUILDING CONSTRUCTION Dpto. ConstruccionesArquitectónicas 1. Escuela T. Superior de Arquitectura de la Universidad de Sevilla.

[4] Tatsuya Hongu, Glyn O. Phillips and Machiko Takigami "Carbon Fiber expands towards the twenty-first century" pp 99-129 in *New millenium fibers* Woodhead Publishing in Textiles, Cambridge 2005.

[5] TOHO TENAX and SCHAPPE *Technical properties of the main Carbon Fibre filament yarns*

[6] R. Fangueiro and F. Soutinho "Textile Structures" pp 62-92 in R Fangueiro (ed) *Fibrous and composite materials for civil and engineering applications* Woodhead Publishing in Textiles, number 104 Cambridge 2011.

TEXTILE STRUCTURES FOR AERONAUTICS (PART II)

SOLER Miquel

Centre de Recerca i Transferència de Tecnologia Tèxtil de Canet de Mar, Barcelona, Catalonia (Spain), Plaça de la Industria, 08360 Canet de Mar (Barcelona)

Coreseponding author : Soler Miquel, E-Mail1: solerlm@diba.cat

Abstract: *Three-dimensional (3D) textile structures with better delamination resistance and damage impact tolerance to be applied in composites for structural components is one of the main goals of the aeronautical industry. Textile Research Centre in Canet de Mar has been working since 2008 in this field. Our staff has been designing, developing and producing different textile structures using different production methods and machinery to improve three-dimensional textile structures as fibre reinforcement for composites. This paper describes different tests done in our textile labs from unidirectional structures to woven, knitted or braided 3 D textile structures. Advantages and disadvantages of each textile structure are summarized.*
The second part of this paper deals with our know-how in the manufacturing and assessing of three-dimensional textile structures during this last five years in the field of textile structures for composites but also in the development of structures for other applications. In the field of composites for aeronautic sector we have developed textile structures using the main methods of textile production, that is to say, weaving, warp knitting, weft knitting and braiding. Comparing the advantages and disadvantages it could be said that braided fabrics, with a structure in the three space axes (+θº, 0º, - θº) *are the most suitable for fittings and frames.*

Key words: *3D, carbon fibre, fabric, woven, knitted, braided, stitching, tufting*

1. CARBON FIBRE STRUCTURES FROM A FABRIC [1], [2]

An objective of this paper is to examine different manufacturing processes of textile structures or fabrics in order to assess advantages and disadvantages of each manufacturing process. According to the technology used, figure 1 shows the different manufacturing processes.

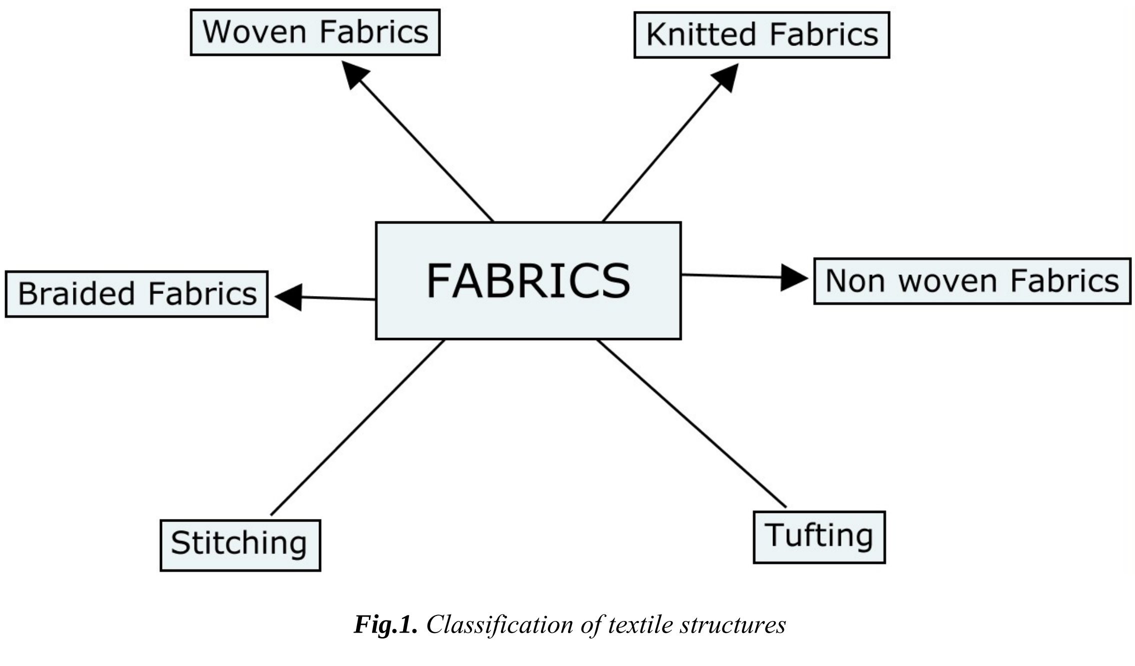


Fig.1. *Classification of textile structures*

Generally speaking fabrics [3] have advantages and disadvantages regarding to reference multilayered laminar structures.

Advantages:
- Easy handling.
- Some of fabrics avoid wrinkles and have good “drapeability”.
- Hybrid fabrics can be designed.
- Possibility of combining fibre and matrix in the same fabric: Twintex® (fibreglass + polypropylene)

Disadvantages:
- The manufacturing process of a textile structure or a fabric implies the bending of carbon fibres (fig. 2). This can cause a large reduction of stiffness and tensile strength. They are less stiffness and strength than reference unidirectional laminar structures.
- Textile structures have got resin-rich areas (matrix) that automatically become weak areas. This is a type of defect with less strength of fatigue failure than reference unidirectional laminar structures.

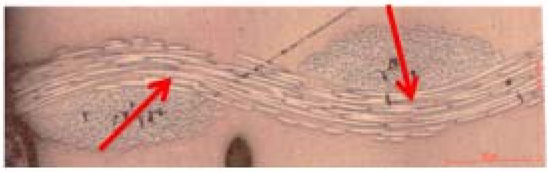


Fig. 2. *Fabric crimping*

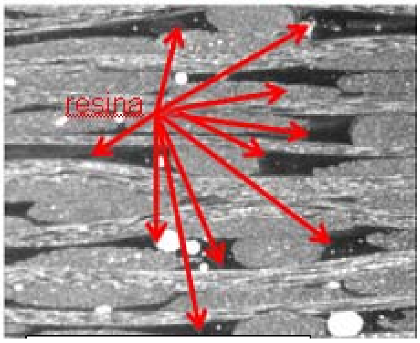


Fig. 3. *Resin-rich zone*

1.1. Woven fabrics [4]

Nowadays weaving is the most widely fabric manufacturing process to obtain carbon fibre textile structures usually through a plain weave fabric or satin weave fabric.

The construction technique consists of overlapping layers of woven fabric having different orientations according to spatial axes setting up a 2,5 D structure.

Advantages:
- Excellent tensile strength.

Disadvantages:
- Delamination when z direction force is applied.
- Low resistance to impact.

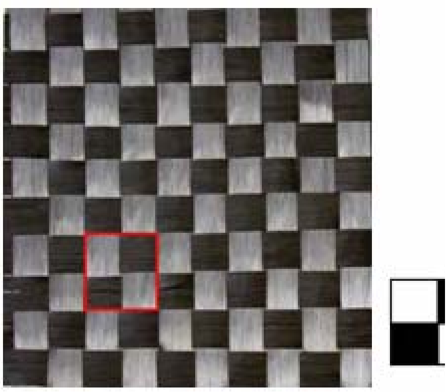


Fig.4. *Plain weave*

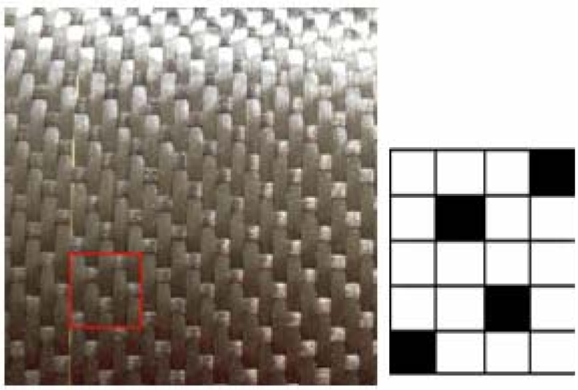


Fig. 5. *Satin*

1.2 Knitted Fabrics [5]

Knitted fabrics can be broadly classified into two groups: weft and warp knitted fabrics. Both of them are fibrous structures characterized by a basic structure called loop. Weft-knitted fabrics are obtained in courses from at least one yarn, while warp-knitted fabrics are produced in wales using a number of yarns identical to the wales to be formed.

As I told above, the bending of carbon fibre is a shortcoming for textile structures. When loop formation is produced carbon fibre bends, so that the use of knitted fabric structures to produce composites with carbon fibre is a disadvantage.

1.2.1 Weft-knitted fabrics

Weft-knitted fabrics are usually used to protect woven or reference fabrics against impact because weft-knitted fabrics have elastic structures suitable for impact attenuation.

Advantages:

- Higher impact damage tolerance.

Disadvantages:

- When loops are formed a high percentage of carbon fibre filaments breaks or fails.
- The outer layer appearance does not show impact. However structural breakages and damages can be observed in inside layers.

a) b)

Fig. 6. *Weft-knitted structure a) and carbon fibre weft-knitted fabric b)*

1.2.2 Warp-knitted fabrics

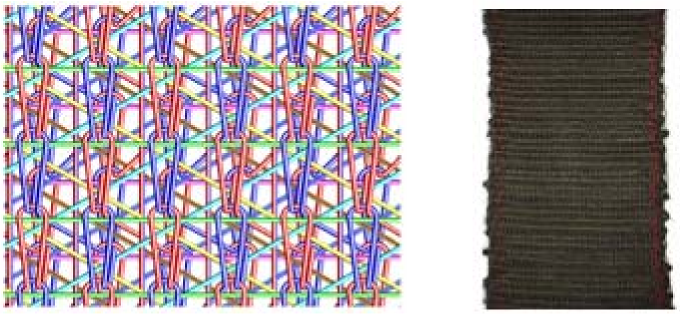
2,5 D fabrics can be obtained trough warp-knitting technique as yarn orientation at 0º, 90º, +45º and -45º.can be inserted.

Advantages:

- Multilayer structure interlocked by stitches can be produced.

Disadvantages:

- When loops are formed a high percentage of carbon fibre filaments breaks or fails.
- Warp-knitted mechanical properties are quite lower when compared to multi-ply reference fabric.



a) b)

Fig. 7. *Warp-knitted structure a) and carbon fibre warp-knitted fabric b)*

1.3 Stitched bonded fabrics

Production technique used to obtain 2,5 D fabrics with yarn insertion at 0º, 90º, +45º and -45º and then fabric layers are bonded by tricot stitching.

Advantages:

- Multilayer structure interlocked by stitches or seams can be produced.

Disadvantages:

- When loops are formed a high percentage of carbon fibre filaments breaks or fails.
- Resin rich areas where interlaminar breakages are produced.

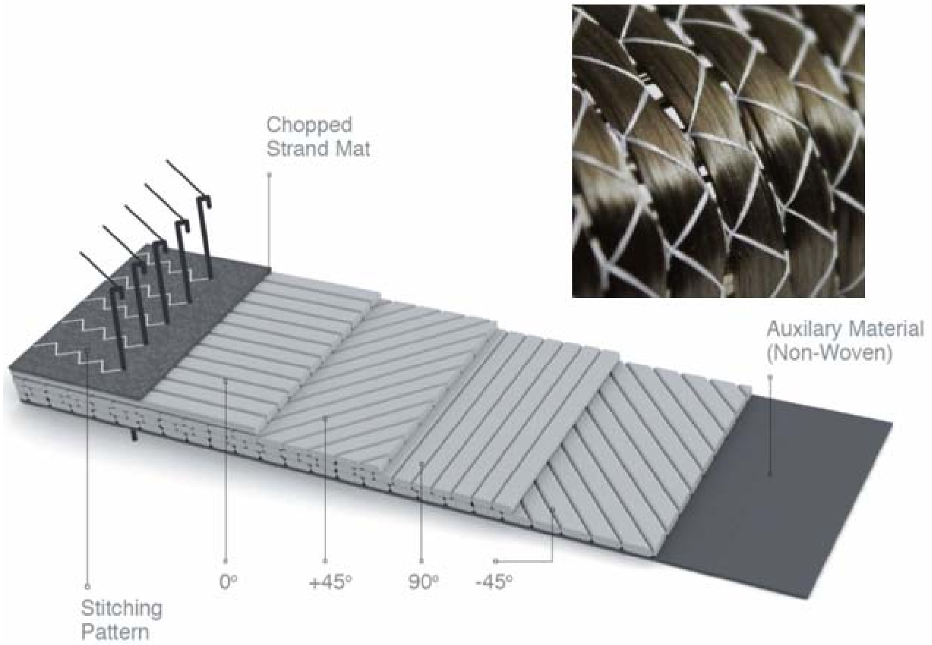


Fig. 8. *Stitched bonded fabric and stitching pattern*

1.4. Tufting Fabrics [6]

Manufacturing process completely excluded when producing carbon fibre composite fabrics, as tufting is used for the production of pile structures or artificial grass green applications.

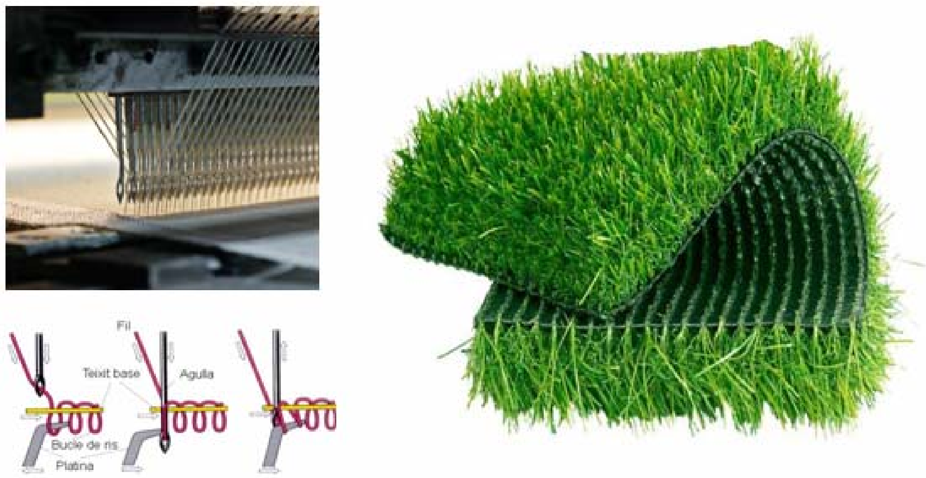


Fig. 9. *Tufting machine and production system of tufting fabric (left). Tufting fabric for artificial turf.*

1.5 Non-woven fabrics + embroidering.

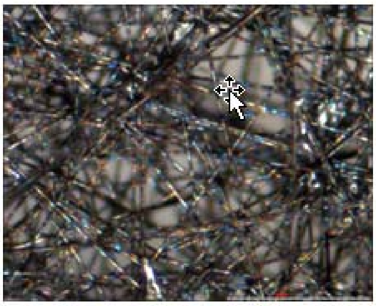
A non-woven fabric would not be a preferred structure for the production of composite material for aeronautics. However, when a non-woven carbon fibre structure is used as a ground base of an embroidered carbon fibre structure conditions change.

Advantages:

- Multilayer structure interlocked by seams can be produced.

- From the beginning to the end the embroidered structure is made using the same carbon fibre yarn.

Disadvantages:
- High percentage of carbon fibre yarn breakage when making a multilayer structure.
- Carbon fibre can not be used as a sewing thread.



a) ***b)*** ***c)***

Fig. 10. *Non-woven carbon fibre fabric a). Embroidery machine head embroidering carbon fibre b). Carbon fibre embroidered multilayer fabric piece c)*

1.6. Braided fabrics [7]
Triaxial braided structures suit perfectly to the needs of aeronautic sector.

Advantages:
- Triaxial compact structures (+θº, 0º, - θº)
- Production of coated structures (core) through triaxial fabrics.

Disadvantages:
- With a regular core, the angle remains at position. However when core diameter varies, carbon fibre angles change so critical points occur as triaxiality (+45º,0º,-45º) can not be maintained.
- Carbon fibre yarn width is not regular through the braided structure.

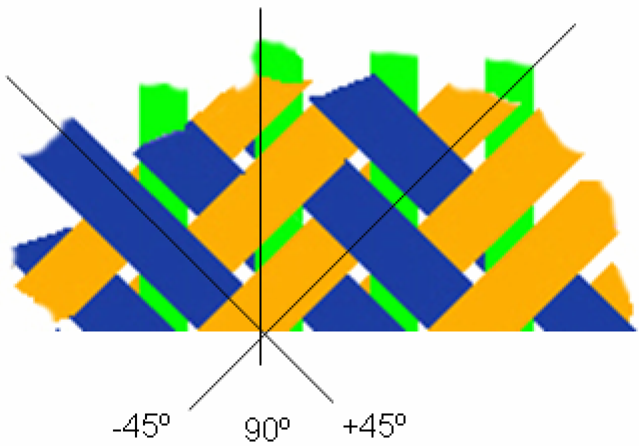
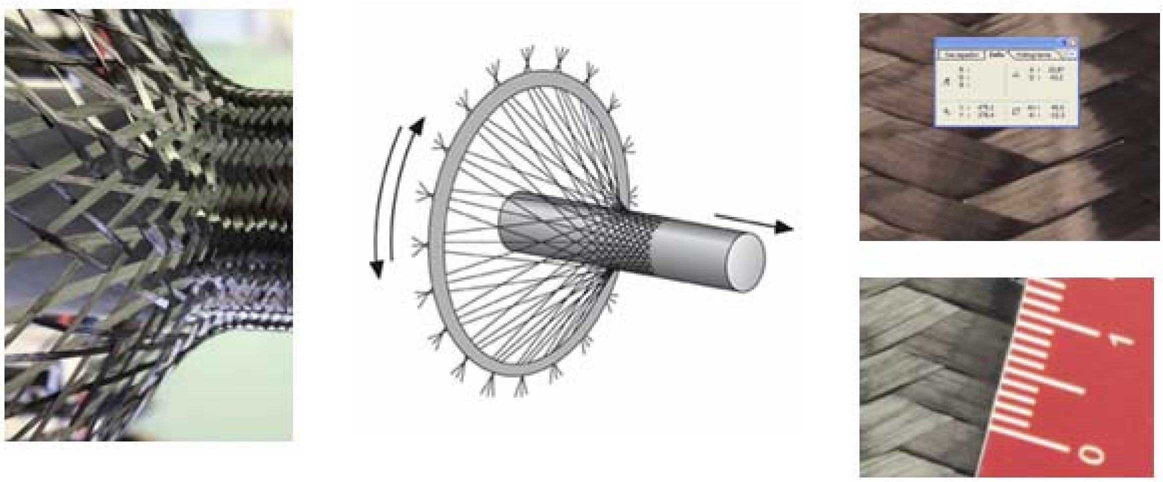


Fig.11. *Triaxial braided structure graphic display*



a) b) c)

Fig. 12. *Carbon fibre braided structure a). Braider outline with core b). Carbon fibre angle variation and width variation in a braided structure c)*

2. CONCLUSIONS

Our Research Textile Centre has manufactured and assessed three-dimensional textile structures within several projects using the main methods of textile production, i.e. weaving, warp knitting, weft knitting and braiding.

Braided Fabrics are the most suitable fabrics for the manufacturing of frames and fittings. Braided fabrics can be triaxial, and this three-dimensional structure suits perfectly to the needs of aeronautic sector. Triaxial fabrics grow its structure in the three space axes (+θº, 0º, - θº). However this structuture has also the shortcoming of delamination.

Textile industry should continue to investigate and improve models in order to offer new and better solutions to aeronautics sector. The main challenge is overcome delamination.

REFERENCES

[1] Jinlian Hu "Introduction to three-dimensional fibrous assemblies" pp 1 – 31 (Chapter 1) in *3D fibrous assemblies* Woodhead Publishing in Textiles, number 74 Cambridge 2008.

[2] "Manufacture of 3D Fibre Preforms" pp 13 -45 in L.Tong, A.P. Mouritz and M.K. Bannister *3D Fibre Reinforced Polymer Composites"* Elsevier 2002.

[3] F. K. Ko "3D textile reinforcement in composite materials" pp 9-42 in Antonio Miravete (editor) *3D textile reinforcement in composite materials"* Woodhead Publishing Limited, Cambridge 1999

[4] Jilian Hu "Multilayer woven structures" pp 104-152 in *3D fibrous assemblies* Woodhead Publishing in Textiles, number 74 Cambridge 2008.

[5] M. Duhovic and D. Bhattacharyya "Knitted fabric composites" pp 193-211 in K.F. Au (ed) *Advances in knitting technology assemblies* Woodhead Publishing in Textiles, number 89 Cambridge 2011.

[6] Eberle, Hannelore et alia *Technologie du vêtement* Ed. Guérin 1999 p 84

[7] T. D. Kostar and T.W. Chou " Braided Structures" pp 217-240 in Antonio Miravete (editor) *3D textile reinforcement in composite materials"* Woodhead Publishing Limited, Cambridge 1999

ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

VIBRATIONS MEASUREMENT IN ORDER TO IDENTIFY THE FAULTS TO THE TABLES AND SUPPORTS ON WHICH THE EMBROIDERY MACHINES ARE PLACED

ŞUTEU Marius [1], INDRIE Liliana[2], GHERGHEL Sabina[3], ALBU Adina[4]

[1,2]University of Oradea, Romania, Department of Engineering and Industrial Management in Textiles and Leatherworks, Faculty of Energy Engineering and Industrial Management, B.St.Delavrancea str. No. 4, 410058, Oradea, Romania, E-Mail1: textile@uoradea.ro

Corresponding author: Marius Şuteu, E-mail: suteu_marius@yahoo.com

Abstract: *The aim of this paper is to accurately and quickly identify the faults of the tables and supports on which the embroidery machines are placed through vibrations measuring method. Vibrations measurements on Happy embroidery machine were performed at S.C. CONFIDEX S.R.L Oradea. A FFT spectrum analyzer Impaq was used, made by Benstone Instruments Inc –SUA.*
The measurements were performed in order to seek the role and importance of the rigidity of embroidery machine supports for a better and more efficient performance of the machine. Before performing these measurements was determined the optimal operating mode of the embroidery machine. The vibration measurements were performed in each measuring point, by installing a vibration sensor on the three directions of the Cartesian coordinates system: axial (X), horizontal (Y), vertical (Z). In the present paper is shown only the measuring direction Z (sensor mounting direction) and advance of the material on x direction (the embroidery direction) this is the most relevant direction, as on this part the embroidery is executed.
After performing these vibration measurements on the HAPPY embroidery machine, previously mounted on a big table, after that mounted on a smaller table and a less rigid base. The same vibrations measurements were performed and it was noticed that it is mandatory to position the machine on a big table and a stable base because it will influence both the reliability and the working regime of the machine.

Key words: *vibrations measurements, FFT spectrum analyzer Impaq, table and support for the embroidery machine, faults.*

1. INTRODUCTION

Frequency analysis of vibrations (FFT analysis) is the one that makes it possible to obtain the necessary information for fault detection in industrial equipment [1].

In order to establish the operational status or fault condition of industrial equipment is necessary to monitor certain parameters of industrial equipment. The values of monitored parameters will be determined when the equipment is new and when is worn, respectively. These values of monitored parameters can be used to study the reliability and maintenance based on fuzzy logic [2], [3], [4], [5].

It is known that any technological equipment does not work without vibrating. It is important however that vibration levels are within the permissible limits. Vibrations study showed that each fault has its own characteristic frequency. During operation, all sources transmit their energy through the table supports both to the table on which the machine is mounted and also to the base on which the table which supports the machine. The only problem is capturing the vibrations with a suitable device and unpacking them in component signals, each signal with its own frequency, depending on the source that produced it.

2. THE EXPERIMENTAL PART

The vibration measurements were performed at S.C. CONFIDEX S.R.L Oradea, on HAPPY professional embroidery machine, with the following characteristics [6]:

- ✓ -embroidery head: 1piece
- ✓ -embroidery area for normal frame: 290x290mm
- ✓ -embroidery area for caps: 70x180mm(2,8x7inch)
- ✓ -number of needles: 12 pieces
- ✓ -speed: 300-1000(normal) and 300-750(for caps)
- ✓ -stitches memory: 250.000
- ✓ -power supply: 220V, la 50/60 Hz
- ✓ -weight: 42kg

The aim of the measurements was to seek the role and importance of the embroidery machine supports as well the base the table of the machine stands on.

Fig. 1: *Support and small table, HAPPY embroidery machine*

Before performing such measurements the optimal operating mode of HAPPY embroidery machine was determined. Determining the optimal operating mode for the embroidery machine, through vibration measurement technique was described by the authors in a previous paper [7].

Vibration measurements were performed in each measuring point by installing a vibration sensor on the three directions of the Cartesian coordinate system: axial (X), horizontal (Y), vertical (Z).

In the present paper is shown only the measuring Z direction (sensor mounting direction) and advance of the material on x direction (the embroidery direction) this is the most relevant direction, as on this part the embroidery is executed.

The amplitude of the vibrations recorded on the vertical measuring Z direction (large mass) and advance of the material in the x direction (the direction of embroidery, fabric-textile fabric) is shown in the table below [7]:

Table 1: *Amplitude of vibrations acoording to the operating mode with sensor on Z (advanse x) – large mass*

OPERATING MODE	VIBRATION AMPLITUDE		
No. Of sinking/min	**VELOCITY** ***mm/s*** **[rms]**	**DISPLACEMENT** ***µm*** **[rms]**	**ACCELERATION** ***g*** **[rms]**
300	**6.4**	**70**	**0.1**
400	**2.2**	**28**	**0.18**
500	**3.8**	**50**	**0.22**
600	**10.8**	**160**	**0.33**
700	**7.6**	**80**	**0.4**
800	**13.7**	**84**	**0.5**
900	**14.4**	**75**	**0.7**
1000	**14.46**	**76**	**0.8**

Based on this table, were determined the diagrams for the: velocity amplitude, displacement amplitude and acceleration amplitude according to the operating mode.

As we can notice in figure 2, the smallest velocity amplitude which does not affect productivity is 7.6 mm/s at 700 stitches/minute operating mode [7], [8].

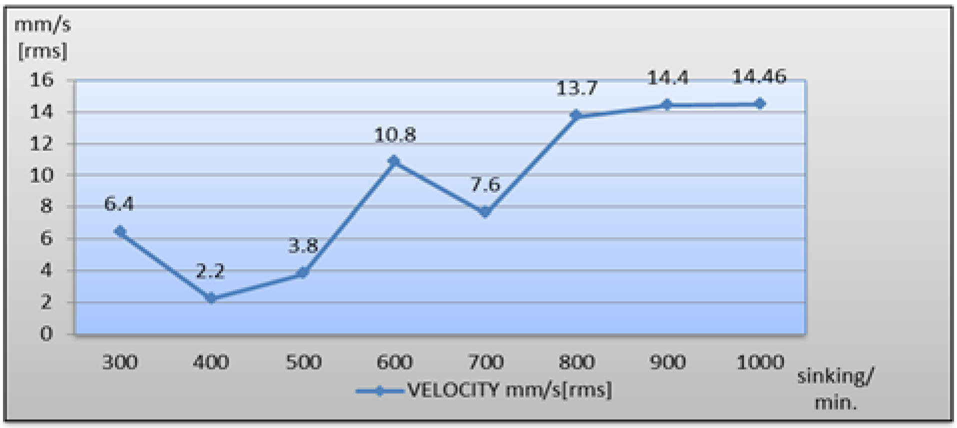


Fig.2: *Amplitude of velocity based on operating modes-large mass*

Displacement amplitude from 700 stitches/minute up to1000 stitches /minute is approximately constant, as can be seen in figure 3.

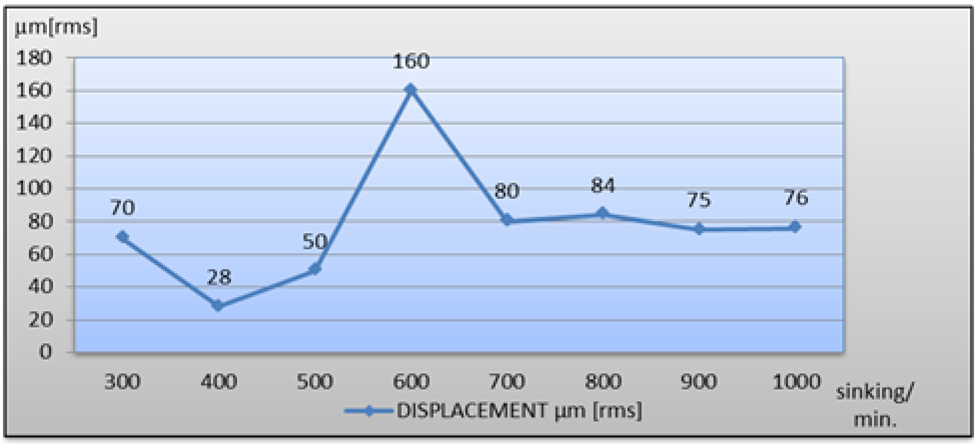


Fig. 3: *Displacement amplitude based on operating modes-large mass*

In figure 4 the acceleration gives the impact “metal on metal”, resulting in an almost linear acceleration.

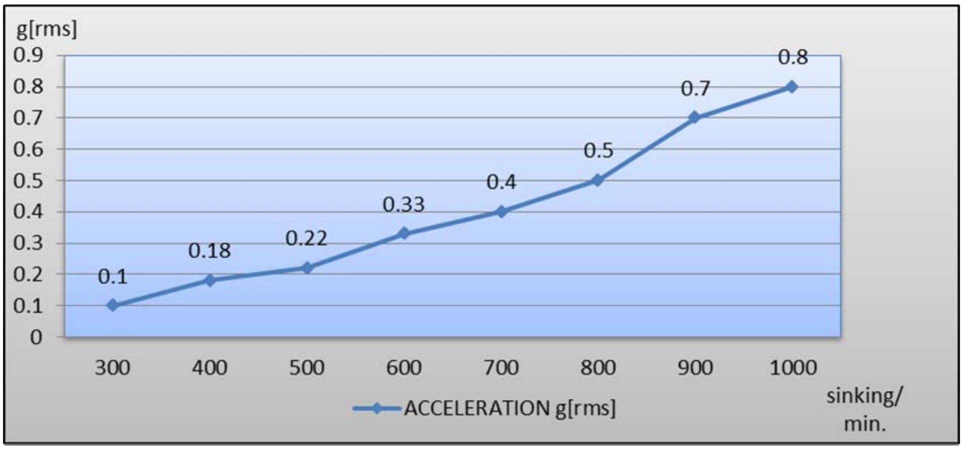


Fig. 4: *The amplitude of acceleration based on operating modes-large mass*

Waveforms and frequency spectrograms obtained for the embroidery “HAPPY” - (large mass), recorded at the measuring point PT1, on the vertical measuring Z direction (sensor mounting direction) and material advance in the x direction (fabric-textile fabric) were presented in the previous paper. [7]

After performing these vibration measurements on Happy embroidery machine, mounted on a large table, the embroidery machine was mounted on a smaller table and a less rigid base and the same vibration measurements were performed.

The vibration amplitude recorded in the vertical measuring Z direction (small mass) and material advance in the x direction (the embroidery direction, fabric-knitted fabric is shown in the table below:

Table 2: *Amplitude of vibrations according to the working regime with sensor on Z (advance x) – small mass*

OPERATING MODE	VIBRATION AMPLITUDE		
No. Of sinking/min	**VELOCITY** ***mm/s*** **[rms]**	**DISPLACEMENT** ***µm*** **[rms]**	**ACCELERATION** ***g*** **[rms]**
500	**4**	**41**	**0,2**
600	**4,5**	**35**	**0,3**
700	**12,9**	**88**	**0,45**
800	**10**	**77**	**0,57**

Based on this table the diagrams for the velocity amplitude, displacement amplitude, and acceleration amplitude according to the operating mode were completed.

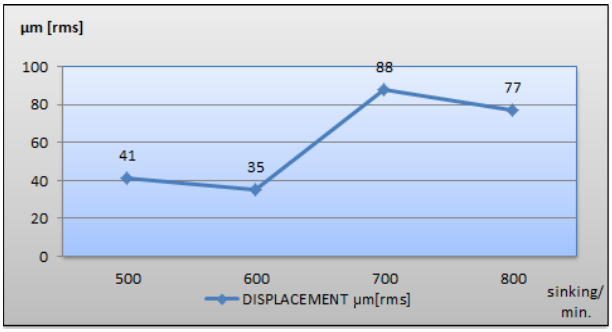


Fig. 5: *Displacement amplitude according to the operating mode with senor mounted on Z vertical 0 small mass (advance on x direction – textile fabric)*

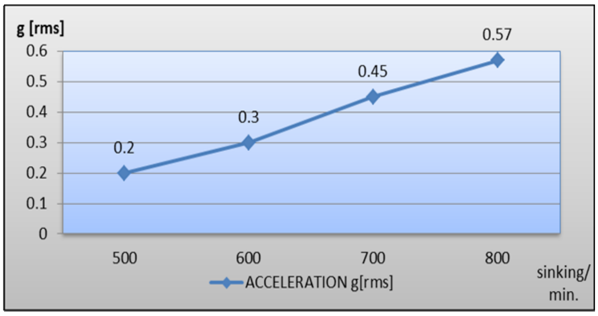


Fig. 6: *Acceleration amplitude according to the operating mode with sensor mounted on Z vertical (advance on x direction – textile fabric)*

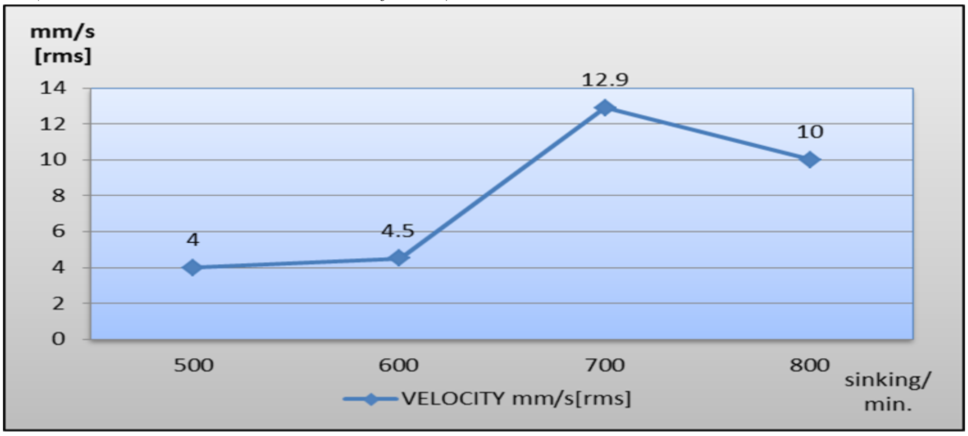


Fig. 7:*Velocity amplitude according to the operating mode with sensor mounted on Z vertical – small mass (advance on x direction – textile fabric)*

Standards in this area indicate that it is appropriate that on any measuring direction should be considered the lowest value of the vibration amplitude.

Waveforms and frequency spectrograms obtained for embroidery machine "HAPPY" - (smaller mass) recorded at the measuring point PT1, on the vertical measuring Z direction (sensor mounting direction) and material advance in the x direction (fabric – textile fabric) are listed below:

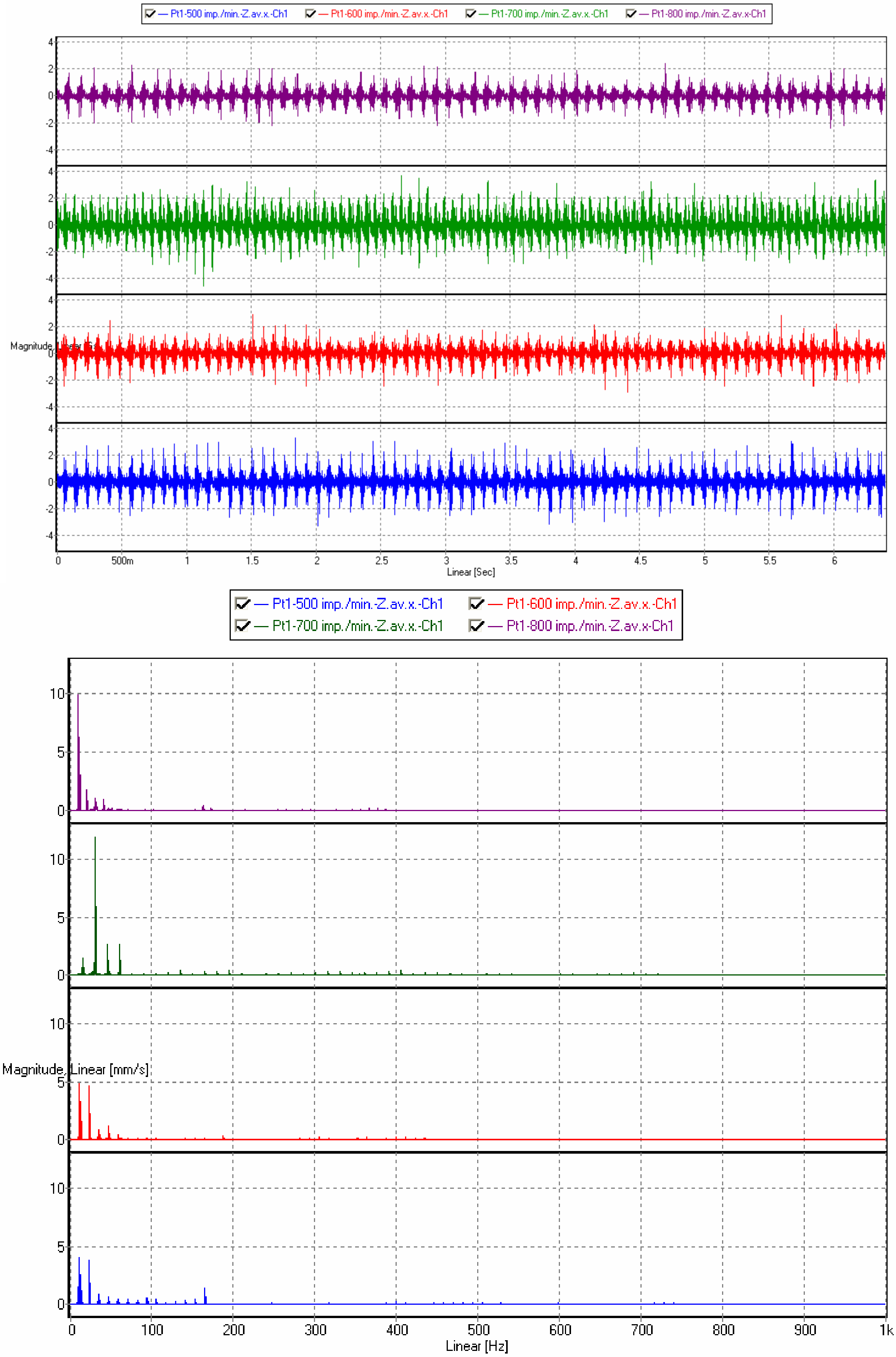


Fig. 8: *Waveforms and frequency spectrograms recorded in measuring point Pt1, on vertical measuring Z direction – (small mass) and material advance in the x direction*

As a result of teh spectral analysis the following were noticed:

a. For 500 stitches/minute operating mode we notice that, the spectral components are relatively similar as dimesion with those of the working regime 600 stitches/minute and the amplitude of vibration velocity has the lowest value 4 mm/s. The disadvantage of this working regime consists in a low productivity.
b. For 600 stitches/minute operating mode in the frequency spectogram can be noticed that bot spectral compoments (1x, 2x) have values aproximatively 5 mm/s, resulting in an increase of global amplitude of vibration velocity reaching the value 4.5 mm/s.
c. For 700 stitches/minute operating mode we can notice in the frequency specrum a significant increase of spectral component 2x over 12 mm/s as well as a slight increase of spectral components order 3 and 4, thus registering an increase of global vibrations over the value 12.9 mm/s. In conclusion this working regime is not recommended because it would lead to decreaseing the machine's reliability.
d. For 800 stitches/minute operating mode we can notice in the frequency spectrum a significant increase of the spectral component 1x over 10 mm/s as well as a decrease of spectral components of 2,3 and 4 order, thus registering an increase of global vibrations.

3. CONCLUSIONS

Following the research performed on HAPPY embroidery machine it was found that the importance of mounting the embroidery machine on a large table and a rigid base has a great influence on the reliability of the machine and implicitly the default operating mode.

At 700 stitches/min operating mode established as optimal by the authors, it is noted that when changing the embroidery machine and its base, the overall vibration level reaches 12.9 mm /s. During this mode is not recommended to work due to the large amplitudes of vibrations which will lead to significantly reducing the reliability of the machine.

When functioning on a small table and a less rigid base, the optimal operating mode of an embroidery machine is 600 stitches/minute because the overall vibration amplitudes have the lowest value. It was found that in this mode and productivity is relatively low.

Hence it can be concluded that for small operating modes the embroidery machine mounted on a small table, the overall vibration level is lower, but the disadvantage is that the productivity is low too.

REFERENCES

[1] D. W.Kammler, *A First Course in Fourier Analysis. Upper Saddle River,* NJ: Prentice Hall, 2000

[2] M, Băban, C.F. Băban, F.S Blaga, *Maintenance planning of cold plastic deformation tools using fuzzy logic*, EKSPLOATACJA I NIEZAWODNOSC-MAINTENANCE AND RELIABILITY, no. 46, pp.21-26, 2010

[3] M.Băban, *Reliability assurance of the motors mechanism cars using the fuzzy systems,* Revista Optimum Q, nr. 1-2-3-4, pg. 97-103, 2004

[4] M.Băban, *The study of the reliability of equipments for welding by pressure processes using fuzzy system*, Annals of the Oradea University. Fascicle of Management And Technological Engineering, ISSN 1583-0691, pp. 1153-1159, 2006

[5] M. Băban, C. F. Băban, I. E. Radu, *Sisteme fuzzy în asigurarea fiabilităţii echipamentelor de presare la rece,* Revista Optimum Q, nr. 3-4, ISSN 120-6598, pp.27-28, 2002

[6] M.Şuteu, Raport de cercetare Nr. 3: *Cercetări şi rezultate experimentale privind asigurarea fiabilităţii proceselor tehnologice din industria textilă*, Universitatea din Oradea, Februarie 2012.

[7] M.Șuteu, M.Baidoc, L. Indrie, M. Ganea, *Determinarea regimului optim de funcționare a mașinii de brodat, folosind tehnica măsurării vibrațiilor*, Revista Industria Textilă, vol 65, nr. 1, 2014, ISSN 1222–5347 (1–62), pp. 17-21

[8] Şuteu, M., Doctorate thesys - „Researches Concerning The Provision Of Technological Processes Reliability In The Textile Industry", University of Oradea, Octombrie 2013.

HIGHLIGHTS OF THE REPRESENTATION COSTUME IN PICTORIAL ART - BAROQUE STYLE -

URDEA Olimpia

University of Oradea, Romania, Department Visual Arts, Faculty of Arts, Universitatii str. 1, 410087 Oradea, Romania, E-mail: oli.urdea@gmail.com

Corresponding author: Urdea, Olimpia, E-mail: oli.urdea@gmail.com

Abstract: *Throughout the social history of human civilization and art history, the human body was and still is a challenging field to explore in various representations, a material for various manners of cultural interventions. The way of artistically representing the body, the clothed body, has followed the path of various artistic movements that marked art history. In the act of interpersonal perception, the costume establishes itself as a particular field of non-verbal communication, one based on image. The present paper refers to the costume, as a particular vector of non-verbal communication in social space, as it was depicted and perceived in the painting of the 17th century and early 18th century, a time marked by the Baroque style. From this point of view, garment received the value of an intermediary in the communication between bodily space and the social one. In Baroque formal portrait, the garment completes by scale and the rendering technique of the texture and chromatics emphasizes the position of the pictorially represented person. Thus, the garment interferes with the gesture and mimics as forms of interpersonal knowledge. The transmitter – the clothed character represented through the eyes of the painter – is exposed to the perceptions of the others, providing a comprehensive matrix of information integrated in the social context. Pictorial representations are included in the matrix of the means by which the body is exposed by the costume in order to communicate with the social environment.*

Key words: *Velasquez, van Dyck, formal portrait, commissioner, formal costume*

1. INTRODUCTION

The image of a garment is a specific aesthetic sign, a code that allows the society to be read in its dynamics. Over the centuries, “fashion has become a powerful transmitter... able to produce and manipulate the signs.”[1] The garment, as an object and sign easily spotted in the social micro-universe, becomes a significant interface of the wearer’s ego. It decorates the body and completes human personality according to the society in which the individual wishes to present himself, a society he wants “to amaze and convince” [2]. By garment, the individual – the wearer – seeks to enrol his body in the social space; a body language in which the human body becomes experimental space. Between the body and social space, as a need to reinvent, the garment asserts itself as a notable material bodily self, looking for identity space.

2. GARMENT AS A SOCIAL SIGN

The clothing systems have shown, over time, particular forms, specific from one civilization to another, from one era to another. Throughout history, the garment played a major part in the social construction of individual identity, being the most visible marker of social status, the easiest means of tracking the individual in pubic space [3]. It gained its attribute of expressing the social body, a device of social individual. What is shown by garment is the concern for self representation and staging. Thus, garment becomes an engine and anticipation of social becoming, a projection of the individual in the social environment [4]. Attire, by its material, constructive and chromatic attributes, is meant to artistically shape the body, thus becoming a personal visual statement.

In the history of universal painting, the human body was represented either nude, thus becoming experimental space, to highlight the morphological-constructive harmony of the body, or clothed to outline a certain state, usually a social one, a social environment. From a morphological point of view, the dressing signs are articulated by juxtaposing or overlapping some elements, by the association of colours and lines, by adding decorative elements in a three-dimensional concert. From a semantic standpoint, it is about an articulation of signifiers. The rules of signification are the ones that determine the meaning of clothing signs; the costume has become such a complex semiotic system with remarkable informational content.

3. BAROQUE COSTUME

3.1 Characteristics of the Baroque movement

The 17th century is marked by Baroque style in all the arts, from the pure to decorative arts, costume, architecture, being associated with the rule and personality of Louis XIV. By what they are providing in this period, the arts are intended to amaze the viewer who is surprised by the greatness and materiality chosen by the artist, by “the dramatic scenes represented and the illusionist use of detail and perspective”[5].

3.2 Characteristics of the Baroque costume

In Baroque painting the characters are represented luxuriously clothed, placed in spectacular backgrounds, richly ornamented, and the shapes of the costume are lavish. The dress code is rigid, formal, the curvilinear constructions being the result of the influence of decorative arts in the Baroque period [6]. The commissioners of the portraits want to amaze with the attitude outlined by the heavy, ample garment. The sophisticated decoration of the Baroque costume is completed by the bold colours of the brocades and silk laces of the best quality. The representation costume, gains powerful meanings and largely dominates the Baroque painting. Whether profane or religious portraits, the emphasized representation of the garment becomes an element that emphasizes personality and social role of the person portrayed.

3.3 Highlights of the representation costume in Baroque painting.

Diego Velasquez was one of the prominent representatives of Baroque portrait representations. In the portrait of the Infanta Margarita Teresa exhibited at the Museum of Art History in Vienna, the composition is dominated by the blue dress. The Infanta's imposing posture is accentuated by the volume of the dress, outlined by the play of lights and shadows. The entire emphasis is laid on the loaded attire, accessorised with a fur muff. The painter shows the same attention for clothing details in the portrait of Prince Felice Prospero. Although the prince was only two years old at the time of painting the portrait, his attire is carefully described by the painter, with fine strokes in order to render the elegance of his clothes, with silver inserts on red garment.

The costume ensemble makes its mark in the formal portrait of Baroque art, creates show, generates admiration and gains an indisputable aesthetic status. It is enough to watch the portrait of Infanta Maria Teresa at 14 years old, painted in 1653 by the same Velasquez or the portrait of King Philip IV created a few years later. While the first portrait is dominated by the volume of the dress, in the second one, the ornamental richness of the costume is surprised by the play of lights and shadows. Being considered a court painter by King Philip IV of Spain, Velasquez renders the social register represented in Las Meninas, a painting in which the sumptuous interior is completed and somehow overshadowed by the outfits worn by the represented characters.

“The work of art is an image whose centre is loaded by the visual energy emanating to the viewer”[7]. The viewer's emotion arises from the understanding of the symbol and the perception of general expressiveness. Such a portrait emerges from a refined living environment which is intended to be of high culture and “high civilization”. In the Baroque formal painting, the garment rigidly defines the character getting to the point that it redefines him; this redefinition depends on the image desired to be projected. As part of the court ritual, painting was a composition of the subject through his garment and the gallery of paintings by Velásquez fully proves it.

In the portrait of Pope Innocent X, the materiality of the garment is loaded with a strong force of visual expression by the fluent technique of the painter. The artistic experience of creating shapes, of suggesting the lights and shadows in the garment, by the silk materiality, complete the constitutive elements of human representation.

Fig. 1 *King Philip IV*
Source: http://www.nationalgallery.org.uk/paintings/diego-velazquez-philip-iv-of-spain-in-brown-and-silver

Fig. 2: *Queen Isabel*
Source: http://www.diegovelazquez.org/Queen-Isabel,-Standing-1631-32.html

Fig. 3: *Pope Innocent X*
Source: http://www.doriapamphilj.it/ukinnocenzox.asp

At Fashion Museum in Bath, England, one can admire Sir Thomas Kirkpatrick's costume, consisting of a robe embroidered with silver, in a rich decorative registry, the rigidity of the garment being a feature of the late Baroque period. The collarless knee-length coat, tight at the waist, ample on the end line, is completed by a waistcoat and knee-length trousers. The whole outfit is considered the predecessor of the current three-piece suits for men.

This social segregation, imposed by those at the top of the social hierarchy, had to be immortalized for the same reason of self-confirming power in a Europe where social prejudices had manifested themselves, above all, through garment. In such a situation, the formal portrait becomes a self-standing art that imposes itself as a necessity to validate the status of the powerful ones. In this context, the works of art – portraits, embroideries – provide precious information on the costume, on the peculiarities of that age, thus becoming a mirror of the society. The function of the garment changes according to social frameworks. Thus, the formal portrait encompasses a range of artistic and social attitudes and behaviours alike, composing the decorative grammar of representation. The portrait, which in the interest in representation gained a wide momentum in the easel painting at one time, can be considered historical document, loaded with demonstrative intentions. Made to order, they belong to the social history of representations. Thus, the identity of the individual becomes an identity of the garment. The portrait, more social than physical or psychological, is narrative, devoid of liveliness and vibrations, getting closer to the still life genre.

In the Flamand Baroque, Antoon van Dyck becomes famous by his representation portraits created at the court of Charles I of England. His portraits reveal the same sense of grandeur, highlighted by the luxury of the clothing. The silk, the privilege of bourgeoisie and royal court, is perceived visually in the heavy velvet of the garments, in the gloss of the satin shown by the play of lights and shadows. The garment creates the predominance of the character's image. It is the one that governs the interpersonal perception in visual communication [8].

In the gallery of representation portraits, the painter aims to create an imposing image in which the accent lays on the rich and sumptuous clothing, as well as on the attitude for the psychological purpose of artistic and social rendering. The main goal of the decorative grammar of the portrait was to enhance representation.

The formal Baroque portraitist uses the body of the person portrayed as a support of ordering axes on which he encompasses his precious fabrics. He wraps the body in the garment and integrates it in the painting ensemble, amplifying its power. The portraitist “describes the costume”, he endows it with force lines in accordance with the body it covers.

4. CONCLUSIONS

The costume has seen, in the course of its history, a continuous metamorphosis, becoming a mirror of the history of society. Baroque, as an artistic style, has left its mark on clothing style in an original way in which the outline of the social status found its expressiveness. Portrait representations of the commissioners offer essential sources for history both from constructive-architectural and material texture standpoint. The position of the person portrayed is essential, less his physiognomy. The image of the person portrayed is invented through the garment. Thus, the representation garment becomes the interest point of the portrait; it has the role of changing attitudes, it puts them in order and amplifies them in accordance to the conditions imposed to the body, shoulders, and arms [9]. The entire composition of the portrait gives an image of the model in order to mould the viewer's psychology.

REFERENCES

[1] R. Berger, *Mutaţia semnelor*, Editura Meridiane, Bucureşti, 1978, p. 439

[2] Al. Husar, *Izvoarele artei*, Editura Meridiane, Bucureşti, 1988, p. 40

[3] D. Crane, *Fashion and its social agendas: class, gender, and identity in clothing,* University of Chicago, Chicago, 2000, p. 1

[4] F. Chenoune, (2012, september 26), *Espace Mode Méditerranée*, [Online]. *Available from:* www.crdp-aix-marseille.fr/sites/crdp-aix marseille.fr/IMG/pdf/Actes-colloque-mode2004.pdf

[5] M. Hollingsworth, *Arta în istoria umanităţii,* RAO International Publishing Company, Bucureşti, 1997, p. 301

[6] M. Mackenzie, *...Isme- să înţelegem moda*, Grupul editorial Rao, Bucureşti, 2010, p. 12

[7] R. Arnheim, *Forţa centrului vizual*, Editura Meridiane, Bucureşti, 1995, p. 68

[8] A. Hollander, *Seeing through clothes,* London, 1993, p. 314

[9] E. C. Alain, *Un sistem al artelor frumoase,* Editura Meridiane, Bucureşti, 1969, p. 54

VARIANCE ANALYSIS OF WOOL WOVEN FABRICS TENSILE STRENGTH USING ANCOVA MODEL

VÎLCU Adrian[1], HRISTIAN Liliana [2], BORDEIANU Demetra Lăcrămioara[3]

[1, 2, 3]"Gh.Asachi" Technical University of Iasi, Romania, Faculty of Textile, Leather and Industrial Management, Prof. Dr. Doc. Dimitrie Mangeron Str., No. 29, 700050, Iasi, Romania

Corresponding author: Hristian Liliana, e-mail: hristianlili@yahoo.com

Abstract: *The paper has conducted a study on the variation of tensile strength for four woven fabrics made from wool type yarns depending on fiber composition, warp and weft yarns tensile strength and technological density using ANCOVA regression model.*
In instances where surveyed groups may have a known history of responding to questions differently, rather than using the traditional sharing method to address those differences, analysis of covariance (ANCOVA) can be employed. ANCOVA shows the correlation between a dependent variable and the covariate independent variables and removes the variability from the dependent variable that can be accounted by the covariates.
The independent and dependent variable structures for Multiple Regression, factorial ANOVA and ANCOVA tests are similar. ANCOVA is differentiated from the other two in that it is used when the researcher wants to neutralize the effect of a continuous independent variable in the experiment.
The researcher may simply not be interested in the effect of a given independent variable when performing a study. Another situation where ANCOVA should be applied is when an independent variable has a strong correlation with the dependent variable, but does not interact with other independent variables in predicting the dependent variable's value. ANCOVA is used to neutralize the effect of the more powerful, non-interacting variable. Without this intervention measure, the effects of interacting independent variables can be clouded.

Keywords: *ANCOVA model, fiber composition, tensile strength.*

1. INTRODUCTION

Analysis of covariance models combines analysis of variance with techniques from regression analysis. With respect to the design, ANCOVA models explain the dependent variable by combining categorical (qualitative) independent variables with continuous (quantitative) variables. There are special extensions to ANCOVA calculations to estimate parameters for both categorical and continuous variables. ANCOVA models can, however, also be calculated using multiple regression analysis using a design matrix with a mix of dummy-coded qualitative and quantitative variables. In the latter approach, ANCOVA is considered as a special case of the General Linear Model (GLM) framework [1].

The study was conducted on woven materials made of combed wool type yarns used for manufacturing outwear clothing, on 63 articles structured as follows [2], [3]:
- Group A: 13 articles with $Nm_{warp}=Nm_{weft}$; 11 articles with $Nm_{warp}\neq Nm_{weft}$.
Total: 24 articles;
- Group B: 13 articles with $Nm_{warp}=Nm_{weft}$; 4 articles with $Nm_{warp}\neq Nm_{weft}$.
Total: 17 articles;
- Group C: 4 articles with $Nm_{warp}=Nm_{weft}$; 5 articles with $Nm_{warp}\neq Nm_{weft}$.
Total: 9 articles;
- Group D: 13 articles with $Nm_{warp}=Nm_{weft}$. Total: 13 articles

The variation limits of the composition and structural characteristics for the tested woven materials are indicated in Table 1.

Table 1: Variation limits of composition and structural characteristics

Group/Fibrous composition		Nm_{Warp}	Nm_{Weft}	T_{warp} Twist $_{Warp}$ (twist/m)	T_{weft} $Twist_{Weft}$ (twist/m)
Group A 100%Wool	min	40/2	24/1	530	410
	max	64/2	37/1	740	730
Group B 45%Wool +55% PES	min	48/2	30/1	600	510
	max	64/2	64/2	780	740
Group C 44% Wool + 53%PES + 3% D	min	56/2	37/1	510	480
	max	60/2	60/2	730	730
Group D 60% PES + 40% Celo	min	52/2	52/2	420	400
	max	64/2	64/2	500	500

The tensile testing was performed using an H 1K-S UTM Tinius Olsen (Hounsfield) testing machine, with a 1 kN load cell. The tests were done accordingly to standard (SR EN ISO 2062, 2002), on both directions – weft and warp [4], [5], [6].

2. EXPERIMENTAL PART

2.1. Collection, systematization and processing of experimental data

Based on the experimental data, the following variables were included in the ANCOVA regression model:

- dependent variable (Y) is tensile strength variance, Pr(daN);
- nominal independent variable is group of woven fabrics depending on fiber composition (100% Wool, 100% PES, 45% Wool + 55% PES, 45%Wool + 52% PES + 3% Dorlastan) – three dummy variables D_1, D_2 respective D_3;
- quantitative independent variables (X1 respective X2) are warp yarns tensile strength P_{rwarp} (daN) and weft yarns technological density D_{weft} (yarns/10cm).

2.2. Hypothesis formulation

H_0: there are no significant differences between tensile strength values of woven fabrics depending of fiber composition, warp yarns tensile strength P_{warp} (N) and weft yarns technological density D_{weft} (yarns/10cm);

H_1: there are significant differences between tensile strength values of woven fabrics depending of fiber composition, warp yarns tensile strength P_{warp} (N) and weft yarns technological density D_{weft} (yarns/10cm), (H_0 is rejected).

2.3. Formulation of the regression model

Nominal independent variable "fiber composition" has four categories so will be three dummy variabels also called alternative variables. Reference woven fabrics (D_1, D_2, D_3) will be those from 100 % wool. Therefore, all the interpretation will be done compared to this group of woven fabrics.
The dummy variables are defined in table 2.

Table 2: *Definition of dummy variables*

Group	D_1	D_2	D_3	Fiber Composition
1	1	0	0	45% wool + 55% PES
2	0	1	0	45% wool+ 52% PES + 3% Dorlastan
3	0	0	1	100% PES
4	0	0	0	100% wool

The ANCOVA model with three dummy variables is defined as relation:

$$Y = a_0 + a_1 D_1 + a_2 D_2 + a_3 D_3 + b1\ X1 + b2\ X2 + \varepsilon \quad \textbf{(1)}$$

The regression, as a conditioned mean, has the following forms:

$$M\ (Y/D) = a_0 + b1\ X1 + b2\ X2 \quad D_1, D_2, D_3 = 0 \quad \textbf{(2)}$$

for tensile strength variance of 100% wool woven fabrics;

$$M\ (Y/D) = (a_0 + a_1) + b1\ X1 + b2\ X2 \quad D_1 = 1 \quad D_2, D_3 = 0 \quad \textbf{(3)}$$

for variance of tensile strength of 45% Wool + 55% PES woven fabrics;

$$M\ (Y/D) = (a_0 + a_2) + b1\ X1 + b2\ X2 \quad D_2 = 1 \quad D_1, D_3 = 0 \quad \textbf{(4)}$$

for tensile strength variance of 45% Wool + 52% PES + 3% Dorlastan woven fabrics;

$M(Y/D) = (a_0 + a_3) + b1\ X1 + b2\ X2 \quad D_3 = 1 \quad D_1, D_2 = 0$ **(5)**

for tensile strength variance of 100% PES woven fabrics.

The coefficients of ANCOVA model defined in table 3 were determined for the established model. Estimators and model estimations are defined similar previous models.

Table 3: *ANCOVA model - coefficients*

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	38,890	12,651		3,074	0,003
	D_1	18,660	5,024	0,160	3,714	0,000
	D_2	-17,705	4,697	-0,211	-3,769	0,000
	D_3	73,901	10,835	0,673	6,820	0,000
	D_{weft} (yarns/10cm)	2,414E-02	,070	0,044	0,344	0,732
	Pr_{warp}(N)	3,207	1,436	0,203	2,233	0,029

a Dependent Variable: Pr_{fabric}(daN)

The estimations of model are: a_0 = 38,890; a_1 = 18,660; a_2 = -17,705; a_3 = 73,901; b_1 = 0,024; b_2 = 3,207

The estimated ANCOVA model has the following expression:

$Y = 38{,}890 + 18{,}660\ D_1 - 17{,}705\ D_2 + 73{,}901\ D_3 + 0{,}02414\ X1 + 3{,}207\ X2$ **(6)**

2.4. Model interpretation

The model interpretation is the following:

a) a_0 = **38,890** is the mean value estimate tensile strength of the fabrics from 100 % wool while the tensile strength of the warp yarns and the weft yarn density technology may be encoded to 0 (X1 = 0, X2 = 0).

b) $a_0 + a_1$ = 38,890 + 18,660 = **57,55** is the mean value estimate tensile strength of woven fabrics from 45 % wool + 55 % PES while the tensile strength of the warp yarns and the weft yarn density technology may be encoded to 0 (X1 = 0, X2 = 0).

c) $a_0 + a_2$ = 38,890 – 17,705 = **21,185** is the mean value estimate tensile strength of woven fabrics from 45 % wool + 52 % PES + 3 % Dorlastan while the tensile strength of the warp yarns and the weft yarn density technology may be encoded to 0 (X1 = 0, X2 = 0).

d) $a_0 + a_3$ = 38,890 + 73,901 = **112,791** is the mean value estimate tensile strength of woven fabrics from 100 % PES while the tensile strength of the warp yarns and the weft yarn density technology may be encoded to 0 (X1 = 0, X2 = 0).

e) b_1 and b_2 shows the tensile strength variance of fabrics type wool while while the tensile strength of the warp yarns and the weft yarn density technology increases by one unit.

It is observed from the table of coefficients that sig. is <0.05 (except sig. D_{weft} (yarns/10cm), the value being 0.732)

Note: Although the sig. D_{weft} (yarns/10cm) exceeds 0.05 (which shows that the weft yarn density does not significantly influence the dependent variable) was not excluded Backward processing method (see Table 4)

Table 4: *Variables Entered/Removed*

Model	Variables Entered	Variables Removed	Method
1	Pr_{warp}(N), D1, D2, D3, Db(fire/10cm)	0,000	Enter

a All requested variables entered.
b Dependent Variable: Pr_{fabric}(daN)

Interpreting the sig value can conclude that there are significant differences between the values of tensile fabric depending on fiber composition, tensile strength of warp yarns Pr_{warp} (N) (the hypothesis Ho it is rejected).

Technological density of weft yarns D_{weft} (yarns/10cm) does not significantly influence the variation of tensile strength of 100% wool woven fabrics.
-Ho: between the values of tensile fabric no significant differences based on fiber composition, tensile strength of warp yarns Pr_{warp} (N) and technological weft density D_{weft} (yarns/10cm)
-H1: between the values of tensile fabric there is significant differences depending on fiber composition, tensile strength of warp yarns Pr_{warp}(N) and technological weft density D_{weft} (yarns/10cm)

2.5. Hypothesis confirmation over errors

2.5.1. M(ε) = 0 (errors mean is nule)

Hypothesis:

- Ho: M (ε) = 0
- H1: M (ε) ≠ 0

The Student t-test t for error (Unstandardized Residual) evaluation is applied as shown in table 4.

Table 4: *Student t-test for testing of errors mean*

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Unstandardized Residual	0,000	63	1,000	-2,1094237E-15	-1,3212957	1,3212957

(Sig.= 1 > 0,05), so hypothesis H_0 is accepted, errors mean is zero.

2.5.2. V (εi) = σ^2 homoscedasticity hypothesis)

A non-parametric correlation test is applied between the estimated errors and the dependent variable (D_1, D_2, D_3).The correlation coefficient Spearman is calculated and the Student t-test for this coefficient is performed. The results are indicated in table 5.

Hypothesis:

- H_0: the correlation coefficient is insignificantly larger than zero (the null hypothesis of the Student t-test is accepted);
- H_1: the correlation coefficient is significantly larger than zero (the null hypothesis of the Student t-test is rejected).

The values of sig. for the correlations D_1 – estimated errors (0,840), D_2 – estimated errors (0,976), D_3 – estimated errors (0,355), D_{weft} (yarns/10cm) – estimated errors (0,091), Prwarp (N) - estimated errors (0,114) are bigger than 0.05, which means that the null hypothesis of the Student test is rejected, so the model is homoscedastic (see Table5).

2.5.3. εi ~ N (0, σ2) – normality hypothesis

Testing the normality of error distribution is done with the nonparametric Kolmogorov-Smirnov test (see Table 5).

Table 5: *Testing of the normality hypothesis. One-Sample Kolmogorov-Smirnov Test*

		Unstandardized Residual
N		64
Normal Parameters	Mean	-1,9790605E-09
	Std. Deviation	5,2895718
Most Extreme Differences	Absolute	0,051
	Positive	0,039
	Negative	-0,051
Kolmogorov-Smirnov Z		0,406
Asymp. Sig. (2-tailed)		0,997

a Test distribution is Normal.
b Calculated from data.

Table 6: *Spearman test for verifying the homoscedasticity hypothesis*

			D_1	D_2	D_3	D_{weft} (yarns/10cm)	Pr_{warp} (N)	Unstandardized Residual
Spearman 's rho	D_1	Correlation Coefficient	1,000	-0,202	-0,132	0,389	0,403	-0,026
		Sig. (2-tailed)	0,000	0,109	0,297	0,001	0,001	0,840
		N	64	64	64	64	64	64
	D_2	Correlation Coefficient	-0,202	1,000	-0,218	-0,750	-0,751	-0,004
		Sig. (2-tailed)	0,109	0,000	0,083	0,000	0,000	0,976
		N	64	64	64	64	64	64
	D_3	Correlation Coefficient	-0,132	-0,218	1,000	0,573	0,561	0,118
		Sig. (2-tailed)	0,297	0,083	0,000	0,000	0,000	0,355
		N	64	64	64	64	64	64
	D_{weft} (yarns/ 10cm)	Correlation Coefficient	0,389	-0,750	0,573	1,000	0,975	0,213
		Sig. (2-tailed)	0,001	0,000	0,000	0,000	0,000	0,091
		N	64	64	64	64	64	64
	Pr_{warp}(N)	Correlation Coefficient	0,403	-0,751	0,561	0,975	1,000	0,199
		Sig. (2-tailed)	0,001	0,000	0,000	0,000	0,000	0,114
		N	64	64	64	64	64	64
	Unstandardized Residual	Correlation Coefficient	-0,026	-0,004	0,118	0,213	0,199	1,000
		Sig. (2-tailed)	0,840	0,976	0,355	0,091	0,114	0,000
		N	64	64	64	64	64	64

** Correlation is significant at the 0.01 level (2-tailed).

The Sig = 0,997 (higher than 0,05), therefore the normality hypothesis H_0 is accepted.

2.5.4. cov (εi, εi) – testing of errors autocorrelation

Hypothesis:

- H_0: $\rho = 0$ (the errors are not auto-correlated);
- H_1: $\rho \neq 0$ (the errors are auto-correlated).

The verification is done with the Durbin Watson test and the results are shown in Table 7.

Table 7: *Durbin Watson test for errors auto-correlated testing*
Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0,989	0,979	0,977	5,51	1,649

a Predictors: (Constant), Pr_{warp}(N), D_1, D_2, D_3, D_{weft}(yarns/10cm)
b Dependent Variable: Pr_{fabric}(daN)

The value of 1.649 is compared with the calculated value of test (dl, du). It has been observed that the obtained value is contained in the (du, 4 – du) interval. Therefore, the nule hypothesis is accepted (the recorded errors are auto-correlated).

2.6. Testing collinearity of independent variables

Table 8: *Testing collinearity of independent variables*
Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	38,890	12,651		3,074	0,003		
	D_1	18,660	5,024	0,160	3,714	0,000	0,193	5,177
	D_2	-17,705	4,697	-0,211	-3,769	0,000	0,115	8,712
	D_3	73,901	10,835	0,673	6,820	0,000	0,037	27,041
	D_{weft} (yarns/10cm)	2,414E-02	0,070	0,044	0,344	0,732	0,022	45,113
	Pr_{warp}(N)	3,207	1,436	0,203	2,233	0,029	0,043	23,016

a Dependent Variable: Pr_{fabric}(daN)

The indicator VIF has high value ranging between (5.177, 45.113), which indicates that there is collinearity between the independent variables used in the model.

3. CONCLUSIONS

a) The ANCOVA model permits us to evaluate the homogeneous character of a population by separating and testing of the effects caused by the considered factors.

b) If the test data obtained after trials on the elements of a sample taken from one homogeneous population are divided in distinct groups, then the mean values of the groups do not differ significantly between themselves.

c) In the case of a non-homogeneous population, the deviations of the individual values as compare to the mean value are not anymore accidental and when dividing the test data in distinct groups the mean values are differ between themselves significantly because of some causes having a systematic action.

d) ANCOVA model included as independent variables, both dummy or alternative variables (fiber composition) and numerical variables (tensile strength of warp and weft yarn density technology) and as the dependent variable, tensile strength woven fabrics.

e) By applying and interpreting regression model ANCOVA sig value can conclude that there are significant differences between the variance of tensile strength of woven fabrics depending on fiber composition, tensile strength of warp yarns Pr_{warp} (N) (the null hypothesis Ho is rejected).

f) Technological weft density D_{weft} (yarns/10cm) does not significantly influence the tensile strength variation of woollen woven fabrics.

REFERENCES

[1] Hristian L., Bordeianu D. L. and Lupu I. G., *"The quantitative and qualitative analysis of woven fabrics type wool surface characteristic using Anova model"*, Annals of the university of Oradea Fascicle of Textiles, Leatherwork, vol. VIX, 2013, No. 2, pp. 50-56.

[2] Hristian L., *„Substantion and Elaboration of a New Testing Methodology of Woven Materials Surface Characteristics with Classical Testing Methods*", Ph.D. Thesis, "Gheorghe Asachi" Technical University, Jassy, 2008.

[3] Hristian L., Bordeianu D. L. and. Lupu I. G, "*The quantitative and qualitative analysis of woven fabrics type wool surface characteristics using Anova model",* Annals of the University of Oradea, Fascicle of Textiles, Leatherwork, vol. VIX, 2013, No. 2, pp. 50-56.

[4] Hristian L., Lupu I. G. and Cramariuc O., "*Employing the ANOVA model for the differentiation of wool type woven materials based on their handle properties",* International Scientific Conference 19-20 November, Gabrovo,Bulgaria, 2010, vol. II,

[5] Neculaiasa M. S., Hristian L., "*Textile metrology*," vol. I, Ed. Performantica, 2004, Iasi.

[6] *Standards SR EN ISO 13934-1:2002-Textiles-Tensile properties of fabrics−Determination of maximum force and elongation at maximum force using the strip method.*

METHOD FOR DETERMINING THE MAXIMUM ARRANGEMENT FACTOR OF FOOTWEAR PARTS

DRIŞCU Mariana[1], INDRIE Liliana[2]

[1] *"Gh.Asachi" Technical University of Iasi, Romania, Faculty of Textile, Leather and Industrial Management, Prof. Dr. Doc. Dimitrie Mangeron Str., No. 29, 700050, Iasi, Romania, E-Mail1: mcocea@tex.tuiasi.ro*

[2] *University of Oradea, Romania, Department of Engineering and Industrial Management in Textiles and Leatherworks, Faculty of Energy engineering and Industrial Management, B.St.Delavrancea str. No. 4, 410058, Oradea, Romania, E-Mail1: lindrie@uoradea.ro*

Corresponding author: Drişcu Mariana, mcocea@tex.tuiasi.ro

Abstract: *By classic methodology, designing footwear is a very complex and laborious activity. That is because classic methodology requires many graphic executions using manual means, which consume a lot of the producer's time. Moreover, the results of this classical methodology may contain many inaccuracies with the most unpleasant consequences for the footwear producer. Thus, the costumer that buys a footwear product by taking into consideration the characteristics written on the product (size, width) can notice after a period that the product has flaws because of the inadequate design. In order to avoid this kind of situations, the strictest scientific criteria must be followed when one designs a footwear product. The decisive step in this way has been made some time ago, when, as a result of powerful technical development and massive implementation of electronical calculus systems and informatics, This paper presents a product software for determining all possible arrangements of a footwear product's reference points, in order to automatically acquire the maximum arrangement factor. The user multiplies the pattern in order to find the economic arrangement for the reference points. In this purpose, the user must probe few arrangement variants, in the translation and rotate-translation system. The same process is used in establishing the arrangement factor for the two points of reference of the designed footwear product. After probing several variants of arrangement in the translation and rotation and translation systems, the maximum arrangement factors are chosen. This allows the user to estimate the material wastes.*

Key words: *pattern, arrangement factor, discretion, simulating*

1. THE OPPORTUNITY OF THE TOPIC

One of the main objectives in any production process is to spend as less material as possible. In the footwear industry, saving material comes in question immediately after the design table: the patterns are theoretically evaluated and arranged in several positions, to determine the most economic combination on the material. The aim is to find the arrangement that leads to minimum waste. Usually, the best combination is chosen by looking at a certain value, the so-called "arrangement factor". Most of the times, the optimal factor is determined manually, after several try-outs of the pattern combination.

This paper presents a methodology that can be used to automatically determine the best arrangement factor. The only task of the user is to introduce data in the computer, representing the coordinates of the points defining the pattern.

2. SIMULATING THE GRAPHICAL PROCEDURE USED IN OBTAINING THE BEST ARRANGEMENT. PRACTICAL STEPS

The core of this procedure is an algorithm based on mathematical modelling of the graphical manual procedure of obtaining the maximum value of the arrangement factor. The main parts of the algorithm are:

Sequence 1: *Modelling the shape on the computer screen, calculating the geometrical parameters and digitizing the geometrical shape into a finite number of steps*

This sequence comprises the following steps:

- first, the pattern is numerically approximated (digitized) either manually or automatically;
- the pattern is modelled in the computer so that we can visualize on-screen its graphical shape;
- we divide the pattern into a discrete, finite number of points, situated at equal distances, using a certain pace, depending on the performances of the computer (see fig. 1).

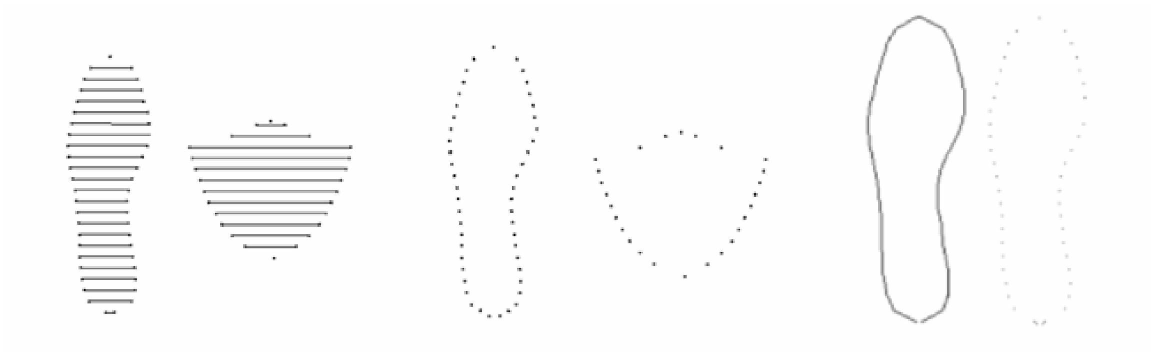


Fig. 1: *Discretization of the geometrical shape into a finite number of steps*

Sequence 2: *Multiplying the shape and obtaining tangent contours*

The mathematically discrete pattern can be multiplied and translated left or right to the initial one. In order to do that, we must first calculate the distance with which the pattern should be translated to obtain a new position, tangent to the initial one.

Fig. 2: *Multiply and move the discrete pattern for creating tangent contours*

Sequence 3: *Making a matricial graphical shape in a translation and roto-translation system*

When arranging the patterns, we must take into consideration the fact that they should be combined on the production material. In order for this sequence to be automatically determined, we must first create a matrix variant of the pattern, formed by three lines and three columns, by translating them (in a translation system – see picture 3) or rotating them (in a roto-translation system – see picture 4).

This will allow the simulation of the graphical manual procedure used in determining the maximum arrangement factor in the two systems.

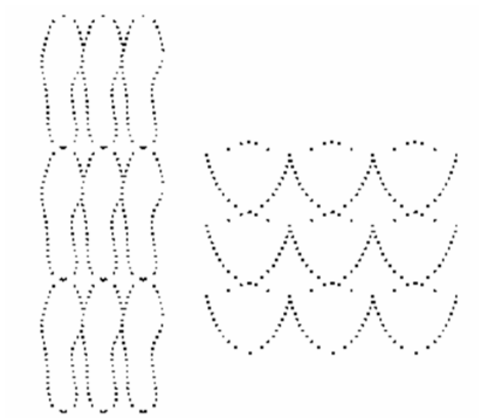


Fig. 3: *Making a matricial graphical shape in translation system*

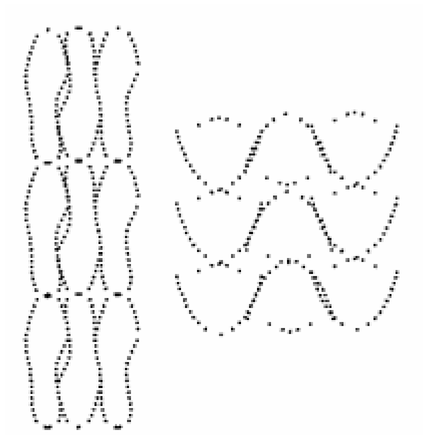


Fig. 4: *Making a matricial graphical shape in roto- translation system*

Sequence 4: *Determining the area of the pattern*

To determine the area of an irregular shape, such as the pattern of a footwear product, we use the tools of modern mathematics. It follows that a definite integral of the function f(x) for the interval $[x_1 , x_2]$ represents the area between the graph of the function and the x_1, x_2 abscises, as described by the relation:

$$\int_{x_1}^{x_2} f(x)dx = \sum_{i=1}^{n} (x_{i+1} - x_i) f(\xi_i) \quad \textbf{(1)}$$

This calls for the division of the x_1, x_2 interval in some other n sub-intervals, $\{x_i , x_{i+1}\}$ and, ξ_i being one point of the elementary subdomain (fig. 5).

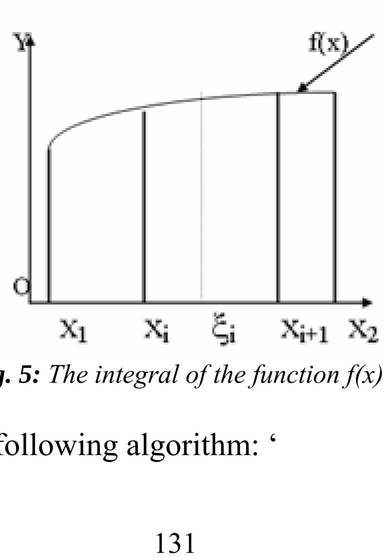


Fig. 5: *The integral of the function f(x)*

The relation suggests the following algorithm: ‘

- if $=\sum(x_{i+1}-x_i)f(\xi_i)$ represents the area of an interval between the axes $x= x_1$, $x= x_2$, axis Ox and the graphic of the function f(x), then the area between the two functions will be the difference between the two sums, as shown by the equation:

$$A=\sum_{i=1}^{n} f_1(x_i)(x_{i+1}-x_i)-\sum_{i=1}^{n} f_2(x_i)(x_{i+1}-x_i) \quad \textbf{(2)}$$

- if the function represents the ordinates of a set of points $\{x_i , y_i\}$, then the area defined by this set of points will be given by the equation:

$$A=\sum_{i=1}^{n-1} y_i(x_{i+1}-x_i) \quad \textbf{(3)}$$

This relation will be further used to determine the area of an irregular shape, corresponding to the digitized pattern of a footwear product.

Sequence 5: *Determining the arrangement factor*

For determining the arrangement factor, we use the following equation for each position:

$$F_a=\frac{nA_{pattern}}{A_{par}} \quad \textbf{(4)}$$

Where:

- n – is the number of the patterns in the parallelogram
- $A_{pattern}$ – the area of the pattern
- A_{par} – the area of the parallelogram

The method allows the graphic visualisation of each outline position and the corresponding value of the arrangement factor. Picture 6 presents all arrangement variants for a pattern of a footwear product.

Sequence 6: *Simulating the manual graphical procedure with the purpose of obtaining the best arrangement variant*

This sequence is done in a number of iterations equal to the number of points that define the shapes situated on one line or one column. For each of the iteration, all the following steps are executed:

- moving the patterns placed on the columns or the extreme lines of the matricial graphical shape with a distance equal to the discretization pace of the contours (established in sequence 1), all along a coordination axis (longitudinal or transversal direction);
- translating them on the other axis (direction), so that, in the end, the contours have the highest possible number of tangent points;
- determining the area of the arrangement parallelogram, a parallelogram containing a mathematically natural number of patterns;
- determining the arrangement factor, using the following equation for each position:

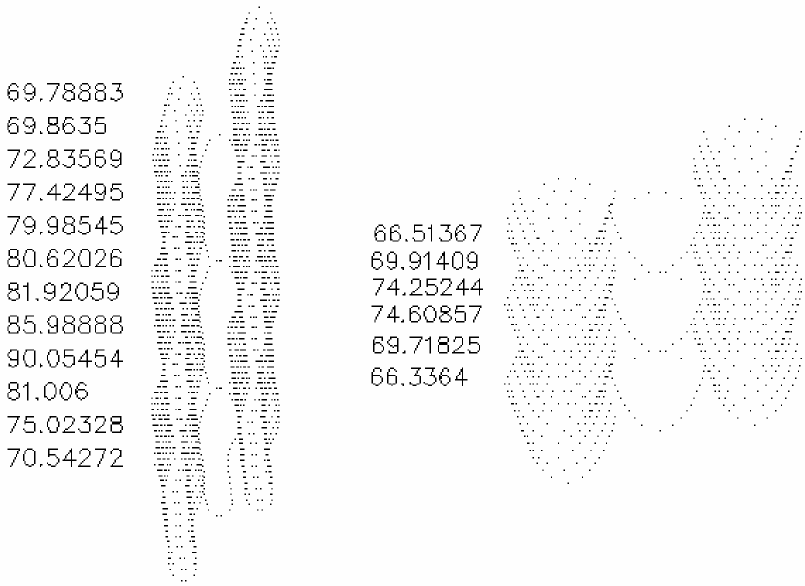


Fig. 6: *All arrangement variants for a part width*

Sequence 7: *Determining the optimal position of arrangement of the patterns corresponding to the matricial form*

The numerical data obtained in the previous sequence are memorised and organized in data bases, allowing the determination of the optimal arrangement variant, according to the following steps:

- we determine the maximum arrangement factor out of all the values;
- we create the optimal arrangement position of the patterns, using the information in the datasheet related to the position corresponding to the maximum arrangement factor;
- we insert the maximum arrangement factor
- we compare the maximum arrangement factor obtained in the two arrangement systems (translation and roto-translation) and we select the highest one. This will be the optimal arrangement factor.

Picture 7 presents the final position of the patterns in the two matricial shapes, displaying both the maximum arrangement factors and the framing parallelogram.

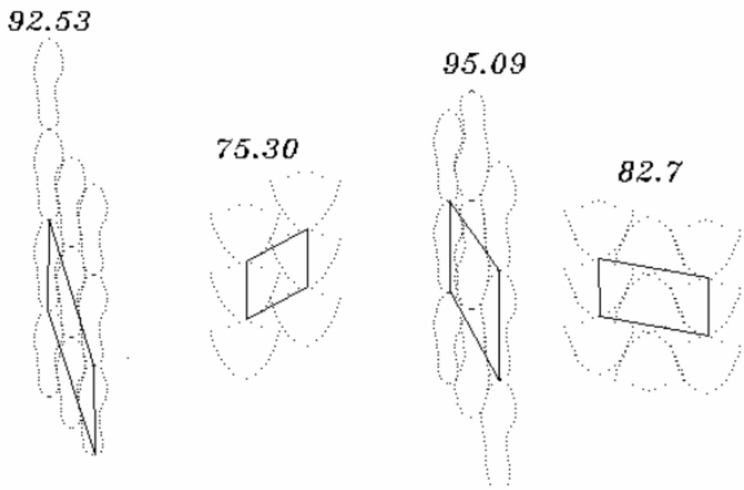


Fig. 7: *The optimal arrangement of the patterns*

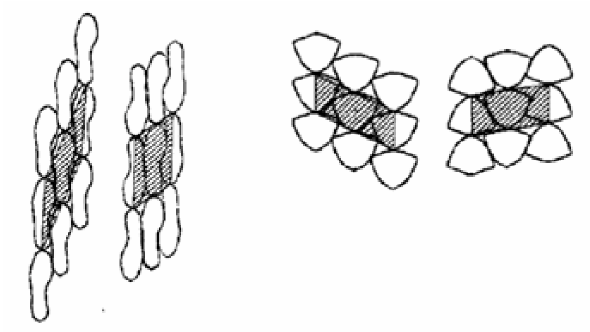


Fig. 8: *The final form of patterns' arrangement*

We repeat the graphical matrix, according to the dimensions of the material and create the optimal combination on the material that can be used in CAM sessions to obtain the patterns (see picture 9).

3. CONCLUSION

Using the common calculus technique in designing footwear products leads to a precise and correct design of each pattern. The stage in which the user estimates the costs, allows him to establish how economically profitable the product is and also allows the manager to take a decision in weather or not to diversify the pattern, in order to obtain even a better output of saving primary materials.

This software makes possible automatic determination of the theoretical arrangement for footwear patterns. The program can easily be used by any company, because it only requires a computer equipped with a digitizer and an output device (plotter or cutting devices) and it can be implemented in any domain dealing with material arrangement.

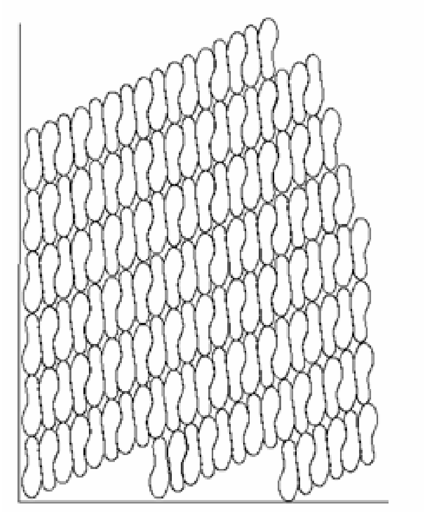


Fig. 9: *The optimal combination on the material that can be used in CAM sessions*

REFERENCES

[1] M. Costea, M. Drişcu, *Crispin Dynamics 3D –New solution for shoemakers creating and modification of the shoe last*, Leather and Footwear Journal 11 (2011), pg 109-120, ISSN 1583-4433

[2] M. Drişcu, *Reconstruction and flattening of the surface shoe last*, Proceedings of The 14th Internaţional Conference, Iaşi&Chişinău ModTech2010, May, 2010, Romania, ISSN:2006-391

[3] A. Mihai, M Costea ş.a., *Customized footwear insers for high arched foot – one case study*, Proceedings of the 3nd International Conference on Advanced Materials and Systems 2010- ICAMS 2010 Bucuresti

[4] G. Mălureanu, A. Mihai, *Bazele proiectării încălţămintei*, Ed. "Gh. Asachi", Iaşi, 2003

[5] R. Burden, J. D., Faires *Numerical Analysis*, PWS-KENT Publishing Comp., Boston, 1985

ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

ALGORITHMS FOR THE PROGRAMMING OF FOOTWEAR SOLES MOULDS ON WORKING POSTS OF INJECTION MACHINES

LUCA Cornelia[1], IONESCU Cozmin[2]

[1, 2] *"Gheorghe Asachi" Technical University of Iasi, Faculty of Textiles, Leather and Industrial Management, Dimitrie Mangeron Str., No. 29, 700050, Iasi, Romania,*
E-mail: cionescu@tex.tuiasi.ro; ionescucozmin@yahoo.com

Corresponding author: Ionescu Luca, Cornelia, E-mail: cionescu@tex.tuiasi.ro

Abstract: *The moulds stock necessary for realization in rhythmically conditions, a certain volume of footwear soles depends on some criterions such as: the range of soles for footwear volume daily realized, the sizes structure of those soles for footwear and, respectively, the sizes tally, the technological cycle for an used mould depending on the equipment efficiency, the provide necessity of spare moulds, the using and fixing conditions etc.*
From the efficiency point of view, the equipments may have two working posts, or more working posts (always, an even number), as 6, 12, 24, 40 posts.
Footwear soles manufacturing takes into account the percentage distribution of the size numbers of the size series. When o portative assembly is used for the manufacturing of the footwear soles using the injection with "n" working posts, it is very important an optimum distribution of the working posts. The disadvantages of these equipments are the situations of the no equilibrium programming of the moulds, so that, in one time, some working posts spread out of the work.
The paper presents some practical and theoretical solutions for moulds stock programming in portative assembly for footwear soles injection, so that an optimum equilibrium degree of the working posts will obtain.

Key words: *footwear, moulds, shoes soles, injection systems, designing*

1. INTRODUCTION

The moulds stock necessary for a certain product volume realization, in rhythmically conditions depends on some criterions such as: the range of products volume daily realized, the sizes structure of those ranges and, respectively, the sizes tally, the technological time for an used mould depending on the equipment efficiency, the provide necessity of spare moulds, the using and fixing conditions. The paper presents some results of the authors' researches about the optimum run of the injection and manufacturing of the shoe footwear soles in moulds and the placing of the moulds on the equipments algorithms, so that, an optimum equilibrium degree of the working posts will obtained. The equipments used in footwear soles manufacturing, by cooling and injection thermo chemical processes are, from constructive point of view, divided in two branches, equipments with injection straight on vamps and soles injection equipments, as semi finished articles which will be assembled on the vamps. From the efficiency point of view, the equipments may have two working posts, left-right, or more working posts (always, an even number), as 6, 12, 24, 40 posts.

These differentiations have a direct influence up to the manufacturing cycle time, respectively, up to the time between two identical successive steps of the process. Entirely, this time has two components: the impose time of the thermo chemical process and the time for the technological servicing of the equipment and of the mould.

When the footwear soles are injected using portative equipments with "n" working posts, the placing of the moulds on working posts has a great importance. This placing must provide the lots of the same kind products realization in contractual pre-established sizes tally, and, in the same time, the equipment working posts must be equilibrated used [1].

2. EXPOSITION

These moulds are for the shoe soles manufacturing, based on thermoplastic polymer blends. The injection takes place after the mould cavity is closed. Then the molding and partial cooling processes take place until it is realized a temperature which avoids the deforming of the products and then, the unloading of the products at high temperature (60-80ºC) depending on the polymer.

The injected soles manufacturing takes place in two situations: the injected soles realization straight on the vamps and the soles realization as semi finished articles which will be assembled on the vamps using gluing or sewing processes. When the soles manufacturing takes place straight on the vamps, there are used, for each pair and for each size number, two sets of moulds for each sole of each leg. Usually, these equipments have two shoe-lasts for each leg, one of them is into the mould (for the sole injection) and the other one has injected sole and waits the footwear unloading. The using of two shoe-lasts for the same mould determines a time for a fitting up of the vamps on the shoe-lasts (for the soles injection), respectively, a time for the unloading of the footwear with sole after the injection, out of the sole thermo chemical process manufacturing. The necessary technological time (a cycle time), (t_c), for one sole manufacturing is pointed [2[,[3] in formulas (1), (2), (3):

$$t_c = t_a + t_p + t_e \text{, (minutes)} \quad \textbf{(1)}$$

$$t_d = t_a + t_e \text{, (minutes)} \quad \textbf{(2)}$$

$$t_c = t_p + t_d \text{, (minutes)} \quad \textbf{(3)}$$

where: t_c- cycle time for a finished sole manufacturing, minutes; t_a - fitting up time of the vamps on the metallic shoe-lasts of the mould, minutes; t_p- time of the thermo chemical injection, moulding and cooling of the polymer blend process, minutes; t_e – time for unloading of the products, minutes.

The process time has the following components: the time for the mould closing and the time for the injection and cooling of the polymer melting used in sole manufacturing. This time is the main one in the technological time, necessary in one product manufacturing and it depends on the polymer blend formula, on the object dimensions and on the cooling regime. For a good efficiency providing, on each working post, respectively, on each mould which realizes a pair of soles, the injection aggregates have refrigerating equipments which decrease the cooling time of the polymer melting after the injection into the cavity. The fitting on the vamps on the metallic shoe-last for the sole injection time (t_a), respectively, the unloading of the footwear with sole from the metallic shoe-last time (t_e) are components of the mould attending time (t_d). This time is during the waiting of the mould, just before or after the sole manufacturing process.

In these conditions, the efficiency of this aggregate (in pairs/480 min) for each working post is [4, 5]:

$$P = \frac{T - t_{pi}}{t_c} \text{, (cycles/480 min)} \quad \textbf{(4)}$$

where: P- pairs/480 min; T- time per shift (480 min); t_{pi} – time for preparing and finishing the work, minutes; t_c – time for one cycle, minutes.

The preparing and finishing of the working time (t_{pi}) has the following components: the time necessary for the preparing of the equipment and of the moulds at the beginning of the work, the time for the cleaning of the moulds at the end of the work and the time necessary for the changing of the moulds during the shift.

The main problem in this case is the used mould number in a continuous process. The used degree of the moulds depends on the soles number sizes tally which must be realized per shift. Depending on this tally, considering the different working posts of the aggregate, the used degree of the moulds is between 6-100%. The adjustment of the moulds necessity, depending on the efficiency of the equipments, on the number of the size tally and on the working posts number of the portative equipment (6, 12, 24,…., 40), is a difficult problem, but a solvable one. The algorithms for establishing of the moulds stocks using program will be presented in the next paragraph and they represent a solution of the problem [4].

Considering that the time of the process (t_p) takes place in the same time with one rotation of the rotative equipment,(excepting the using time (t_d)), the number of the moulds working posts per one worker is:

$$n_m = \frac{t_c}{t_d} \quad \textbf{(5)}$$

where: n_m – number of the moulds a worker may use.

The rotation rhythm of the injection aggregate uniselector depends on the number of the working posts, respectivelly, on the number of the moulds (m), depends on the time of one cycle (t_c) and on the using time (t_d), as in formula (6):

$$t_c = m \cdot t_d \text{ (minutes)} \quad \textbf{(6)}$$

When the soles are obtained injecting straight on the vamps, experimental researches [5],[6] show that almost all aggregates (whatever how the number of the working posts is) have a medium efficiency for one mould, at about 100-200 pairs/8h. Industrial conditions show that the preparing and finishing time for one shift (t_{pi}), is about 30 minutes. Replacing the values in formula (4), the time of one cycle per mould (t_c), becomes about 2,25 minutes. This time will be completed with the time necessary for closing and opening the mould which is about 0,4 minutes. So, the time for one cycle per mould is about 2,65 minutes.

In the soles moulds case, the using time contains only the unloading time of the product. Providing of the necessary time of the process (t_p) (considering the using time to be maximum 0,2 minutes), increases the posts numbers of the uniselector till 24, even 40 working posts.

3. EXPERIMENTAL PART

3.1. The programming of the assembly of the moulds and the working posts balance in the researched case

The quantity of soles which must be processed on each working posts depends on the distribution of the moulds on the posts, for an optimum balance degree of the used equipments obtaining. The paper presents some theoretical and experimental conclusions of the authors and the results of the researches obtained [7],[8] using an uniselector with 12 working posts.

The lot of products taking into consideration, has the size P = 7500 pairs of footwear of the perforated type, for the teenagers, with injected soles straight on vamps, in the VAMOS model. To make the lot of footwear/shoes which covers sizes from 22 cm to 28.5 cm, it will be used a set of moulds which have a cavity corresponding to the model of the sole. The delivery of the footwear according to sizes and of the moulds in the VAMOS set is presented in the Table no.1 below. From Table 1, we draw the conclusion [8] that the set contains 20 pairs of moulds which will be set on the 12 working posts of the equipment to get different quantities of footwear according to size numbers; this will lead to the coupling of the moulds of different sizes on the same post, in order to ensure a balanced loading of the working posts.

It is considered that the balance of the working posts of the equipment may be appreciated by the degree of balance of the loading, symbolized by E, expressed in % and which may be determined using the equation (7):

$$E = \left[1 - \frac{M(n - n_{\min})}{(M-1)n_{\max}}\right].100 \text{, (\%)} \quad \textbf{(7)}$$

where: M- number of the working posts of the equipment; n- number of cycles of the rotating table necessary to make the lot of products P, for a certain assembly programmed and rolling of the moulds; n_{min} - minimum number of cycles of the rotating table necessary to make the same lot of products P, in the condition of an ideal balance of 100%, for M posts; n_{max} - possible maximum number of cycles necessary to make the lot of products in the condition of null balance, 0%, respectively, when all moulds of the set would be placed successively only on one working post. In short, the degree of balance, E, can be calculated using the equation (8).

$$E = \frac{M(P-n)}{P(M-1)}.100\ ,(\ \%) \qquad \textbf{(8)}$$

Table 1:*Outfit of moulds for a certain production*

Footwear size, cm	Quantity, pairs	Number of moulds, pairs
22	40	1
22,5	80	1
23	130	1
23,5	420	1
24	780	2
24,5	690	2
25	1270	2
25,5	1010	2
26	1010	2
26,5	680	2
27	650	1
27,5	410	1
28	230	1
28,5	10	1
Total	7500	20

In the equation (8), the terms have the same meaning as in the equation (7). For the concrete case under discussion:

M=12

$$n_{\min} = \frac{p}{m} = \frac{7500}{12} = 625\,; \quad n_{\max}\text{=P=7500}$$

$$n = \frac{P}{number \cdot pair\,/\,cycle} = \frac{7500}{6} = 1250$$

The degree of balance, E, calculated using both equations, has the value of 90,9 % in the case under discussion. To make the lot P=7500 pairs of shoes with the set formed of 20 pairs of moulds, which surpass the number of working posts (12) of the equipment, it appears the problem of establishing the type of coupling of the moulds of different sizes on certain working posts. This time, symbolized T, is expressed in hours and can be determined using the equation (9).

$$T = \frac{PAS(M.L + I - M) + \sum Ts_i}{3600}\ \text{, (hours)} \qquad \textbf{(9)}$$

in where: PAS- rhythm of the equipment, seconds, that is the time between 2 successive injections; M- number of posts of the equipment; L - loading of the respective mould expressed through the quantity of products which are made on it, expressed in pairs; I - number of the order of the respective working post on the rotating table of the equipment; ΣTs_i - sum of the changing time of the moulds from other posts on which the moulds where replaced, seconds, if the replacement demanded to stop the equipment. At the injection installation of carousel type, the DESMA makes, PAS = 6s and ΣTs_i = 400 s [9],10].

3.2. The obtained results and their interpretation

Taking into consideration the concrete values of the above sizes, through the automatic processing of the data there were obtained the results presented in Table 2. The results [5], [9] in Table 2 show that out of the set of 20 moulds, only 19 will be used, when the equipment starts to function and they will be assembled on the 12 posts of the equipment in the following order: 28/1, 25/2, 25/3, 22.5/4, 28.5/5, 22/6, 25.5/7, 27/8, 23/9, 26.5/10, 26.5/11, 24.5/12. After producing the quantity of shoes, the moulds that correspond to the extreme numbers of the series will be replaced with others as follows: 28 ----27.5 (post 1), 22.5 ---26 (post 4), 28.5----26 (post 5), 22---- 25.5 (post 6), 23---- 23.5

(post 9), 26.5---24 (post 10), 26.5----24 (post 11). Through coupling the moulds of different sizes on the working posts shown, the variable loading is between the limits of (505 – 730) pairs/posts and after a number of 15.3 h of continuous functioning of the injection installation there can be achieved the entire lot of shoes of 7500 pairs.

Table 2: **Moulds placing on working posts**

Order number of working post	Size number of the mould set on the post(cm)	Quantity of shoes made on the post and mould(pairs)	
1	initial 28	230	
	27.5	410	640
2	25	635	
3	25	635	
4	initial 22.5	80	
	26	550	630
5	initial 28.5	10	
	26	550	560
6	initial 22	40	
	25.5	505	545
7	25.5	505	505
8	27	650	
9	initial 23	130	
	23.5	420	550
10	initial 26.5	340	
	24	390	730
11	initial 26.5	340	
	24	390	730
12	24.5	690	
Total	19 moulds	7500 pairs	

For the variant of distribution and use of moulds on the working posts of the presented equipment in Table 2, the concrete degree of balance of the equipment (E), calculated with the equation (8), has the following value of the equation (10):

$$E = \frac{12(7500 - 730)}{7500(12 - 1)}.100 = 98,47\% \qquad \textbf{(10)}$$

4. CONCLUSIONS

- To balance the loading of working posts of the injection installation of Carousel type presented in the paper, can be achieved only when the number of moulds of the set is bigger than the number of the working posts of the equipment.
- The balance degree (E) is influenced by the type of rotation of the set of moulds on the working posts of the equipment, the total size of the lot of shoes, the series of sizes in the lot, the quantity of shoes, on each size number of the series.

- The automatic processing programmed of data used in the concrete case presented in the paper has a general character and it is used in all cases which obey the specified restriction in the first formulated.

REFERENCES

[1] E. Chirilã , *Theoretical number of the nests that a cast must have*, Buletinul I.P.Iaşi, Tomul LIV(LVIII), Fasc. 1-3, Secţia Construcţii de Maşini Iaşi, 2008, pp.125-129, ISSN 1011-2855, Romania

[2] E. Chirilã, *Solutions of the different models of cavities for soles obtaining*, Annals of the University of Oradea, fascicle of Textiles-Leatherwork, volume IX, 2008, p.236-240, ISSN 1582-5590, Romania

[3] V.Cociu, R.S. Volocariu, and C. Ionescu, *Matriţe şi dispozitive de formare*, Rotaprint, Universitatea Tehnicã "Gheorghe Asachi" Iaşi, 1994, Romania.

[4] R. McNeel, R., *Shoe Design and Visualization*, Institute of Biomechanics of Valencia, Rhinoceros Advanced Training Series, 2005 Available from: https://anna.nscad.ns.ca/help/pdfs/rhino_shoe.pdf

[5] C. Ionescu, *Matriţe şi procese de formare în matriţe din industria de încãlţãminte*, Editura Cronica Iaşi, ISBN 973-9206-09-3,1995, Romania.

[6] C. Ionescu Luca and A.Dragomir, *Algorithme de projection des moules pour contreforts de chaussure,* Buletinul I.P.Iaşi, Tomul LIV(LVIII), Fasc. 1-3, Secţia Construcţii de Maşini, p. 383-389, ISSN 1011-2855, Romania

[7]C. Ionescu Luca, *Contributions for establishing the right number of nests that a cast must have,* Annals of the Oradea University, Fascicle of Manage Contributions for Establishingment and Technological Engeneering, Vol. VII (XVII), 2008, pp. 863-866, ISSN 1583-0691, Romania

[8] M. Iuhas and C. Ionescu, *Flexible technologies for footwear soles injection marking*, Annals of the University of Oradea, fascicle of Textiles-Leatherwork, volume IX, 2008, p.240-246, ISSN 1582-5590, Romania

[9] Project No.401064/2007 SIMSANO, (2007-2013). Modern Interventional Footwear Design And Rapid Prototyping System For Compensating Locomotors Deficiencies And Prophylaxis Of Foot Disorders. Undergoing research project under the framework of Romanian National Research Programmed. Available from: www.simsano.ro

[10] Project no. 134124-LLP 2007-RO-LMP, Project no. 2007-3111/001-001 LE3-MULPRO Available from: (http://www.virtual-shoedesign.com/).

THE INFLUENCE SEWING MACHINE ON FOOTWEAR MOCCASIN ECONOMIC INDICATORS OF ASSEMBLY OPERATIONS

MALCOCI Marina[1] , PASCARI Ioana[2], CALDARE Olga[3]

[1, 2, 3] *Tehnical University of Moldova, Chisinau, Republic of Moldova, E-Mail: mmalcoci2005@yahoo.com*

Corresponding author: Malcoci Marina, E-mail: mmalcoci2005@yahoo.com

Abstract: *With the evolution of time changes, grows and improves, construction, form, rationality and argumentation usefulness of various types of footwear, namely machines. In the present paper analyzes a number of sewing machines, bound for achieving moccasin shoes. With sewing machines can perform a wide variety of stitches, they create an aesthetically pleasing, but all at once enable product diversification with minimum expenses. Sewing machines moccasins are distinguished by technological parameters, number of stitches, design and affordability. Sewing operation carried out in these machines is carried out within 72 seconds to manual operation - 22 minutes. A flow diagram mechanical requires a reduced number of workers (e.g., 3 workers), to a manual flow diagram - 38 workers. Labour productivity in the use of sewing machines increase by 10 times, and operation cost decreases from 3,7 to 5,7 lei. Regardless of the sewing moccasins construction company helps to increase productivity, quality completion of the operation, ie products, reducing the time required to manufacture the products, shortening manufacturing cycle. Among the cars analyzed, the most recommended sewing machine as OS 7700 P Global company because it represents the best technical features. Sewing machines for manufacturing footwear moccasin were implemented in Moldova in 2010, at the "Cristina Mold Rom Simpex" in Chisinau. Because, company management understood beneficial role of sewing moccasins on quality operation, but also on other economic indicators. Currently the majority of footwear enterprises in Moldova sewing moccasins are done manually. One problem is the high price of sewing machines moccasins.*

Key words: *sewing machine, moccasins, stitch, productivity, time, enterprise.*

1. INTRODUCTION

First moccasins were made of suede, consisting of a single landmark. Currently moccasins kept only certain elements of the original moccasins [1]. Current moccasins are light, made from home with the idea of giving a leg lightness in movement, appearance of freedom in movement is very well suited to the relaxing aspect of the foot. Therefore, we can say that moccasins are practical footwear that mediates the transition from sports shoes to classic shoes [2].

Moccasins have become a very sought after in recent years because they are very comfortable and stylish products, which can be worn both in summer and in the cold.

2. STUDY SEWING MACHINES FOR MANUFACTURING FOOTWEAR MOCCASIN

One of the characteristics of this type of footwear is the way to combine parts assembly (figure 1). Moccasin stitching is done both manually and mechanically special sewing machine [3].

As follows are several types of sewing machine that sews moccasin (figure 2-5) [4-7].

Fig. 1: *Examples of moccasins [3, 4]*

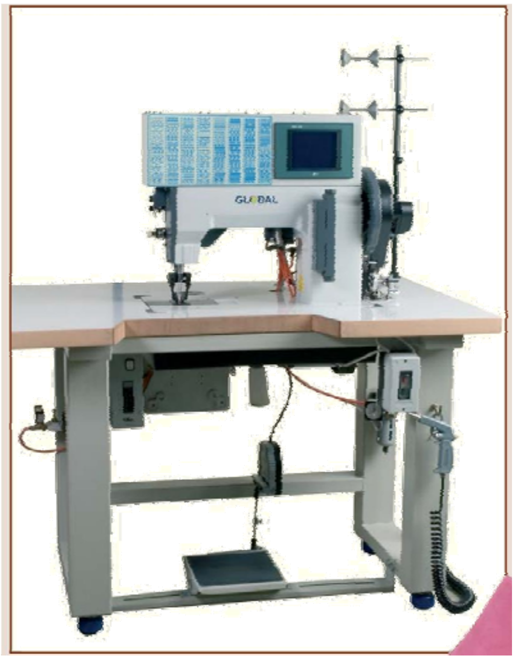


Fig. 2: *The sewing machine OS 7700 P, Global [4]*

Fig. 3: *The sewing machine FA-226, FAMAS [5]*

Fig. 4: *The sewing machine FT 50, Falan [6]*

Fig. 5: *The sewing machine FM 70, Falan [7]*

In table 1 presents the technical characteristics of sewing machines loafers.

Table 1: *Study sewing machines for manufacturing footwear moccasin*

No crt.	Brand and company sewing machine	Sewing machines feature
1	OS 7700 P, Global [4]	• The number of needles - 2 • Machine speed - up to 400 rev / min • Stitch length – 6,5 mm • Distance lifting the foot - 10 mm • Needle - DY × 23 • The number of standard models - 100 • Pneumatic switching needle • The control unit is in 9 different languages • Programmable memory function
2	FT 50, FALAN [6]	• Machine speed - 400 rev / min • Stitch length - 8 mm • thread thickness - 1 mm • Needle - 320-214 x 2 • Engine - EFKA DC 1550 vol / min, 220 V, 50-60 Hz • Net weight of the machine - 160 kg
3	FA-226, FAMAS [5]	• The number of pins - 1-2 • stitch length - 0-12 mm • Machine speed - 500 rev / min • needle length - 4-7 mm • Needle - 328/214 x 1 • table height - 110 mm • Engine - EFKA DC 1550 230 V, 50/60 • Car Noise LpA = 72 • Net weight machine - 130 kg • Gross weight machine - 150 kg • Provides the ability to make pleats
4	FM 70, FALAN [7]	Machine speed - 500 rev / min. Stitch length - 0-12 mm. Thread thickness - 1.2 mm Needle length - 4-7 mm Needle - 1 x 320-214 Table height - 110 mm Engine - EFKA DC 1550, 220 V, 50-60 Hz Net weight of the machine - 145 kg Gross weight of the machine - 165 kg

With sewing machines can perform a wide variety of stitches (fig. 6 - 7), they create an aesthetically pleasing, but all at once enable product diversification with minimum expenses.

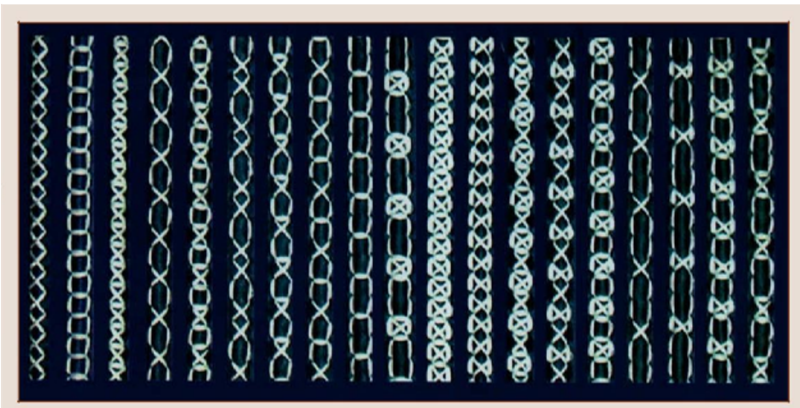


Fig. 6: *Types of stitches*

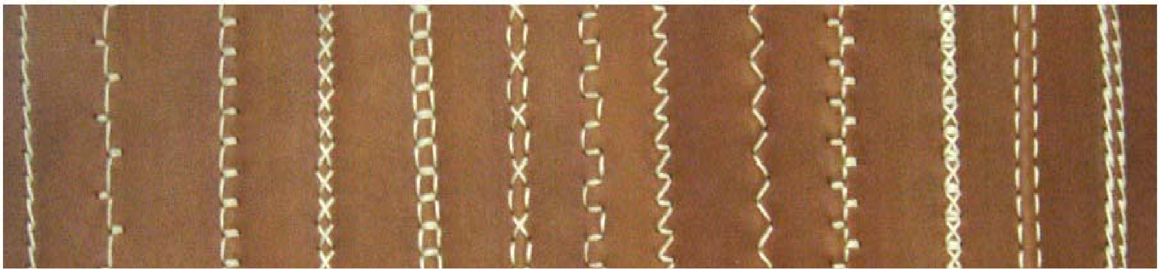


Fig. 7: *Types of stitches*

3. STUDY THE INFLUENCE OF FOOTWEAR MOCCASIN SEWING MACHINE ON ECONOMIC INDICATORS OF OPERATION ASAMBBLARE

Sewing machines for manufacturing footwear moccasin were implemented in Moldova in 2010, at the "Cristina Mold Rom Simpex" in Chisinau. Because, company management understood beneficial role of sewing moccasins on quality operation, but also on other economic indicators. Currently the majority of footwear enterprises in Moldova sewing moccasins are done manually. One problem is the high price of sewing machines loafers. Table 2 presents a comparative analysis of the technical and economical operation of the assembly of parts (eg, pound with a vamp).

Table 2. *Comparative analysis of the economic indicators assembly operation*

No. crt.	Indicators technical and economic	Type of operation	
		manual	mechanical
1	Number of workers, pers.	38	3
2	The time required for processing a landmark	22 min.	72 sec.
3	The cost of the operation, lei	5-7	1,30
4	Productivity, per/8h	24 - 28	240

Analyzing the data in table 2 shows that the operation performed mechanically require less cost to the company for making moccasin shoes.

4. CONCLUSIONS

1. Labour productivity in the use of sewing machines increase by 10 times, and operation cost decreases from 3,7 to 5,7 lei.
2. Sewing operation carried out in these machines is carried out within 72 seconds to manual operation - 22 minutes.
3. A flow diagram mechanical requires a reduced number of workers (e.g., 3 workers), to a manual flow diagram - 38 workers.
4. Regardless of the sewing moccasins construction company helps to increase productivity, quality completion of the operation, ie products, reducing the time required to manufacture the products, shortening manufacturing cycle, reducing the number of workers involved in the technological assembly of flexible parts.

REFERENCES

[1] G. Mălureanu, A. Mihai. *Fundamentals of footwear design.* Iași: Ed. Performance, 2003.

[2] http://www.wisegeek.com/what-are-moccasin-slippers.htm (accesat pe 26.09.2013).

[3] http://www.bestchoicereviews.org/clothing/mens/shoes/top-10-best-mens-slippers/ (acesat pe 16.09.13).

[4] http://www.sinmos.ru/catalog/49/118/124/194.html. (accesat pe 30.09.2013).

[5] http://b2b-lightindustry.ru/tovari/5317 (accesat pe 16.09.13).

[6] http://www.leibrock-msm.com/oborudovanie/falan/proizvodstvomokasin/ft50/default.aspx (accesat pe 26.09.2013).

[7] http://www.leibrock-msm.com/oborudovanie/falan/proizvodstvomokasin/fm70/default.aspx. (accesat pe 30.09.2013).

ASPECTS OF THERMODYNAMICS IN SPORTS FOOTWEAR

POPOVICI Mihaela[1], BUDESCU Emil[2]

[1] *Ioan Bococi Theoretical High School, Oradea, Romania, Tudor Vladimirescu str, no. 42, Oradea, Romania, E-Mail: mihatex@yahoo.com*

[2] *"Gh. Asachi" Technical University of Iasi, Romania, Biomechanics Laboratory, Mechanical Engineering Faculty, D. Mangeron Str, 43, Iasi, E-Mail: emil.budescu@gmail.com*

Corresponding author: Popovici Mihaela, E-Mail: mihatex@yahoo.com

***Abstract**: The paper presents experimental thermal analysis of sports footwear in order to identify areas that provide the best ventilation of the foot for comfort in running. For analysis, using thermographic cameras, infrared, five athletes have been tested, running shoes Nike, Killtec type and Lotto. Thermographic recordings were made at three different times, which after a workout, then two minutes after your workout, and 10 minutes after the workout. Using a specialized software, the images have been processed, the resulting temperature variations over the entire shoe. They were identified as the most comfortable pair of shoes, which have secured the release of heat in the feet the highest rate.*
Was able to determine the extent of aeration provided by each type of footwear under review, as evidenced by the aeration temperature on flow shoes can lose over a period of time. Through such analysis experimental Thermodynamics can be personalized, elect the type of footwear the best an athlete, based on specific physiological parameters. In addition, aeration and incălţămintea thermal protection role when necessary.
By using termography related can be determined types of footwear suitable for the purpose, in particular for heat a situation or another.

Key words: *biomechanics, thermography, performance, material, pressure.*

1. INTRODUCTION

Athletic footwear plays an important role in obtaining the performance, especially in athletics. It is well known that research in the field has led to the emergence of new materials used in sports shoes, with senior elasticity indices, optimum forms of footwear that provide aerodynamic taloneţi of parsonalizaţi, for the best possible pressure distribution and planting attractive colours, to induce different emotional States, using knowledge of Chromotherapy.

Athletic footwear, used for training or competition, had acquired over the years aimed at increasing the performance values. Thus, if in ancient Greece athletes to run in bare feet, with the territorial expansion of the Roman Empire many athletes ran with sandals, to protect themselves from low temperatures. Once these athletes became winners, public opinion is shifting and wearing Sandals was seen with suspicion and associated with cheating. Once it has been recognised that the soles of sandals increase adhesion on the ground and spreads leg before with greater efficiency, many athletes have adopted wearing these sandals.

In England in the 18th century it was developed a method to reduce the weight of the shoe the athletes to "float" above the ground easier. For competitions, shoes made of leather, fit well, but due to the fact that they were not waterproof, folds appeared in the outsole by making them useless for running. In 1832 he patented a Webster Wait method of attaching the rubber soles of shoes and boots, making them more resistant and avoiding the appearance of creases. The 1860s-1870s they meant an evolution for special use of shoes biccligti shoes, using very light and with 8 or 10 rows of laces.

Joseph William Foster founded the first shoe company in Boulton, England, in 1890. His nephew took over the business and renamed the company Reebok. The popularity of the game of tennis in the 1920s led to wearing Reebok shoes in her spare time, intended for recreation.

The father of the modern running shoe was Adolf Dassler started manufacturing this type of footwear in the 1920s. In 1936 this footwear has been recognized as the best in this field and has become of favorite athletes of the calibre of Jesse Owens. Adolf Dassler is specialized in the design of the shoes sport, so in 1948 he founded the company Adidas, which, however, was divided into companies, Adidas and Puma. For better efficiency in running, Adolf Dassler has added three lateral bands on shoes, model first appeared in 1949.

In 1962 he introduced the first New Balance Shoes tested scientifically, these weighing 95 grams. It is known that between the State of comfort and performance footwear there is a direct dependency, so a shoe that provide optimum aeration of the leg can lead to performance. Testing the degree of aeration is achieved either by means of temperature, pressure or by filming in infrared. In the latter case, the temperature measured is of great precision, ranging from tenths up to thousandths of a degree and can be specified at any point on the surface.

The purpose of this paper is to present the termografic criterion to choose a sports footwear for optimizing thermal comfort and improving performance.

2. COMFORT AND PERFORMANCE IN SPORTS EQUIPMENT

A sports equipment has different items depending on the sport and the type of physical activity carried out (workout, walk or competition). Thus, for athletics, athlete training, are used in general: short, t-shirts, socks, athletic shoes. The comfort provided by these depends on the materials used and their construction, all together to provide more aeration and biomechanical parameters: thermal protection in an optimal rate, good adhesion to the ground for footwear, as well as less drag from the environment, good mobility of the body etc. Of the materials used, mainly, can be listed: polyamide and polyester, cotton, for clothing and natural rubber skin compact, translucent rubber, Microcellular rubber, microdur, crepul, vinilinice resins, etc., for footwear.

A sports footwear shall carry out depreciation of efficiency, flexibility, control and stability in the heel area, ease and traction. It can be hard to choose from the vast range of sports footwear available. There are differences in design and variety of materials and weight. These differences have been established to protect the areas of the foot that have the most stress in sports.

Thermal comfort footwear for track and field sports require that the outside to allow a good aeration in a relatively short time, so leg temperature may not be much greater than that of the body and the perspiration produced can be absorbed entirely by the socks. Moreover, sports footwear also has a custom character, with a different behavior from one person to another, depending on each person's metabolism, with multiple degrees of thermal comfort for the same type of footwear but used in different individuals.

Investigation of thermal comfort by means of infrared Thermographic recordings offers the best characterization, at the moment, they are a person who wants to achieve athletic performance.

Infrared thermography is a modern technology of remote sensing and surface temperature telemăsurare in State of rest or motion, based on the emission and absorption phenomena of infrared radiation. Remote-sensing instruments transforms images of objects invisible radiation spectrum visible images in black and white or color [1, 2, 3].

The main advantages of the termografic control are:

• do not require light sources whereas each object emits infrared radiation;
• temperature measurement objects can be done remotely, without direct contact and without disturbing the temperature;
• thermal, global information or detail is obtained in real time;
• measurement accuracy is high;
• allow the pairing with complex equipment for recording, storing and processing.

A thermal imaging system is composed of [4, 5]:

- sistem of thermal imaging-infrared camera;
- sistem thermal imaging-specialized program computer.

Operating parameters for the infrared camera used in the experimental records are: measured temperature range between-20 ° C to 500 ° C; sensitivity-0,1 ° C; the autonomy of operation-3 hours. Temperature determined by infrared thermography can be viewed on time, on specific areas of interest or that the variation between the minimum and maximum values of all measured surfaces.

3. EXPERIMENTAL RESULTS

Thermographic recordings were made on a group of five athletes shoes equipped with athletes for training, with the following brands of footwear: Nike, Killtec and Lotto. Are indicated in table 1, through images, the type of shoe worn by each athlete sports analyzed in part.

Table 1: *Types of sports shoes review*

Topic number	Footwear type	Footwear picture
1	Nike – 1	
2	Nike – 2	
3	Nike – 3	
4	Killtec	
5	Lotto	

Temperatures registered by the infrared camera were taken at three different times: immediately after a workout, after another two minutes and after 10 minutes after the first record. Thermographic images obtained in table 2 provides detailed information on the field of temperature and degree of aeration, in circumstances where the ambient temperature in the filming was 20 ° c. Temperature scale used for temperature field is given in Figure 1.

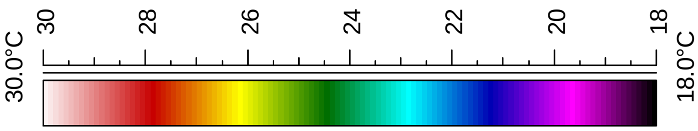
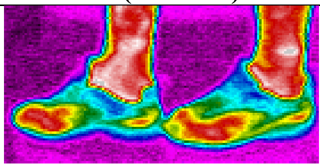
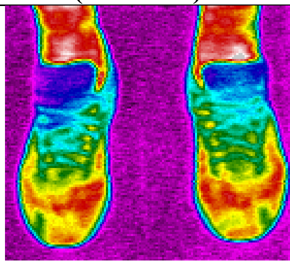
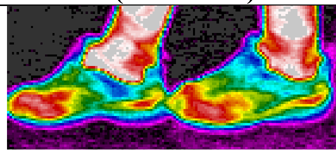
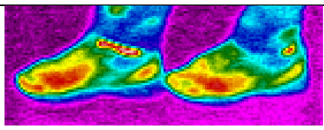
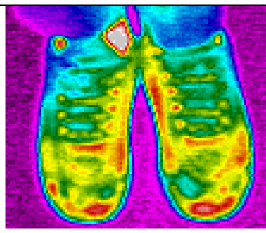
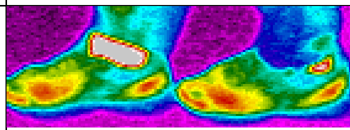
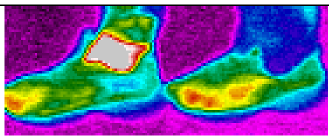
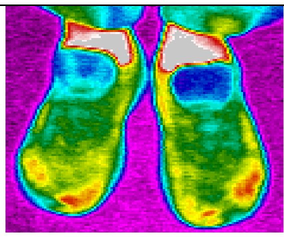
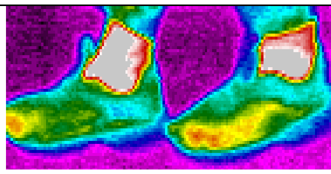
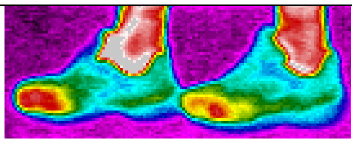
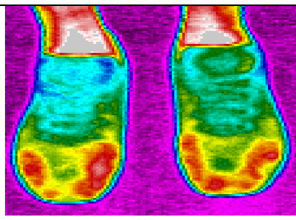
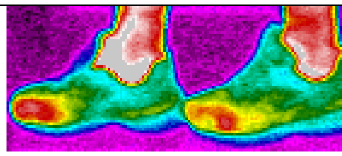
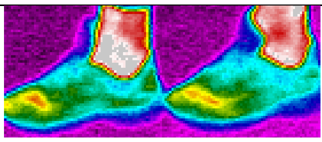
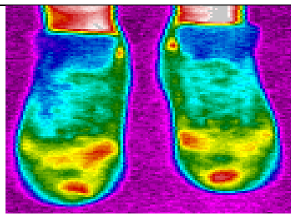
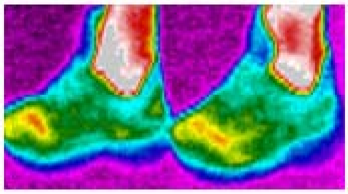


Fig. 1: *Temperature Scale used in the Thermographic recordings.*

Table 2: Thermographic Images experimental

Topic number	Time 1 (0 minute)	Time 2 (2 minutes)	Time 3 (10 minutes)
1			
2			
3			
4			
5			

Using a specialized software, Thermographic images were attached and the graphs of temperature variation on the entire surface of the footwear, both for his left foot and the right being numeric values highlighted extreme.

4. DISCUSSION

Using images in table 2, as well as graphs of temperature, as shown in figures 2 and 3, the following aspects can be identified from the thermodynamic point of view:

• heat in footwear builds generally towards the tip of the foot, other parties having a neighbourhood close to the environment, which creates a degree of aeration;

• the tip of the foot can be divided into three distinct zones with different temperatures: distal extremities of the big toe and second, and third fingers of the foot and the two distal sides, internal and external;

• of the three temperature zones highlighted, the less airy are the sides of the foot, where the flow of warm air can be discharged too quickly;

• of the five pairs of shoes, the best is the one with the number 3, which allows for efficient heat dissipation for the entire duration of registration;

• the most disadvantageous footwear is the number 5, which blocks the heat indoors, it can be used when you want the thermal protection of the foot

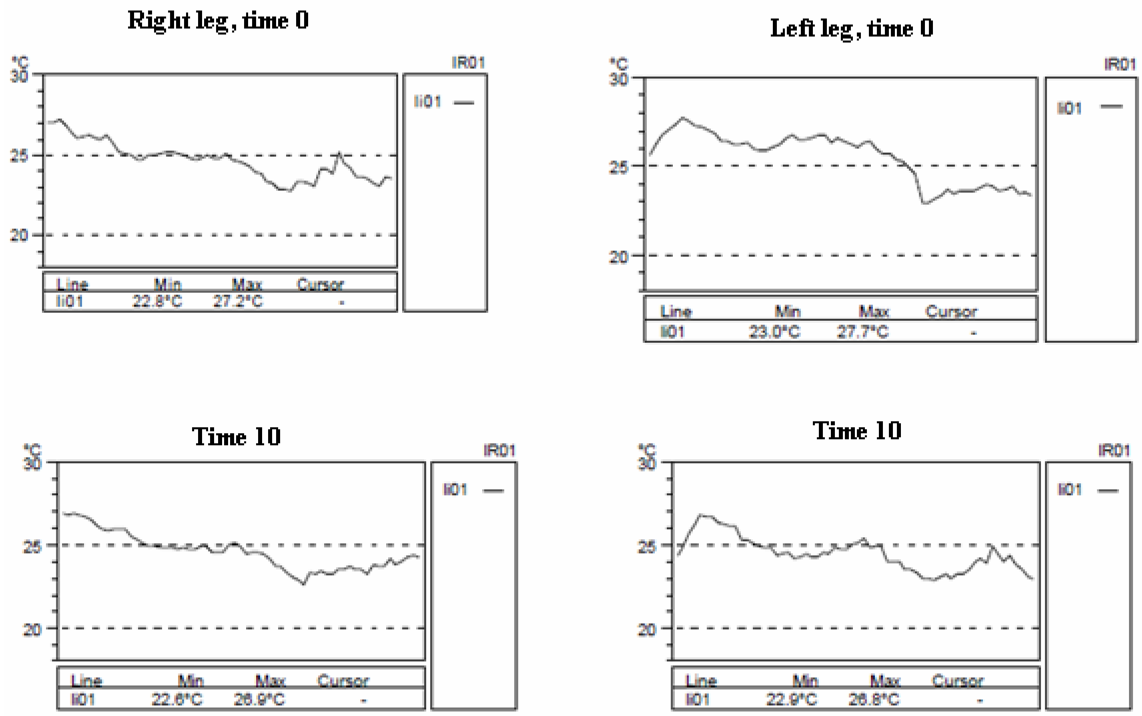


Fig. 2: *Variation in temperature from 3 pair of shoes*

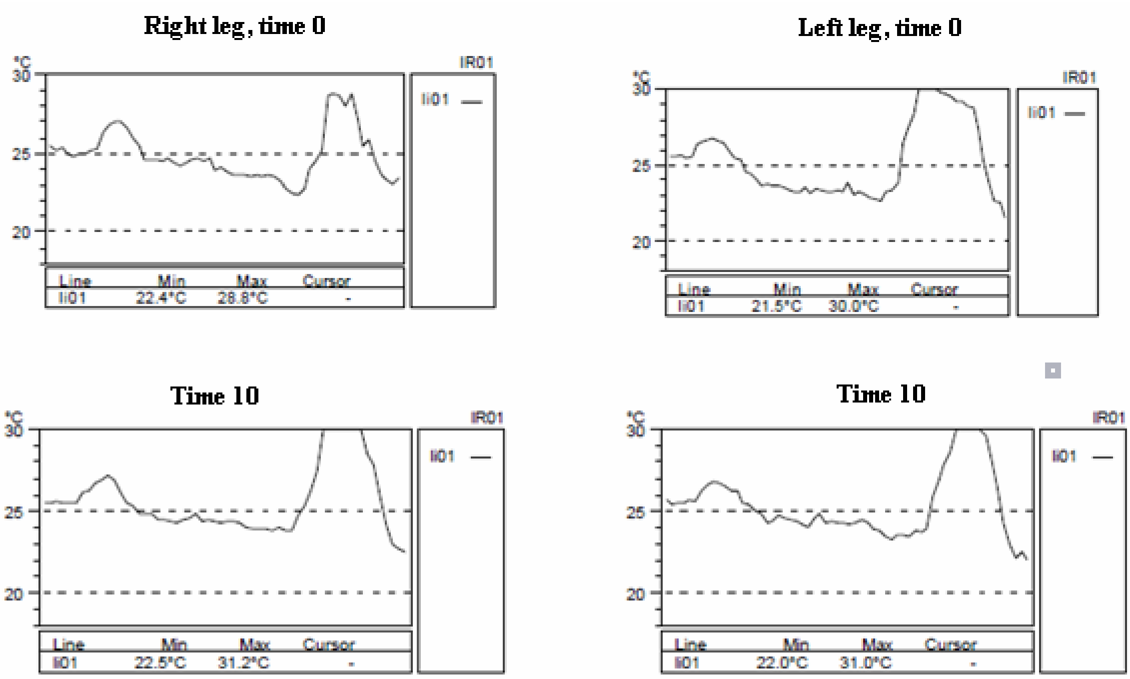


Fig. 3: *Variation in temperature from 5 pair of shoes*

In the charts it is observed that the amplitude of temperature variation is much smaller at the pair of shoes with the number 3 to the number 5.

5. CONCLUSIONS

Investigating shops allows the determination of the most appropriate footwear from the viewpoint of thermal protection, either for general use footwear or athletic shoes for aeration, specifically.

Investigated and analyzed data showed the possibility of sports footwear and personălizării from the thermodynamic point of view, being highlighted the best footwear, among those tested, for test subjects.

REFERENCES

[1] M. W. Zemanski and R. H. Dittman, "*Heat and Thermodynamics*", Ed. New York: McGraw-Hill, 1997, ISBN 0-07-017059-2, pp. 15–114.

[2] E. P. Gyftopoulos and G. P. Beretta, "*Thermodynamics: Foundations and Applications*", Dover, 2005, ISBN 0-486-43932-1, pp. 9–57.

[3] X. P. V. Maldague, T. S. Jones, H. Kaplan, S. Marinetti and M. Prystay, "*Chapter 2: Fundamentals of Infrared and Thermal Testing*", in Nondestructive Handbook, Columbus, Ohio, ASNT Press, 2001, pp. 26- 137.

[4] X. P. V. Maldague, "*Theory and practice of infrared technology for nondestructive testing*", Wiley, 2001, ISBN 0-471-18190-0, pp. 15–59.

[5] V. A. Poryev and G. V. Poryev, "*Experimental determination of the temperature range of a television pyrometer*", in Journal of Optical Technology, 71(1) pp. 70-71 (2004).

ASPECTS REGARDING THE SETTING OF TIME STANDARDS FOR THE PRODUCTION AND SEWING OPERATIONS

SECAN Cristina[1], DORSONSZKY Laszlo[2]

[1] *University of Oradea, Department of Engineering and Industrial Management in Textile and Leatherworks, Faculty of Energy Engineering and Industrial Management, B.St Delavrancea str., no 4, Oradea, Romania,*
E-Mail: cris_secan@yahoo.com

[2] *Sînmartin, Morii Str., no 9, Romania, E-Mail:dorlaci@yahoo.com*

Corresponding author: Secan Cristina, E-mail:cris_secan@yahoo.com

Abstract: *This paper presents the technological process of manufacture of a shoe for women in IL system in order to establish the time and the production norm in the processing-sewing procedure. The sequence of operations is presented in a case study that analyzed how can be obtained the upper assembly of a footwear product that later becomes integral part into the finished product. Drawing up the technological process is done considering both the manual operations and the manual-mechanical operations for processing and assembling the parts that make the whole upper assembly by gluing the parts, by seaming and securing the joints. The type of equipment chosen to carry out operations is influencing through its productivity the necessary material calculated and hence the labour force required. The amount of time consists of time needed for preparation-finishing time, operative time, time of working place service and time of regulated interruptions. These periods of times were determined basically by timing assistance of the manufacturing process throughout its development. Production norm is calculated on the basis of the standard time, taking into account that it represents the amount of products manufactured in a work shift In order to improve the process by reducing the time of production and the number of workers engaged we are considering the automation of the manufacturing process by using modern methods using laser cutting or cutting under running water, automatic sewing machines, strip conveyor belts with pace imposed etc.*

Key words: *footwear, cutting, technological process, production norm*

1. INTRODUCTION

In order to manufacture footwear in a certain quantity, in the processing-sewing workshop, it is necessary that the product goes through all the stages of the technological process in a given time so that the norm of production will be achieved with the support of labour force, which should be correlated with the cost of manufacturing the product, in the organizational and technical conditions specified [1].

The amount of time is expressed according to the preparation-finishing time, operative time, time of working place service and time of regulated interruptions.

The production standard calculated based on the amount of time, will subsequently serve to establish the required labour force for all operations in the technological process [2].

The amount of time **(Nt)** - is the time allotted to a contractor to manufacture a product unit, considering the technical and organizational conditions established of the working place within the respective operation[3,4].

Nt is expressed in minutes person / pair of shoes and it is composed of:

$$Nt = Tpi + Top + Tdl + Tir \quad \textbf{(1)}$$

Tpi – time for preparation – finishing

Top – operative time

$$Top = tb + ta \quad \textbf{(2)}$$

Tdl – time for diversifying the working place

$Tdl = tdo + tdt$ **(3)**

tb – basic time
ta – assisting time
tdo – time for organizational service
tdt – time for technical service

$Tir = ton + tto$ **(4)**

ton – time for rest and physical needs
tto –time for disruption conditioned by labour technology and organization

The production standard **(Np) –** represents the products quantity that can be manufactured in a time unit in the conditioned established.

The amount of time can be used as it is or to establish the production norms, knowing that between the amount of time and the norm of production there is the following relationship:

$Np = 1 / Nt$, (per./ min. person) **(5)**

Where the determination Np on the shift is necessary, we will use the relationship:

$Np = Tm / Nt$, (per. / 8h person) **(6)**

Tm – duration of work shift = 480 minutes

In the amount of time, the sum of components Tpi, Tdl and Tir, for the sewing operations, depends on the type of sewing machine used; this sum of time is expressed in relation to the Top, applying a coefficient of different value, as follows:

$Tpi + Tdl + Tir = K \times Top$, **(7)**

K = 0,154 (for flatbed sewing machines with a needle, for simple seams with 2 threads and zigzag)
K = 0,170 (for sewing machines with one column and 1 needle)
K = 0,200 (for flatbed sewing machines, with 2 needles and for sewing machines with one column and 2 needles)

Knowing the type of the sewing machine, we can calculate the amount of time NT (minutes/pair of shoes).

$Nt = Top (1 + K)$ **(8)**

To establish the production norm we will use the relationship:

$Np = Tm / Nt = 480 / Nt$(pairs of shoes / 8 hours-person) **(9)**

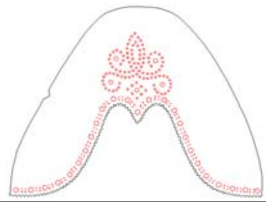
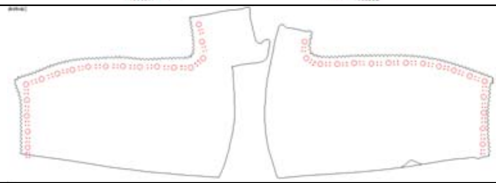
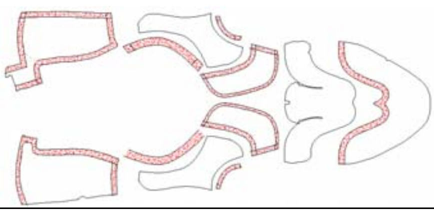
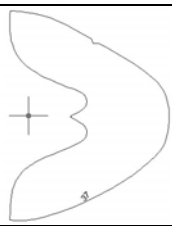
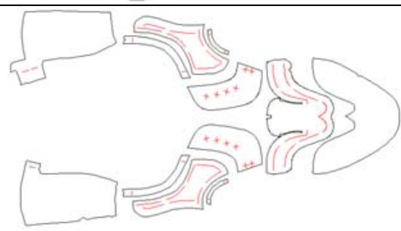
2.CASE STUDY

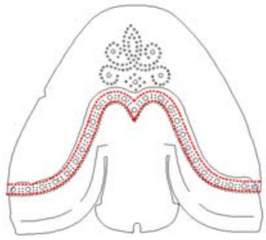
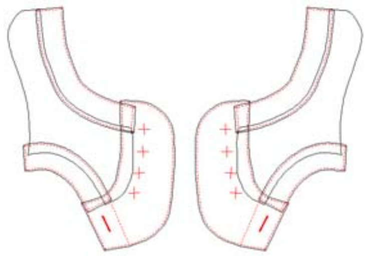
To illustrate the organization method of processing-sewing in continuous flux, in order to establish the amount of time and norm of production, the technological process is shown of a woman's footwear in IL system, made of full grain leather combined with split leather

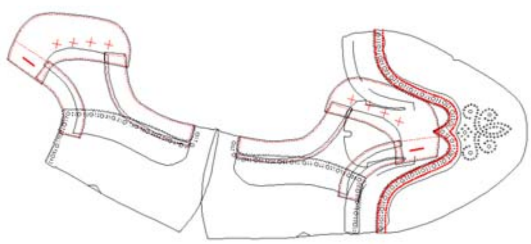
Fig. 1: *Woman footwear*

The way the product is formed from appropriate subassemblies and assemblies, covering the manufacturing flow made up of operations that are carried out in sequence or parallel-sequential, as well as the condition changes that materials undergo during the process are shown below, choosing the type of machine with the help of which the product will be manufactured [5,6].

Table 1: *The technological process*

	Operation	Exterior subassembly of upper assembly
1.	Cutting upper parts: top bands, vamp, decorative top marker, tack seal and linings Execution mode of operation: mechanic Amount of time:3,2 [min* person/pair] Production norm:150 [per. / 8h person]	
2.	Levelling the upper parts and lining Execution mode of operation: mechanic Amount of time: 0,8 [min* person/pair] Production norm: 600 [per. / 8h person]	
3.	Thinning the edges of parts: skewed finite thinning, slightly skewed thinning and straight thinning Execution mode of operation: mechanic Amount of time: 1,5[min* person/pair] Production norm: 320 [per. / 8h person]	
4	Stamping the upper parts in the reserve Execution mode of operation: mechanic Amount of time: 10[sec* person/pair] Production norm: 2880 [per. / 8h person]	
5	Marking the parts Execution mode of operation: manual Amount of time: 20 [sec* person/pair] Production norm:1440 [per. / 8h person]	
6	Greasing for folding the edges of top band Execution mode of operation: manual Amount of time: 18 [sec* person/pair] Production norm: 1600 [per. / 8h person]	
7	Folding the top bands edges Execution mode of operation: mechanic Amount of time: 1,2 [min* person/pair] Production norm: 400[per. / 8h person]	
8	Greasing and placing the decoration and top bands Execution mode of operation: manual Amount of time: 2,51[min* person/pair] Production norm:191,23 [per. / 8h person]	

9	Greasing and placing top vamp on vamp Execution mode of operation: manual Amount of time: 1,49 [min* person/pair] Production norm: 322,14 [per. / 8h person]	
10	Sewing top vamp on vamp Execution mode of operation: mechanic Amount of time: 1,35[min* person/pair] Production norm: 355,5 [per. / 8h person]	
11	Sewing top bands on the first row Execution mode of operation: mechanic Amount of time: 1,28[min* person/pair] Production norm: 375,00 [per. / 8h person]	
12	Greasing and placing tack seal on the top bands Execution mode of operation: manual Amount of time: 50 [sec* person/pair] Production norm: 576 [per. / 8h person]	
13	Greasing and placing the vamp Execution mode of operation: manual Amount of time: 30 [sec*person/pair] Production norm: 960 [per. / 8h person]	
14	Sewing around the lashing and stiffening the seam Execution mode of operation: mechanic Amount of time: 43,3[sec* person/pair] Production norm: 665,1 [per. / 8h person]	
15.	Sewing the tack seal on the top bands Execution mode of operation: mechanic Amount of time: 1,1[min* person/pair] Production norm: 436,36 [per. / 8h person]	
16.	Applying the laces and greasing for folding the edge of the tack seal Execution mode of operation: manual Amount of time: 3,20[min* person/pair] Production norm: 150 [per. / 8h person]	
17.	Bending the edge of the tack seal Execution mode of operation: mechanic Amount of time: 2,48[min* person/pair] Production norm: 193,54 [per. / 8h person]	
18	Greasing and placing top bands on the vamp Execution mode of operation: manual Amount of time: 1,47[min* person/pair] Production norm: 326,53 [per. / 8h person]	

19	Greasing and placing counter stiffener on the upper parts and applying gummed tape Execution mode of operation: manual Amount of time: 1,46[min* person/pair] Production norm: 328,76 [per. / 8h person]	
20	Sewing counter stiffener on the upper parts and the stiffener at the back Execution mode of operation: mechanic Amount of time: 4,28[min* person/pair] Production norm: 112,14 [per. / 8h person]	
21	Preparing the lining: greasing and placing Execution mode of operation: manual Amount of time: 17[sec* person/pair] Production norm: 1694,1 [per. / 8h person]	
22	Finishing the lining of the counter stiffener Execution mode of operation: mechanic Amount of time: 18[sec* person/pair] Production norm: 1600 [per. / 8h person]	
23	Levelling and placing band on the lining of the counter stiffener Execution mode of operation: manual Amount of time: 25[sec* person/pair] Production norm: 1152 [per. / 8h person]	
24	Greasing the upper parts and linings and folding the braid Execution mode of operation: manual Amount of time: 1,1[min* person/pair] Production norm: 436,36 [per. / 8h person]	
25	Lining the top bands Execution mode of operation: manual Amount of time: 1,20[min* person/pair] Production norm: 400 [per. / 8h person]	
26	Sewing around the top bands Execution mode of operation: mechanic Amount of time: 2,43[min* person/pair] Production norm: 197,53 [per. / 8h person]	
27	Cleaning the lining Execution mode of operation: mechanic Amount of time: 20[sec* person/pair] Production norm: 1440 [per. / 8h person]	
28	Sewing the top bands and key Execution mode of operation: mechanic Amount of time: 3,20[min* person/pair] Production norm: 150 [per. / 8h person]	
29	Greasing and gluing the lining of the top bands with the lining of the vamp Execution mode of operation: manual Amount of time: 47[sec* person/pair] Production norm:612,76 [per. / 8h person]	
30	Sewing the lining of the vamp with the	

	lining of the top bands Execution mode of operation: mechanic Amount of time: 2,20[min* person/pair] Production norm: 218,18 [per. / 8h person]	
31	Cleaning the lining of the top bands and lashing Execution mode of operation: mechanic Amount of time: 1,0[min* person/pair] Production norm: 480 [per. / 8h person]	
32	Perforating the top bands for the laces Execution mode of operation: mechanic Amount of time: 20[sec* person/pair] Production norm: 1440 [per. / 8h person]	
33.	Applying the top cap Execution mode of operation: mechanic Amount of time: 0,8[min* person/pair] Production norm: 600 [per. / 8h person]	
34.	Pulling the thread ends and cleaning the semi-manufactured product Execution mode of operation: manual Amount of time: 1,57[min* person/pair] Production norm: 305,73 [per. / 8h person]	
35.	Control, errands transport in the regrouping warehouse Execution mode of operation: manual Amount of time: 1,5[min* person/pair] Production norm: 320 [per. / 8h person]	

3. CONCLUSIONS

The amount of time has an important role in determining the number of manual jobs and manual-mechanical jobs and the number of workers needed who serve in order to achieve the products volume.

In determining the operative time, the sewing operations influence the seams route, their length, the radius of curvature, the time required for different handling required for joining by sewing
A special influence has the type of the sewing machine adopted with the help of which the amount of time is calculated.

With the amount of time we will then calculate the production norm and also the number of jobs for all operations in the technological process.

REFERENCES

[1].Secan C.,Harnagea F.(2013). *Aspects of the technological process of manufacturing-sewing a footwear product for women, type shoe,* Annals of the Oradea University,"Fascicle of Textile - Leatherwork", The International scientific conference, "Innovative solutions for sustainable development of textiles industry", vol XIV, Ed.Universităţii din Oradea, ISSN 1843-813X , pp 99

[2].Secan C, Dorsonszky L.(2011). *Lucrări practice şi de proiect la disciplina ''Procese de fabricaţie în pielărie''*, Editura Universităţii din Oradea, ISBN 978-606-10-0525-3.

[3]. Volocariu R. S., Mărcuş L.(2007). *Îndrumar de laborator pentru procese de fabricaţie în industria confecţiilor din piele*, Editura Pim, Iaşi.

[4].Harnagea F.(2002). *Tehnologia articolelor de marochinărie*, Editura Performantica, Iaşi.

[5]. Volocariu S. R.(1999). *Procese de fabricaţie în industria produselor din piele şi înlocuitori*, Editura Gh. Asachi, Iaşi.

[6].Croitoru D. F.(1987). *Utilaje şi automatizări pentru industria confecţiilor din piele şi înlocuitori*, Rotaprint , I.P.Iaşi.

MANAGEMENT OF PROCESSING AND RECOVERY OF LEATHER WASTE

STAN Ovidiu Valentin[1], ALBU Adina Victoria[2], GHERGHEL Sabina[3], ŞUTEU Marius[4]

[1,2,3,4]University of Oradea, Department of Engineering and Industrial Management in Textiles and Leatherwork, Faculty of Energy Engineering and Industrial Management, B.St Delavrancea str., no 4, Oradea, Romania, E-mail: textile@uoradea.ro

Corresponding author: Stan Ovidiu Valentin, E-mail: stan.ovidiu@ymail.com

Abstract: *The leather and leather goods industry development is conditioned by the development of the supply of raw materials - animal husbandry and chemical industries, sectors that tend to develop intensive on vertical - which causes a shortage of raw materials in relation with the market demand for quality products. The leather is the basic raw material of the leather and leather goods industry, this raw material is the most substantial contribution to downstream sectors, giving them a competitive advantage and it is known that the leather has the greatest potential to add value to the products in which it is incorporated. The advantages of using leather are many, the most important qualities are its hygienic properties, flexibility and adaptability to a wide variety of applications. Leather is manufactured on demand for each type of application, such as shoes, clothes, gloves, handbags, furniture upholstery or car interiors, yachts and planes.*
It requires better use of raw materials by using new technologies and manufacturing processes based on non-invasive methods on the environment leading to increase the product life cycle. The leather and leather goods industry is a supplier of large amounts of waste from the production cycle, waste that has the same properties and qualities as raw material used in the base product. Leather waste represents a loss for the companies, an additional cost related to storage and environmental protection.

Key words: *leather industry, recycling, economic efficency, environmental protection, pollution prevention and control*

1.INTRODUCTION

Throughout history man has realized so much, the qualities and capabilities that distinguish him from other species that he has forgotten his role and place in the planetary ecosystem balance. The cumulative intelligence and inquiring minds of man have created new machinery and technology that contributed to the development of industry and agriculture. At the same time ignoring their place and role in natural balance, man has become the only species that consumes more than it needs, the only species that produces waste in quantities so large that nature can not "recycle" by itself.

Man is part of nature and all the elements of nature, living or non-living, are in a close relationship and therefore create a natural balance. Man has used natural raw materials and created others without realizing that it damages the environment.

The discovery of new machinery, applying new technologies have facilitated the development of industries and due to the intense human activity the amount of waste has increased.

The project approaches the idea of using a raw material leather waste – which is abundant on the market – because it requires very low cost of processing and therefore can become a profitable business.

2. LEATHER WASTE, ENVIRONMENTAL PROTECTION AND SUSTAINABLE DEVELOPMENT

Environmental protection in the context of sustainable development, focus on combating pollution from human activities, preventing possible damages, assimilation, adaptation and application of environmental requirements, implementation of common international projects to protect biodiversity, monitoring the water quality and the condition of the forests and also solving acute problems such as the decrease and recovery of waste and greening agriculture, promoting clean technologies and the transformation of human settlements into sustainable cities. Sustainable development includes environmental protection and environmental protection condition the sustainable development. The waste management has an important role within the concept of sustainable development, waste can be also a source of secondary raw materials, not only a potential source of pollution. [1].

The management strategy includes an analysis of the current situation of waste management and measures that need to be taken to improve environmental conditions and preparing for re-use, recycling, recovery and disposal of waste and an evaluation of how the plan will support the implementation of objectives.

Following the studies conducted before the beginning of the project [2], it can be concluded that in Romania are about 1200 manufacturing companies in the leather and leather goods industry that produces about 3% of GDP. There are no reliable statistical data on the amount of leather waste that is produced by these companies, but from existing data it can be estimated that in Romania are produced monthly about 5-7 tons of leather waste. A small amount, over a ton of leather waste is reintroduced into circulation, the rest being discarded in landfills or incinerated, which is in contravention with "Stockholm Convention on persistent organic pollutants" adopted by the European Union in 2004.

In 2003 in Romania was founded the Waste Stock, but it works as a commercial site rather than a stock system online.

3.PROJECT PURPOSE

The purpose of this project is to highlight the ways and means of processing and recovery of leather waste resulting from the production cycle in order to lead to:

- re-introducting the leather waste in the production cycle;
- use of non invasive procedures and processes on the environment;
- reduction of the loss of the companies;
- reduction of the storage costs of leather waste for the companies;
- reduction of the environmental protection costs;
- use the leather waste in leather goods industry, footwear, handcraft production, in the creations of visual artists and designers;
- create new jobs;
- expansion and diversification of the markets;
- introducing useless leather waste in non invasive products for the environment;
- research and technological innovation oriented in high efficiency;
- creating sustainable products for customer and consumer demand, manufactured under ethical rules, with a low environmental impact;

Using this approach the project wants to provide a possible alternative for recycling the leather waste that combines leather processing and leather engineering with industrial design and fashion for making leather goods, footwear, handbags, leather accessories that are produced from leather waste.

4. RECOVERY, PROCESSING AND RE-USE OF LEATHER WASTE

The project addresses to companies, artisans, designers - industrial, environmental, product and fashion - artists, disadvantaged socio-professional sectors and specialists in environmental management. [3]

This project was developped from December 2013 to April 2014 and offers a different perspective on recycling leather waste in manufacturing companies and where recycling is not possible, selling their leather waste to secondary and tertiary users.

The amount of generated leather waste can be classified in two categories:

- high and constant amount;
- medium-small, random amount.

Considering the high economic interest and the environmental impact, the focus is on the constant generators of large amount of leather waste , but it can’t omit others, taking into account that for some activities, socio-professional categories the request for leather waste is relatively small. The use of leather waste as raw material for making products or accessories has attracted a real interest from private entrepreneurs, artists, designers, hand makers or folk. The selling mode is different from one manufacturer to another, but you can define specific common elements: classic trade conducted in

specialty stores, online shopping, direct trade in fairs and exhibitions, and trade on the basis of a contract made between the manufacturer of accessories or ornaments and their users.
In the past two years the market of handmade products made out of leather and leather waste has increased so that today there are hundreds of artisans who live only from this activity that brings a steady income of several thousands lei per month.

For the secondary entrepreneurs is required knowledge about leather types and quantities of leather waste available according to their needs. The correlation between different types of leather waste, quantity required, the type of product to be made, its design is a prerequisite for the efficient use of leather waste and a sustainable management strategy.

In the supplying with leather waste, there must be taken into consideration the following:

- the final product;
- the design of the product that willbe produced;
- auxiliary materials (thread, lining, eyelets, snaps, buckles, soles, heels, etc.);
- the required quality and quantity of leather waste;
- technical and technological equipment;
- professional training of the workforce;
- costs (transport, utilities, handling, labor, etc.);
- technological losses.

For the documenting phase and implementing the project various companies from the leather industry were contacted, but also visual artists who use leather waste for making artistic articles with complex processing and high commercial potential.

One of the partners of this project is S.C. CLUJANA S.A., one of the most famous manufacturers of shoes in Romania, which showed interest and support for creating products from leather waste. With the support of the company manager and creative team, were made different types of footwear and leather goods with unique appearance and well received by customers. Production costs were much lower than in the classical production and economic efficiency and profit were superior.

The handbags made from leather waste by visual artist Gabriel Carp stand out with great quality, refinement and originality, being true artistic creations that attract public attention.

The project focused on the achievement of different products, such as:

- Handbags (Fig.1):

Fig.1: *Handbags by Gabriela Carp, Visual Artist*

- Footwear (Fig.2) and Belts (Fig.3)

***Fig.2**: Footwear by Stan Ovidiu Valentin (fashion designer), produced at S.C. CLUJANA S.A.*

***Fig.3**: Belts by Stan Ovidiu Valentin (fashion designer), produced at S.C. CLUJANA S.A.*

- Decorative ornaments made from leather waste (Fig.4)

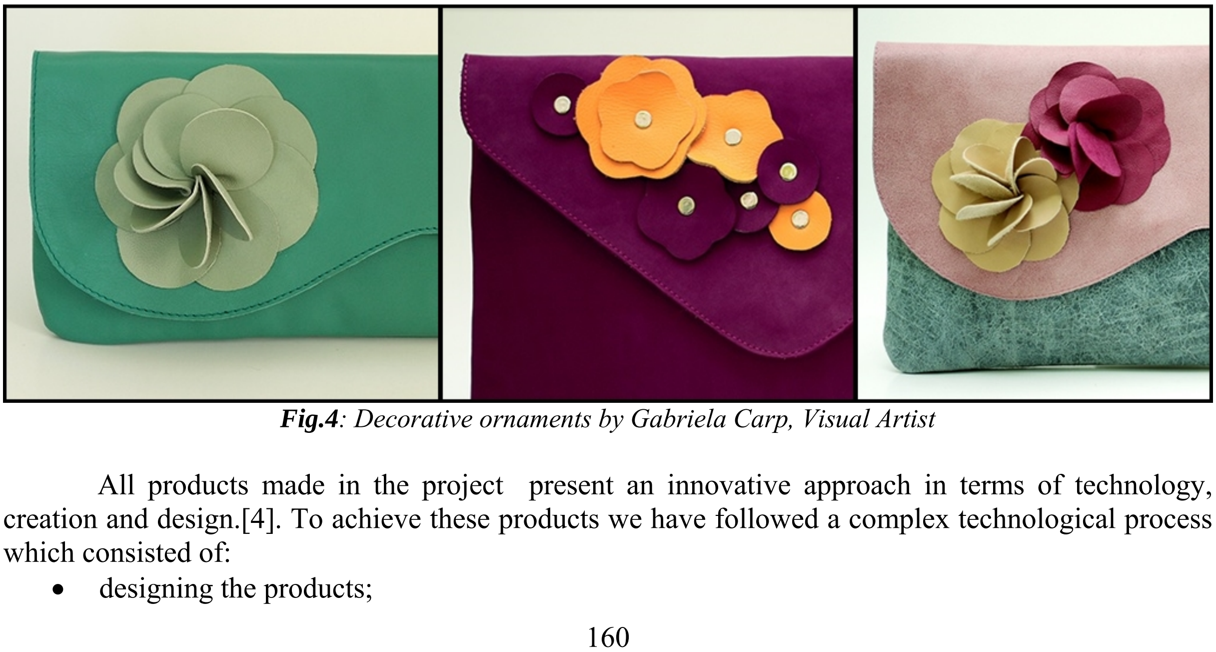


***Fig.4**: Decorative ornaments by Gabriela Carp, Visual Artist*

All products made in the project present an innovative approach in terms of technology, creation and design.[4]. To achieve these products we have followed a complex technological process which consisted of:

- designing the products;

- drawing the necessary patterns and templates;
- determination of the production costs;
- establish the technological process for each product;
- release the products for manufacturing;
- manufacturing the products;
- selling the products;
- reduction of costs and technological looses;
- minimize the environmental impact.

In this project to achieve the specific products were used different sewing techniques and refining such as patchwork (a technique that involves sewing, riveting together pieces of leather waste to create a larger design) and ornamental applications (by gluing, sewing or riveting). The products can be made in small series/quantities or unique and they may represent suggestions, directions in leather waste recovery and also attract labor in individual manufacturing business development.

The products made in the project can be sold in stores, art galleries, showrooms, trade fairs or online. The sale price of these products may be higher considering the high degree of manufacturing, bold design and their uniqueness. Therefore the development of this kind of products may represent an additional source of income for the companies that generate different amount of leather waste, costs reduction and an alternative solution for leather waste management and environmental protection.

5. ENVIRONMENTAL PROTECTION AND RECOVERY OF UNUSABLE LEATHER WASTE

Inevitably after any production process, including the use of leather waste, result an amount of waste that can’t be used. This waste represents an additional expense for the manufacturer and have a direct impact over the environment, which implies difficulties to solve, both for producers and for environmental protection. The leather waste that results from the production process can be processed to obtain biofertilizers with protein additives, biofuels or suface-active materials for the construction industry.

Environmental protection in the leather industry occurs in two directions: pollution prevention and pollution control. There is a difference between “clean production” and the traditional pollution control strategy based on “end-of-pipe” technologies. The "clean production" is preventive, while pollution control strategy accepts waste and emissions as a "given" and try to find ways to treat and minimize them. Toward the end of technological process the amount of waste decreases but increase the complex composition of the waste. A modern technology management which proposes a "clean production" has three important aspects:

1. Pollution prevention through the use of appropriate chemicals [5]
2. The technological development of the company
3. Liquid and solid waste management

The waste treatment is an important component of management for a "clean production" because in the leather industry will never be totally avoided waste generation. Therefore, new methods of destruction, decontamination or neutralization waste to give less harmful substances, have a particular importance in the context of waste management. [6].

The unusable leather waste results from the production process or the recycling process can be processed in order to obtain advanced products for the production of:

- biomaterials used in human medicine, veterinary medicine, cosmetics, dermatology;
- biofertilizers with protein additives;
- biofuels;
- surface-active materials for the construction industry.

6. CONCLUSIONS

From the study and the practice of the project it can be concluded that leather waste is a major environmental risk factor - for aerobic and anaerobic environment - with harmful effects on the environment and human. The leather waste can be a source of raw materials for a wide range of activities and products, some of which have been exemplified in the project. By using leather waste, it can reduce the consumption of raw materials, increase the level of general use and recovery. Equally it is a source of steady income for companies and an opportunity to create new jobs.

REFERENCES

[1]. S.Campanu, M.Ciobortica, D.Constantinescu, L.Avadanei, (2009), *Valorificarea deseurilor textile – Obiectiv al strategiei nartionale de gestionare a deseurilor*, Simpozionul “Impactul Acquis-ului comunitar asupra echipamentelor si tehnologiilor mediului”, 26 – 28 august 2009, Acquistem, Agigea, Statia ICPE

[2]. Agentia Nationala Pentru Protectia Mediului (ANPM), (2012), *Raport anual – Starea factorilor de mediu in Romania*

[3]. *Raport Social si de Mediu – Industria europeana de pielarie*, [Online]. Available: http://www.euroleather.com/socialreporting, (2012),

[4]. E.Carpus, E.Visileanu, C.Niculescu, M.Ciorobatca, S.Campanu, *Considerente privind valorificarea ecologica a deseurilor textile,* [Online]. Available: http://www.inginerie-electrica.ro/acqu/2011/S2_4_Considerente_privind_valorificarea_ecologica_a_deseurilor_textile.pdf

[5]. Gustavo Gonzales-Quijan, (2004), *Pregatirea sectorului de pielarie pentru provocarile viitorului,* Eveniment National PERFECTLINK – Bucuresti, Romania, 08 Noiembrie, 2004

[6]. ISO 14001:2004, *Impact asupra mediului – orice modificare a mediului, daunatoare sau benefica, care rezulta total sau partial din aspectele de mediu ale unei organizatii*

ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

TAX EVASION IN CROSS BORDER TEXTILES OPERATIONS

ANDREESCU Nicoleta Alina[1], STANCIU Dorica[2]

[1] *University of Oradea, Romania, Department of Engineering and Industrial Management in Textiles and Leatherwork , Faculty of Energy Engineering and Industrial Management, B.Şt Delavrancea Str., no4, 410058, Oradea, Bihor, Romania, E-Mail: nandreescu@uoradea.ro*

[2] *University of Oradea, Romania, Department of Economics, Faculty of Economic Sciences, Universitatii Str., no. 1, 410087,Oradea, Bihor, Romania, E-Mail:dorica.oradea@yahoo.ro*

Corresponding author: Nicoleta Alina, Andreescu, E-mail: nandreescu@uoradea.ro

Abstract: *We appreciated that the work can be divided into four chapters designed to enlighten, as far as possible the negative effects that evasion has, particularly the socio-economic phenomenon, faced by all countries. The negative effects generate an indisputable fraud phenomenon and tax evasion, which are felt directly on the level of tax revenue receipts, causing major distortions in the functioning of the mechanism of the market. Fiscal policy using the taxes generates psychological, financial, economic, social effects on a socio-economic environment. The public power that realizes the reality of the tax consequences of the action taken as solution changes of the tax system structure in order to modulate the effects according with the expected outcome. Therefore, the aimed pursued extent influences the technical characteristics of the taxes, and they influence the micro and macroeconomic effects. In this respect it has been proved that reducing tax evasion it allows the creation of budgetary resources necessary for allotting funds for economic growth.*
Developing and implementing a modern and predictable tax for a medium and long term, would be indispensable in the context of competition that occurs between the European states for attracting new investment and creating new jobs. The taxes do not have to shape the behavior of taxpayers, they must be the same regardless of the type of income, it should not include distortions. In order to be reasonable, the fiscal tax should be distributed as wide as possible.

Key words: *tax evasion; VAT, textiles; border operations*.

1. INTRODUCTION

In Romania the phenomenon of tax evasion has taken in the last twenty years, a particular dimension, seriously affecting the economic development of the country. However, tax evasion is still very difficult to control and quantify. This is due to several factors, among which we mention the imperfections and particularities of tax legislation, the low living standards of the majority of the population, the reduced level of civilization, culture and civic consciousness, aggressive fiscal policies that the state promotes and last but not least corruption which is present in authorities with responsibilities in combating tax evasion. In Romania and at European Union level, tax evasion and fraud have serious consequences for the budgets of the Member States and on their own resources system, leading to violations of the principle of fair and transparent taxation, and can distort the competition damaging the functioning of the internal market.

We believe that, no matter how one defines this phenomenon, ultimately tax evasion is a bad thing approached maliciously by the taxpayer. Regarding crimes of tax evasion, they include deeds alleged as such in the criminal law. Tax evasion has a direct and instant effect on the levels of tax revenues, fact that leads directly to imbalancies in market mechanisms as well as enrich illegally, practitioners of this method of cheating that affect the country and ultimately, each of us, the honest taxpayers. [1]

2. FISCAL FRAUD IN THE SALE OF TEXTILE PRODUCTS

The accelerated decrease of lohn volume once our country integrated into the European Union, although alarming for companies in the textiles-footwear domain, however, at that time was considered not dangerous at the national level because it was compensated by other sectors development. However year after year, Romanian lohn has reduced its ratio in total exports of clothing and textile industry, out of which a big part of lohn contracts, was drastically reduced, production declined year by year in the context of many factories having closed their doors.

Most retailers have come to Romania for skilled labor and proximity to western markets. However, Romania has lost the battle with the Asian market on the wage costs segment, factories in China, Bangladesh and Pakistan working on much smaller wages than in Romania. In this context and also in the context of the crisis, Romanian factories lost customers, thousands of workers were unemployed, and some factories have closed. In this situation, production decreased by 94% during 1989-2011. A part of economic operators established after EU accession, but not only, have quickly assimilated criminal fraud practices of tax liabilities used successfully for many years in the Community. The mechanism itself is structured in the current transitional arrangements for the taxation of intra-Community trade, which requires as a general rule, taxation of intra-Community goods performed between taxable persons in the Member State of destination.

In the case of textiles and clothing production many factories have decided to pull the shutters, being defeated by the competition of cheap products coming from China on the one hand and Italy on the other for persons with average income. In this situation, starting with 2008 some operators began to defraud the tax obligations for clothing and textile operations, creating companies on behalf of foreign or Romanian citizens hardly identifiable, companies for whom they began to do intra-Community transactions of such goods. Depending on each case, the purchased garments and textiles were sold in Romania at competitive prices without tax obligations, the afferent accounting records were not carried out or the transactions were closed by other intra-community operations or fictitious exports.

In addition to these methods still practiced, in the period 2008 - 2009, the textiles made in China entered the EU through western harbours, were introduced illegally in Romania and released for free circulation without payment of afferent tax obligations, associated with the complicity of state representatives both in Romania and in other Member States, by registering the respective transports as output from Romania, especially to Ukraine and Moldova.

Tax fraud in this area was further materialized through:

- Undeclared production of goods;
- Undeclared imports from China and other Asian or under-developed countries;
- Non-inclusion in the base taxation;
- Procurement of large quantities of goods by individuals especially in Turkey and China and selling them on the black market;
- Fictitious exports.

This type of fraud involves a chain of successive operations of sale and purchase performed on the Community market and on Romania territory, made by a group of economic operators who sometimes seek to exploit, in an apparent hint of legality, and differences of tax rates applied by EU Member States for the purpose "of cheaper" goods subject to such transactions and, consequently, of creating a comparative advantage in the market in terms of trading price. [2]

3. FISCAL FRAUD IN CROSS BORDER TEXTILE PRODUCTS

Carousel type fraud regarding VAT related to intra-Community transactions is an undeniable presence in intra-Community space, estimates of its size are worrying. The mechanism of this type of fraud is divided into the current transitional arrangements for the taxation of intra-Community trade, which requires as a general rule, taxation of intra-Community goods carried out between taxable persons in the Member State of destination.[3]

This type of fraud is based on a fairly simple mechanism, namely the economic operator from the country of origin is invoicing without VAT and the economic operator in the country of destination shall apply the reverse charge system for this operation.As noted above, there are multiple methods, but the real analysis covered in this paper are those identified as entering Romania under suspensive customs transit.

Thus, in 2008 there were identified a total number of 32 transit operations having as object goods of extra Community origin - China, being introduced into the customs territory of the European

Community and placed under a suspensive customs mode, with the final destination, different companies from Ukraine and Moldova. Customs transit operations were opened by customs offices in six EU member states, being completed and confirmed informatically in specialized module called NCTS by the customs offices at the Romanian border with recipient countries, without the possibility that the transited cargo could leave the European Community territory.

We mention that when placing some extra-Community goods under customs suspension regime and the opening of transit in a Member State of the European Communities (European Union), it represents a pecuniary guarantee, recorded by the main obliged state, that is returned when the goods leaves the common customs area. For 2008, it was established that customs officials in the offices of Romania's border with recipient countries, have falsely confirmed, both on paper and in the customs computer system, leaving the country and implicintly the customs area, with extra-Community destination, transport of those goods, with the consequent cash refund constituted guarantees and thus elusion of payment of European customs duties, the consequences of this being the illegal diminution of the resources of the general budget of the European Communities (European Union), by the non-payment of customs duties and avoiding the related VAT obligation to be paid to the Romanian state for goods released for free circulation in Romania. [3] [4]

Mentioning in the shipping documents of the same transport companies (even if shipments were made on the same day) in case the means of transport included on the accompanying documents have not entered Ukraine, through the crossing points mentioned. At the same time, the companies listed in customs documents as recipients of goods, were either not registered as businesses or were already liquidated. With regard to companies listed in the customs documents as recipients of goods which have been identified as active companies in Ukraine, from the verifications conducted by the competent authorities, it has been revealed that they have not made such imports.

At the same time, the failure to confirm the recipients partners of these operations, could be established by competent authorities that the goods being confirmed as going the Community, were sold in Romania, the state budget being caused a prejudice consisting of added value tax and profit fee and also illegal diminution of the resources of the general budget of the European Communities (European Union), by the non-payment of related customs duties. [3] [4] Given that a transport value was averaged at about 50,000 Euros, the customs value for the 32 shipments is 1,600,000 Euro.

According to TARIC (Integrated Customs Tariff Community) duties owed for such products during 2008 were considered by 12% of the customs value (the average percentage taking into account that it cannot be determined what kind of textile is about, in TARIC being recorded many tariff headings). Therefore, it was established that, by falsified confirming of withdrawal from Romania and thus from common customs area of teh entire quantity of textiles, the general budget of the European Communities has illegally been decreased, by non-payment of related customs duties totaling 192,000 Euros, and Romania's genral consolidated budget in amount of 340,480 Euro, accounting for value added tax, according to data from Table 1. [2]

The tax base for VAT was determined based on data and information available, according to the following formula:

BIMP vat. = value at the customs + customs duty [5]

To determine the VAT, a rate of 19% was applied to the tax base calculated according to the above formula.

Tabel 1: *Calculation of tax liabilities for the 32 transit operations*

Nr. crt.	Name	Customs Value	Customs duties	B.I. VAT	VAT
1	Tranzit 1	48.300	5.760	53.760	10.214
2	Tranzit 2	51.000	6.120	57.120	10.853
3	Tranzit 3	52.000	6.240	58.240	11.066
4	Tranzit 4	49.500	5.676	52.976	10.065
5	Tranzit 5	50.000	6.000	56.000	10.640
6	Tranzit 6	51.000	6.120	57.120	10.853
7	Tranzit 7	49.500	5.940	55.440	10.534
8	Tranzit 8	51.500	6.180	57.680	10.959
9	Tranzit 9	52.000	6.120	57.120	10.853

10	Tranzit 10	48.000	5.760	53.760	10.214
11	Tranzit 11	51.700	6.204	57.904	11.002
12	Tranzit 12	49.000	5.880	54.880	10.427
13	Tranzit 13	50.500	6.060	56.560	10.746
14	Tranzit 14	50.000	6.000	56.000	10.640
15	Tranzit 15	50.500	6.060	56.560	10.746
16	Tranzit 16	52.000	6.240	58.240	11.066
17	Tranzit 17	51.000	6.120	57.120	10.853
18	Tranzit 18	49.000	5.880	54.880	10.427
19	Tranzit 19	48.000	5.760	53.760	10.214
20	Tranzit 20	49.500	5.940	55.440	10.534
21	Tranzit 21	51.000	6.120	57.120	10.853
22	Tranzit 22	51.500	6.180	57.680	10.959
23	Tranzit 23	50.500	6.060	56.560	10.746
24	Tranzit 24	47.500	5.700	53.200	10.108
25	Tranzit 25	49.000	5.880	54.880	10.427
26	Tranzit 26	50.000	6.000	56.000	10.640
27	Tranzit 27	51.000	6.120	57.120	10.853
28	Tranzit 28	50.000	6.000	56.000	10.640
29	Tranzit 29	48.700	5.844	54.544	10.363
30	Tranzit 30	49.300	5.916	55.216	10.491
31	Tranzit 31	52.000	6.120	57.120	10.853
32	Tranzit 32	50.000	6.000	56.000	10.641
	TOTAL	**1.600.000**	**192.000**	**1.792.000**	**340.480**

Source: Processing author from www.mfinante.ro,www.eurojust romania, www.just.ro

4. CONCLUSIONS

Although there is sufficient staff the fiscal and customs offices doot have the expected efficiency in many situations due to operating system of these institutions, being needed a consolidation at the local level and due to delays in terms of controlling and improving tax provisions it is necessary the use and improvement of the information systems. To improve the collection of taxes is absolutely necessary a profound reform of the administration of taxes in Romania.

Given the shipped goods origin, and the addressed, in such cases, after applying appropriate control procedures, it is required a risk assessment. In order to avoid such future practices it is necessary a specific procedure affixed to artery into and out of the customs territory, which can establish specific tasks for each phase of the operations of the physical, documentary, registration records etc., each customs officer assigned to specific responsibilities or per shift as well as a better management of access passwords in the computer system.

REFERENCES

[1] N. Hoanţă, „*Evaziunera fiscală*”, ed. a II-a, Editura H.Beck, Bucuresti2010,

[2]D.A.P. Florescu şi colectiv, „*Evaziunera fiscală”,* 2013,

[3]http://www.cdep.ro/pls/legis/legis_pck.htp_act_text?idt=52436 LEGE nr.571 din 22 decembrie 2003 privind Codul fiscal

[4] http://www.customs.ro/.../Legea%2086%20privind%20Codul%20vamal%20a Legea nr. 86/2006 privind Codul vamal al României

[5]http://www.customs.ro/ro/agenti_economici/taxe_vamale_si_masuri_de_politica_comerciala/prezentare_taric-ro.aspx

[6] http://www.customs.ro/ro/agenti...regim.../tranzitul.../reglementari.aspO.U.G. nr.150/2005, pentru aderarea României la Convenţia privind regimul de tranzit comun adoptată la INTERLAKEN, la 20 mai 1987, aprobată prin Legea nr.22/2006.

[7] http://www.mfinante.ro,

[8] http://www.eurojust romania,

[9] http://www.just.ro.

ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

DEVELOPMENT OF A SYSTEMATIC ANALYSIS FOR THE CHARACTERIZATION OF SPANISH PRODUCTIVE SME PERFORMING PROJECTS R&D&I

PEREZ MOLINA Ana Isabel[1], DÍAZ GARCÍA Pablo[1], GISBERT SOLER Víctor[2]

[1] Universitat Politècnica de Valencia, Spain, Departamento de Ingeniería Textil y Papelera, Plaza Ferrándiz y Carbonell, s/n 03801 Alcoy (Alicante), Spain, E-mail; anpemo@upv.es , pdiazga@txp.upv.es

[2] Universitat Politècnica de Valencia, Spain, Departamento de Estadística e Investigación Operativa Aplicadas y Calidad, Plaza Ferrándiz y Carbonell, s/n 03801 Alcoy (Alicante), Spain, vgisber@eio.upv.es

Corresponding author: Díaz Pablo, E-mail: pdiazga@txp.upv.es

Abstract: *Innovation in SMEs is a key to competitiveness and economic growth pillar. Currently, in Spain, the most important policy to support innovation is tax incentives for R&D&I, based on the issuance of Motivated Binding reports of the Ministry of Economy and Competitiveness.*
This work offers SMEs a quantitative and qualitative model of analysis, and enterprise-level projects, which aims to help them get a favorable structure for innovation. Specifically, a systematic analysis is proposed for Spanish SMEs that perform productive R&D&I, based on factors of company, projects and on both of them, and based on an interview for SMEs, on an analysis of the projects based Motivated Binding a Report and on a review of key data presented in the Mercantile Register.
The method developed has been endorsed by a panel of experts in the field: managers related to innovation, researchers from the University, Agents involved in Institutions binding Motivated management Reports, Managers of innovative SMEs, Business Associations, etc.
By providing a systematic analysis, it will be able to make a quantitative and qualitative empirical study of a representative sample of companies, based on the application of this method.
With all this, we will achieve the characterization and modeling of the Spanish productive SMEs performing R&D&I, obtaining, a model able to assist Spanish companies to achieve including the R&D&I, in its business strategy, which will generate new possibilities for improving competitiveness.

Key words: *research, development, innovation, company*

1. INTRODUCTION

Innovation in SMEs is a key to competitiveness and economic growth pillar. Currently, in Spain, the most important policy to support innovation is tax incentives for R&D&I, based on the issuance of Motivated Binding reports of the Ministry of Economy and Competitiveness. [1]

After an investigation, it is established that there are numerous quantitative studies on SMEs performing in R&D&I, but if a company decides to start innovating, there are no references on what its structure, organization, operation, etc. should be. [2], [3], [4], [5], [6], [7], [8], [9].

Also, after inquiring about the systematic analysis of existing companies, both explicit and implicit, it appears that they do not cover all aspects needed to characterize and model the Spanish productive SMEs performing R&D&I. [10], [11]. Therefore, the need to develop a complete specific systematic, that combines and integrates aspects of business, project, strategy, organization, etc. and relate these aspects together.

It is considered appropriate to raise a systematic that brings together the advantages of the existing ones, that is why it is decided that this work will be developed around two main axes:

- Personal and specific analysis for each company which aims to get specific information about the situation of each company and its projects.

- General analysis of each company based on data from which general information of the company can be obtained and some of the information obtained in the other axis can be validated.

It is considered that to characterize and model the Spanish productive SMEs performing R&D&I, the application of various statistics is not enough that reflect disparate aspects of the R&D&I. Since one of the main limitations of the prior art is that the existing studies are based solely on quantitative variables, so that important actors in the R&D&I are excluded. Therefore, it is intended that the scheme of analysis is able to work with both quantitative and qualitative indicators.

It is intended to find a solution based on the mathematical use of multiple variables both inputs as outputs, and even of the process itself, with the aim of providing a comprehensive and multifaceted vision.

2. DEVELOPMENT

To achieve the objectives, it is considered essential to raise a systematic able to study and relate company factors, projects and mixed, both qualitatively and quantitatively, and it is considered essential that the basic structure of systematic includes the following sections:

- Survey - SMEs personalized interview (included in the personal scan axis).
- Detailed analysis of the R&D&I performing companies (included in the personal scan axis).
- Assessment of the main data submitted to Mercantile Register (included in the axis of the general analysis).

The choice of variables in each of the sections is complicated, due to both its availability and representativeness, therefore, the most appropriate variables will try to be found considering the subsequent need for mathematical combination.

This routine is intended to correct defects and complement existing systematic deficiencies in the application of diagnostic models of Spanish SMEs in their R&D&I. This is based on the following considerations:

- We do not part from a developed or imitated model which has been used in totally different areas.
- The proposed systematic is based on research and previous experience in similar SMEs to be analyzed, but without giving up the use of existing universal concepts on the analysis of companies.
- Within the systematic proposal it is pretended to work always with the manager of the company, and the major directors of the different bussiness areas.

It is intended to achieve a systematic analysis that provides confidence in the results and facilitates the statistical treatment of the data collected so that it is considered adequate to sumarise the variables assessed in this methodology, so once the analysis process of the company and its projects is done, it will be necessary to capture information from a structured way for later work and to get statistically information so thah SMEs can be characterized.

The model includes a systematic questionnaire-interview with the following major sections: general information, organizational structure, HR and training, technology and innovation capacity, products and processes.

Detailed analysis of the R&D&I performed by firms study is based on existing information in the Motivated Binding Resports issued by the correspondent Ministry, such as the duration, planning, cost structure, support received, type of novelty etc.

The assessment of key data submitted to Mercantile Register will include aspects such as the evolution of turnover, profits, profitability, etc.

Bellow there is a table that includes variables both for projects and companies, which must be completed after and / or during the analysis of each of the companies and projects thus, it will be with this table with which the subsequent mathematical-statistical analysis will be proceeded.

Table 1. *Variables studied mathematically at the enterprise level.*

Sector.
Autonomous Community.
Workers number in years n, n-1, n-2 and n-5.
Created company year.
Billing years n, n-1, n-2 and n-5.
Benefit years n, n-1, n-2 and n-5.
Profitability (%) year n.
Financial Performance (%) year n.
Debt (%) year n.
Is there a strategic plan?
Reputation rating company in the market.
Most prominent feature of the company distinguished by customers.
Degree of export.
R&D&I Expenditure years n, n-1 and n-2.
Total expenditure on R&D&I (personal) accepted by the MINECO in different projects. Years n, n-1 and n-2.
Is there enough staff in the business?
Are there plans for more staff?
How is the working environment in the company?
Is teamwork encouraged?
Are internal communication mechanisms adequate?
Is the innovation encouraged in the company from management?
Manager training.
Business and manager bonding.
Is there an adequate learning environment?
How is the technological capability of the firm considered?
Is there strategic R&D&I ot technological plan?
How do you consider the level of professionalism of the company?
Number of R&D&I projects in years n, n-1, n-2.
Number of R&D&I management in the years n, n-1 and n-2.
Number of dedicated people (total or partial) to R&D&I. Years n, n-1 and n-2.
Number of Doctors dedicated (total or partial) to R&D&I. Years n, n-1 and n-2.
Number of Higher Degree dedicated (total or partial) to R&D&I. Years n, n-1 and n-2.
Number of Graduates dedicated (total or partial) to R&D&I. Years n, n-1 and n-2.
Number of Graduates in Vocational dedicated (total or partial) in R&D&I. Years n, n-1 and n-2.
Number of No Graduates dedicated (total or partial) to R&D&I. Years n, n-1 and n-2.
How do you consider the level of structure of the R&D&I?
Are sufficient human resources devoted to R&D&I?
Do you have management systems R&D&I?
Number of publications in professional journals in the last 3 years?
Does it have trouble to finance R&D&I?
Does it innovate in a structured way?
Do they use tools to improve R&D&I?
Rating novelty goods.
Rate the importance of the brand to the introduction of new products.
Rate the state for improvement / optimization of existing processes in the company.
Rate the degree of investment in recent years.
Does the company present projects every year? Or only sporadically?
Real average project duration (average of actual project duration in months).

Table 2. *Variables studied mathematically at the project level.*

UNESCO Code.
Expected duration of the project in number of months.
Real total project duration in number of months.
Total budget for the entire project (differentiating in years).
R & D budget for the entire project (differentiating in years).
Innovation budget for the entire project (differentiating in years).
Total cost justified the entire project (differentiating in years).

Justified cost on R & D of the whole project (differentiating in years).
Justified cost on Innovation of the whole project (differentiating in years).
Full accepted cost of the entire project by MINECO (differentiating in years).
Accepted cost on R & D of the whole project by MINECO (differentiating in years).
Accepted cost on Innovation of the whole project by MINECO (differentiating in years).
What is the cost accepted by MINECO for internal staff for the entire project? Specify R&D&I. Specify for years n, n-1 and n-2.
What is the cost accepted by MINECO for Universities and / or Innovation Centres for the entire project? Specify R&D&I. Specify for years n, n-1 and n-2.
What is the cost accepted by MINECO for external collaborations for the entire project? Specify R&D&I. Specify for years n, n-1 and n-2.
What is the cost accepted by MINECO for consumables for the entire project? Specify R&D&I. Specify for years n, n-1 and n-2.
What is the cost accepted by MINECO for depreciation for the entire project? Specify R&D&I. Specify for years n, n-1 and n-2.
What is the cost accepted by MINECO for other expenses for the entire project? Specify R&D&I. Specify for years n, n-1 and n-2.
Where is the innovation in the project?
Is there a new or substantially improved product / process?
Is the novelty of the project objective or subjective?
Does the project involve a national or international technological innovation? Or internal?
Is the project based on a radical, incremental or imitative innovation?
Is it a multiobjective project?
What is the final strategic objective of the project?
Total number of people dedicated to the project. Specify in years n, n-1 and n-2.
Total number of doctors dedicated to the project. Specify in years n, n-1 and n-2.
Total number of higher degree dedicated to the project. Specify in years n, n-1 and n-2.
Total number of graduates dedicated to the project. Specify in years n, n-1 and n-2.
Total number of graduates in vocational dedicated to the project. Specify in years n, n-1 and n-2.
Total number of no graduates dedicated to the project . Specify in years n, n-1 and n-2.
Total number of people solely on the project. Specify in years n, n-1 and n-2.
Type of people dedicated exclusively.
Does the manager participate in the project?
Has the project received state aid?
Quantity provided by a financial institution at market rate?
Quantity received as a grant?
Quantity received in the form of preferential loans?
Rating technicality of external collaborations of the projects
Is the project conducted in cooperation with other entities?
Are the results of the project protected by property rights?

From the combination of some of the above variables which are obtained others are identified as "outcome variables", both at company and project, which also work in statistical analysis. These variables are shown in the following tables.

Table 3. *Outcome variables at company*

% Workers assigned to R&D&I tasks in year n / total workers in year n.
% Workers assigned to R&D&I tasks in year n-1/ total workers in year n-1.
% Workers assigned to R&D&I tasks in year n-2 / total workers in year n-2.
% Profit in year n / Turnover in year n.
% Profit in year n-1 / Turnover in year n – 1.
% Profit in year n-2 / Turnover in year n – 2.
% Profit in year n-5 / Turnover in year n – 5.
% R&D&I costs in year n / Profit year n.
% R&D&I costs in year n-1 / Profit in year n – 1.
% R&D&I costs in year n-2 / Profit in year n-2.
% R&D&I costs in year n-5 / Profit in year n-5.
% R&D&I costs in year n / Turnover in year n
% R&D&I costs in year n-1 / Turnover in year n – 1.
% R&D&I costs in year n-2 / Turnover in year n-2.
% R&D&I costs in year n-5 / Turnover in year n-5.
% R&D&I costs in year n / Number of projects in year n.
% Cost for internal staff in R&D&I in year n / R&D&I costs in year n.

% Cost for internal staff in R&D&I year n-1 / R&D&I costs in year n-1.
% Cost for internal staff in R&D&I year n-2 / R&D&I costs in year n-2.
% Cost for internal staff in R&D&I in year n/ Number of people of R&D&I department in year n.
% Cost for internal staff in R&D&I in year n-1/ Number of people of R&D&I department in year n-1.
% Cost for internal staff in R&D&I in year n-2/ Number of people of R&D&I department in year n-2.
% Number of doctors of R&D&I department in year n/ Number of people of R&D&I department in year n.
% Number of doctors of R&D&I department in year n-1/ Number of people of R&D&I department in year n-1.
% Number of doctors of R&D&I department in year n-2/ Number of people of R&D&I department in year n-2.
% Number of higher degree of R&D&I department in year n/ Number of people of R&D&I department in year n
% Number of higher degree of R&D&I department in year n-1/ Number of people of R&D&I department in year n-1.
% Number of higher degree of R&D&I department in year n-2/ Number of people of R&D&I department in year n-2.
% Number of graduates of R&D&I department in year n/ Number of people of R&D&I department in year n.
% Number of graduates of R&D&I department in year n-1/ Number of people of R&D&I department in year n-1.
% Number of graduates of R&D&I department in year n-2/ Number of people of R&D&I department in year n-2.
% Number of graduates in vocational of R&D&I department in year n/ Number of people of R&D&I department in year n.
% Number of graduates in vocational of R&D&I department in year n-1/ Number of people of R&D&I department in year n-1.
% Number of graduates in vocational of R&D&I department in year n-2/ Number of people of R&D&I department in year n-2.
% Number of no graduates of R&D&I department in year n/ Number of people of R&D&I department in year n.
% Number of no graduates of R&D&I department in year n-1/ Number of people of R&D&I department in year n-1.
% Number of no graduates of R&D&I department in year n-2/ Number of people of R&D&I department in year n-2.

***Table 4.** Outcome variables at project*

% Economic deviation.
% Cost accepted by MINECO for internal staff / total cost accepted by MINECO.
% Cost accepted by MINECO for Universities and / or Innovation Centres / total cost accepted by MINECO.
% Cost accepted by MINECO for external collaborations / total cost accepted by MINECO.
% Cost accepted by MINECO for consumables / total cost accepted by MINECO.
% Cost accepted by MINECO for depreciation / total cost accepted by MINECO.
% Cost accepted by MINECO for other expenses / total cost accepted by MINECO.
% Total number of Doctors dedicated to the project / Total Number of people dedicated to the project
% Total number of Higher Degree dedicated to the project / Total Number of people dedicated to the project.
% Total number of graduates dedicated to the project / total number of people dedicated to the project.
% Total number of graduates in vocational dedicated to the project / total number of people dedicated to the project.
% Total number of no graduates dedicated to the project / total number of people dedicated to the project.
% Amount financed by a financial institution / Total expenditure executed.
% Amount received as subsidy / Total expenditure executed.
% Amount received on preferential credit / Total expenditure executed.

By providing a systematic analysis, it will be able to make a quantitative and qualitative empirical study of a representative sample of companies, based on the application of this method.

Note that the method developed has been endorsed by a panel of experts in the field: managers related to innovation (Technology Centers, European Business and Innovation Centres, etc.), researchers from the University, Agents involved in Institutions binding Motivated management Reports, Managers of innovative SMEs, Business Associations, etc. With the panel of experts' participation we achieve to improve the method and demonstrate the efficiency of the results described throughout this work.

With all this, we will achieve the characterization and modeling of the Spanish productive SMEs performing R&D&I, obtaining, a model able to assist Spanish companies to achieve including the R&D&I, in its business strategy, which will generate new possibilities for improving competitiveness.

3. CONCLUSIONS

This work provides a systematic quantitative and qualitative analysis, and enterprise-level projects, suitable for analyzing any SMEs, regardless of size, sector, age, etc. It identifies and defines the influential variables and attributes in the innovation process of SMEs, both at the enterprise level, as individual projects; and is able to cover the necessary aspects to characterize and model the Spanish productive SMEs performing R&D&I.

REFERENCES

[1] Ministerio de Industria, Turismo y Comercio. "*Informes Motivados para deducciones fiscales por actividades de I+D e innovación tecnológica. Ejercicio fiscal 2005".*

[2] N. López. "*Análisis del comportamiento innovador en la empresa manufacturera española"*. 2004.

[3] R. Jordá y A.L. Lucendo. "*Escenarios para una estadística sobre innovación de dimensión regional. Su apliación en Andalucía"*. Economía Industrial, 2002, no 344, p. 177-190.

[4] D. Rodeiro, D. López y M.C. Penabad. "*A innovación como factor clave na competitividade empresarialun estudo empírico en pemes galegas".* Revista galega de economía: Publicación Interdisciplinar da Facultade de Ciencias Económicas e Empresariais, ISSN 1132-2799, Vol. 16, Nº. 2, 2007.

[5] N. Mancebo, J. Llach y A. Bikfalvi. "Patrones *regionales de comportamiento innovador. Análisis de la encuesta del INE a partir del caso de Cataluña.: El comportamiento de la empresa ante entornos dinámicos":* XIX Congreso anual y XV Congreso Hispano Francés de AEDEM, Vol. 1, 2007.

[6] M.F. Madrid, R. Sabater y R. Sanz. *"La I+D en la Comunidad Autónoma de la Región de Murcia"* 2008, Vol. Revista madri+d.

[7] A. M. Gómez y J.L. Calvo. *"Un análisis de las relaciones entre I+D, innovación y resultados empresariales: el sector de electrónica e informática en España".* Economía industrial, ISSN 0422-2784, Nº 376, 2010.

[8] G. García. *"Capacidad de innovación a nivel sectorial: modelización y evidencia empírica para España".* 2011. Tesis Doctoral. Universidad de Cantabria.

[9] J.L. Calvo. *"Una caracterización de la innovación tecnológica en los sectores manufactureros españoles: algunos datos".* Economía industrial, ISSN 0422-2784, Nº 331, 2000.

[10] V. Suesta y J. Tornero. *"Descripción de distintas metodologías de diagnóstico empresarial".* XVII Congreso Nacional de Ingenieria de Proyectos- murcia. 2001.

[11] V. Suesta, J. Gutierrez y J. Tornero. *"Comparativa de metodologías de diagnóstico empresarial".* XVII Congreso Nacional de Ingenieria de Proyectos - Murcia. 2001.

THE COMPETITIVENESS OF TEXTILE INDUSTRY

PRUNEA Ana

[1] *University of Oradea, Department of Economy, Faculty of Economics, Universitatii str. No. 1, 410087, Oradea, Romania*

Corresponding author: Prunea, Ana, E-mail: ana_prunea@yahoo.com

Abstract: *The role of this paper is to highlight the position of the European players in the textile market and the challenges to which they are subjected. In this paper are presented ways, taking the „diamond" model of M. Porter and are adapted to the situation of the textile market. These adaptations have outlined the main existing problems and the possible solutions that can ensure the long-term competitive advantage. Gaining a competitive advantage based on innovation, the development of production and outsourcing strategies using the "diamond" model of M. Porter, we can say that is one of the viable solutions for gaining competitive advantages necessary for proper European companies to face competition from countries outside Europe. As developing countries do not meet certain environmental standards or norms of European law, but in terms of product innovation and development of new materials, they do not have the necessity for technology. We conducted an analysis of the factors that play a key role in the production of textiles, representing how they are used in the favor of European companies such investments to be supplemented can be found in how these factors act on the total costs.*

Key words: *competition, factors, strategies, competitive advantage*

1. INTRODUCTION

The massive competition between producers in the EU and those who are in countries like China, Japan, Turkey, Korea provoked questions on the EU textile industry and its lifetime. The desire to maintain market share, many manufacturers are in the European Union they were forced to take drastic measures such as reducing of staff. European textile market in 2013 had an income of 190 billion euro in 2010 had an income of 172 bilion euro. Largest textile market segment is represented by the casual wear, they share with 36.7% of all textiles, and the next place is the textile 35.4%.[1].

The textile industry continues to have a significant role in the European economy and its decline will have a serious impact on the EU economy.

The concern is caused by the production of textiles in Western Europe because it competes directly with the regions outside the EU who have a cheaper labor force, and in terms of environmental standards they are more relaxed and most of or do not exist at all. Finding alternative ways to EU producers with which they can survive. The strong points held so far at the same time are not sufficient prerequisites for competitive advantage.

In this analysis we use Michael Porter's theory on competitive advantage. According to it, the goal of all businesses is to obtain an competitive advantage in the relations with competitors on the market.This advantage can be achieved by two ways, ie selling products at a lower price, or their differentiation.[2] Regarding the price of the products, we can specify that the EU does not practice the lowest prices, but to enjoy a competitive advantage that can ensure the longevity of textile manufacturing companies requires a differentiated product. This differentiation it can be able to make through quality, namely providing superior quality products that are competing manufacturing companies in countries like China. We have to consider that competitive advantage in any industry is represented by the synergy of factors and not just by one. To use the competitive advantage we need to know the weaknesses and threats that confront major textile producing countries in the EU.

In his book The Competitive Advantage of Nations, Porter introduces the notion of national competitive advantage, which refers to "the decisive characteristics of a nation that allows companies to create a sustainable competitive advantage in some areas" [2]. In our case we consider that the most advanced countries like France, Germany and the United Kingdom, because according to statistics conducted by Datamonitor in these countries produce the largest quantity of textiles in Europe. But to face competition from outside the EU, manufacturing companies have to believe or support their competitive advantages.

Table. 1: *Europe textile market segmentation*

Country	%Share
France	15,6%
Germany	15,3%
United Kingdom	14,3%
Italy	13,8%
Spain	9,4%
Rest of Europe	31,5%

2. FACTOR CONDITIONS

These factors are represented by human resources (their quantity, quality, and knowledge), data resources of capital (cost of finance industry) and infrastructure (here we include transportation system, communications, health care, cultural conditions). Given that some of these factors are detained by a default country, and have different combinations of factors from one industry to another, we can specify that the competitive advantage of a country is the result of the mix of these factors. But we have to mention that in creating competitive advantage not all factors are equally important, so Porter has classified as "basic factors" (human resources, unskilled labor), "advanced" (modern infrastructure, trained personnel in research), "general" (transportation system, motivated staff with basic general education high school) and "specialized" (specialized or adapted infrastructure industry, specializing in a particular field staff).

In textile production factors are required basis, the general being rare. General factors, represent the processes that need qualified staff rarely found, one of the processes that it takes these factors are the production of synthetic fibers. Otherwise, the main production processes can take place using only basic factors, ie mainly unskilled or basic knowledge, the resources required for the production of textiles finding is easy. These factors can be considered as the generators of competitive advantage, but their operation is typical of countries where we find abundant and the breakneck small. In Europe the labor cost is relatively high compared to countries beyond, developing countries. Imports of textiles from developing countries such as Indonesia, India, Pakistan, grows twice as fast as exports of textiles to the EU regions [3]. Noticing that brain source of competitive advantage is in practice a low cost because competition can not be surpassed in this respect, European manufacturers were going to invest in other ways to create competitive advantage. They developed the design, fashion, even created new materials, by investing in research. We may say that was created a competitive advantage based on innovation.

3. THE DEMAND FACTOR

The second factor in creating competitive advantage in an industry is represented by the existence demanded for its products. In the early 1980s has been changing the way of buying clothing that is people have begun to purchase clothing only for one season. This custom came with creating the concept of fashion and lifestyle change that until 1980 does not take place only once or twice a year. The appearance of this concept has led to intensified competition in consumption growth. European producers have focused more on fashion in style textile quality and less on their price. This demand for textiles in fashion having different colors and patterns are more likely to be satisfied by 'local' or Europeans manufacturers than by those from outside Europe because Europeans are the ones who invented this concept, it will occur subsequent changes or adaptations throughout Europe. The competitive advantage enjoyed by European manufacturers bringing with him a number of other advantages:

a) the response speed to challenges demand;
b) lower distribution costs;
c) there will be costs due to long period’s stationary products in stock.

With the advent of large brands, the buyers began to associate with quality, preferring them instead of them located in Asia for example where they are unknown. With the growth of the industry based on demand, manufacturers have started to look for distributors that would ensure quick delivery of products and to deal with frequent changes of style in this area. In Europe the company which registered in 2010 the highest incomes in Europe is Bennetton Group. This is recorded in Milan, Italy and is the main activate the production of clothing for adults and children and the second activity is the production of textiles. Benetton has nearly 10,000 employees and in 2012 had $ 3,2 million turnover [1]. Indeed, in Italy the percentage that you spend on clothes per citizen is the highest, being 10% of total revenues in 2000 [3]. As consumers are more sophisticated applications with both pressure faced by manufacturing companies is higher.

4. STRATEGY STRUCTURE AND RIVALRY

In a globalized and liberalized world, there is a clear line of demarcation between "cost routing" and "differentiation".

Differentiation markets can go hand in hand with directing supply chain costs.

A competitive strategy used by European companies is represented by textile manufacturer's collaboration with the fashion designers, resulting in the creation of materials and new designs. We mention here one of the most popular joint Marks & Spencer ventures.

One method to enter the retail sector of many European countries without fear of loss of identity large companies is the method called franchising. Benetton was among the first who used this method and managed to deliver around the world textile and clothing without losing autonomy and thus having control over the distribution network.

The major companies have considered relocating production as the only method that could cope with success in this area. The relocation takes place only in the production and is in countries where labor is cheap. Both the research and part design and product design will be outsourced.

This outsourcing of production takes place in countries from Europe, most of them belonging to the Central and Eastern EU. Eastern European countries have come to be among the leading textile providers of West European with Turkey and North Africa.

Investments made in research and development has led to the creation of new types of materials, like those ecological and environmentally and are difficult to copy by the EU's main competitors represented as barriers to entry of new producers less developed.

Regarding competition, we can consider the one threatening from India and Pakistan. Their products are limited to simple items like t-shirts or underwear. China already produces complex items of superior quality the aforementioned countries. It holds a 30% share of EU imports in 2003 and owns 50% of imports from Italy. [1]. The key to success of China, lies in practicing a very low price for a product "good" or well done. Counterfeiting products has become a highly practiced in China. To strengthen its position in the Chinese industry is mostly used in practicing state dumped. Although, with China's accession to the WTO (World Trade Organization) should have the advantages establishing fair competition. But these advantages cannot be operated because there complete information on the conditions of production and sales in China.

5. RELATED INDUSTRIES

The competitive advantage comes from tight cooperation between large suppliers and companies. They help companies to gain access to information on new technologies and methods [2]. EU textile sector is composed from small and medium companies. In 2010 the European textile industry realised a total turnover of € 172 billion and employed 1.9 million people in more than 127,000 companies. The average number of employees in a company in 2010 was about 19. [4] The largest drop has been registered in Spain, France, Germany, Czech Republic and the UK. All have experienced a decline above 55%, the largest seen in the UK with 67%. The lowest declines were registered in Belgium, Netherlands (both 43%), Finland24 (37%) and Bulgaria with only 17%. In Bulgaria textile manufacturing employment declined by 50% whereas clothing manufacturing employment only declined by 9%.[1]

The speed of the producers response to customer needs, flexibility and the speed at which manufacturers can adapt to environmental changes occurred is really to competitive advantage. The high degree of regional concentration, combined with decentralization, creates conditions for the phenomenon appointed by Marshall an "industrial district" [5]. These types of small concentrations of the same type and in the same place are the most common in Italy and each company is specialized in a specific type of activity production process.

This "industrial district" has a greater flexibility, and companies that are part of this district do with the changes more quickly, being bulk cooperation. On the other hand, companies focused but behave independently, these do not receive the information to others and engineering of the atmosphere located in the district.

6. CONCLUSIONS

With the increasing of international competitiveness and market belong to the new "players" such as China, companies in Europe must awareness of, the basis of competition is not only the low price. To face the challenges must develop their certain skills such as flexibility. The innovation has an important role in combating competition, there is need for investment in research and development areas, where they develop new products, new materials with different uses. Needs of the customer are put on the first plans, the importance of speed of response to requests from producers to drug users. Manufacturers focus on the niche markets is an asset owned by Europeans because they are hardly satisfied, most often these markets are product customization, but at small series. The access from China manufacturers such competitors in these markets are difficult because the response speed, quality, and innovation are key features of this market. Although at this time the textile industry in Europe is not competitive in terms of production costs, the solution found by the major manufacturers, namely outsourcing is the optimal production. It also benefits from the ability of European producers anticipate customer needs, which are increasingly difficult to satisfy. This prediction is made by changing trends, adapting them to the main activities of most consumers. In the future, European companies need to adopt new strategies to be based on demand trends and national distribution systems.

REFERENCES

[1] ec.europa.eu/enterprise/sectors/textiles

[2] M. Porter, "*The Competitive Advantage of Nations*", Macmillan Press ltd. London 1985, pp. 34–39.

[3] European Comission, Eurostat, "*Textiles*", August 2000, pp.20-100.

[4] "*Textile and Clothing sector*".[Online]. Availible: trade.ec.europa.eu, February 2011

[5] A. Marshall, M. Paley Marshall " *The Economics of Industry* ",Acmillan and CO ,London, 1879.

[6] OECD 1983*,"Textile and Clothing Industries :Structural Problems and Poliicies in OECD Countries",* OECD Paris

[7] A. Bull, M. Pitt and J. Szarka, "*Entrepreneurial Textile Comunities*" Chapmanii and Hall Press London, 1993, pp.20-50

ECO-INNOVATION FOR A SUSTAINABLE FUTURE

RATIU Mariana

University of Oradea, Romania, Department of Engineering and Industrial Management in Textiles and Leatherwork, Universitatii str., no.1, 410087 Oradea, Romania, E-mail: mratiu@uoradea.ro

Corresponding author: Ratiu Mariana, E-mail: mratiu@uoradea.ro

Abstract: *Eco-innovation is any form of innovation resulting in or aiming at significant and demonstrable progress towards the goal of sustainable development, through reducing impacts on the environment, enhancing resilience to environmental pressures, or achieving a more efficient and responsible use of natural resources. States and governments of the world, different institutions and organizations actively involved and aware in public policies, strategies and actions, reaffirm their commitments and reassess actions in order to achieve a truly sustainable development. In the common vision and the resolutions and other documents of the United Nations Conference on Sustainable Development, Rio+20, the words "environment", "innovation", "green economy" appear very often and almost always along the same context, to achieve the objectives of the sustainable development. The objectives of EU's Europe 2020 strategy for smart, sustainable and inclusive growth, are being implemented through a number of Flagship Initiatives addressing the main challenges, like "Innovation for a sustainable Future - The Eco-innovation Action Plan (EcoAP)". Eco-innovation Observatory developed the Eco-Innovation index, the first tool to assess and illustrate eco-innovation performance across the EU Member States. Like in all fields, in textiles and leatherwork field, eco-innovation is present and there are a lot of tools available that measure environmental damage and help manufacturers and brands become more sustainable. Eco-innovation is not just a trendy concept but a reality and a necessity nowadays, a way to achieve a sustainable future for ourselves and future generations.*

Key words: *environment, innovation, eco-innovation, eco textiles, sustainable development*

1. INTODUCTION

More and more severe environmental challenges and resource constraints have lead to growing worldwide demand for environmental technologies, products and services and have facilitated the emergence of green industries. Appeared a lot of new expressions and concerns, such as eco efficiency, eco smart companies, eco industries, clean production, which put in place, leading to rational and efficient management of resources, reduce energy consumption, increased competition and the number of technological alternatives available, and finally to a better quality of life, to a better and right development for entire society. In this context appeared, the same, the expression "eco-innovation" which is closely linked to the way we use our natural resources and to how we produce and consume.

Eco-innovation is any form of innovation resulting in or aiming at significant and demonstrable progress towards the goal of sustainable development, through reducing impacts on the environment, enhancing resilience to environmental pressures, or achieving a more efficient and responsible use of natural resources. [1] Today, eco-innovation concept is used worldwide, at all levels, in public politics and strategies, in production and business, research and education, in all fields.

2. UNITED NATIONS CONFERENCE ON SUSTAINABLE DEVELOPMENT

In the common vision and the resolutions (Resolution 1 adopted by the Conference on Sustainable Development, Rio+20, "The future we want") and other documents of the conference, stated:

“We, the Heads of State and Government and high-level representatives, having met at Rio de Janeiro, Brazil, from 20 to 22 June 2012, with the full participation of civil society, renew our commitment to sustainable development and to ensuring the promotion of an economically, socially and environmentally sustainable future for our planet and for present and future generations.”

“We therefore acknowledge the need to further mainstream sustainable development at all levels, integrating economic, social and environmental aspects and recognizing their interlinkages, so as to achieve sustainable development in all its dimensions.”

“We resolve to take urgent action to achieve sustainable development. We therefore renew our commitment to sustainable development, assessing the progress to date and the remaining gaps in the implementation of the outcomes of the major summits on sustainable development and addressing new and emerging challenges. We express our determination to address the themes of the United Nations Conference on Sustainable Development, namely, a green economy in the context of sustainable development and poverty eradication, and the institutional framework for sustainable development.”

“We affirm that green economy policies in the context of sustainable development and poverty eradication should: … promote sustained and inclusive economic growth, foster innovation and provide opportunities, benefits and empowerment for all and respect of all human rights”.

“We underscore the importance of supporting educational institutions, especially higher educational institutions in developing countries, to carry out research and innovation for sustainable development, including in the field of education, to develop quality and innovative programmes, including entrepreneurship and business skills training, professional, technical and vocational training and lifelong learning, geared to bridging skills gaps for advancing national sustainable development objectives. [2]

As you can see in these few remarks, the words "environment", "innovation", "green economy" appear very often and almost always along the same context, to achieve the objectives of the sustainable development.

3. EUROPE 2020 - A STRATEGY FOR SMART, SUSTAINABLE AND INCLUSIVE GROWTH

The EU's Europe 2020 strategy for smart, sustainable and inclusive growth was launched by the European Commission in March 2010 and approved by the Heads of States and Governments of EU countries in June 2010. The document sets out concrete targets to be achieved within the next decade in areas such as employment, education, energy use and innovation in order to overcome the impact of the financial crisis and put Europe back on track for economic growth.

The Europe 2020 strategy is about delivering growth that is: smart, through more effective investments in education, research and innovation; sustainable, thanks to a decisive move towards a low-carbon economy; and inclusive, with a strong emphasis on job creation and poverty reduction. The strategy is focused on five ambitious goals in the areas of employment, innovation, education, poverty reduction and climate/energy. Europe 2020, a strategy for jobs and smart, sustainable and inclusive growth, is based on five EU headline targets:

1. Employment:
   - 75% of 20 to 64 year old men and women to be employed
2. Research &Development
   - 3% of GDP to be invested in the research and development (R&D) sector
3. Climate change and energy sustainability
   - reduce greenhouse gas emissions by 20% compared to 1990 levels
   - increase the share of renewables in final energy consumption to 20 %
   - 20% increase in energy efficiency
4. Education
   - reduce the rates of early school leaving to below 10%
   - at least 40% of 30 to 34 year olds to have completed tertiary or equivalent education
5. Fighting poverty and social exclusion
   - reduce poverty by lifting at least 20 million people out of the risk of poverty and social exclusion. [3]

Can see that the environmental protection and innovation through education, research and development are seen as the main way forward for achieving the strategy’s targets.

4. THE ECO-INNOVATION ACTION PLAN

The Europe 2020 strategy's objectives are being implemented through a number of Flagship Initiatives addressing the main challenges.

- the *Youth on the move* initiative, to enhance the performance of education systems, non-formal and informal learning, student and researcher mobility, but also young people's entry to the labour market [4]
- the *Innovation Union*, to support the production of innovative products and services, in particular concerning climate change, energy efficiency, health and the ageing population [5]
- the *industrial policy for the globalisation era* initiative, to help businesses to overcome the economic crisis, integrate into world trade and adopt more environmentally-friendly production methods [6]
- the *agenda for new skills and jobs*, to improve employment and the sustainability of social models. The aim is to encourage the strategies of flexicurity, worker and student training, but also gender equality and the employment of older workers [7]
- the *Resource-efficient Europe* initiative, to support the sustainable management of resources and the reduction of carbon emissions, while maintaining the competitiveness of the European economy and its energy security [8]
- the *Partnering in Research and Innovation* initiative, use existing public and private resources for research and innovation (R&I) in a smart way to optimise the contribution of public and private players in achieving sustainable growth. [9]

Another Flagship Initiative, who complements other Europe 2020 Flagship Initiatives, is ***Innovation for a sustainable Future - The Eco-innovation Action Plan (EcoAP)***. The Eco-innovation Action Plan includes targeted actions both on the demand and supply side, on research and industry and on policy and financial instruments. The implementation of the actions will be supported by the partnering approach between stakeholders, private and public sector, and the European Commission.

The Commission will foster key drivers for the market uptake of eco-innovation by:
- using environmental policy and legislation as a driver to promote eco-innovation (Action 1)
- supporting demonstration projects and partnering to bring promising, smart and ambitious operational technologies to the market that have been suffering from low uptake (Action 2)
- developing new standards boosting eco-innovation (Action 3)
- mobilising financial instruments and support services for SMEs (Action 4)
- promoting international cooperation (Action 5)
- supporting the development of emerging skills and jobs and related training programmes to match the labour market needs (Action 6)
- promoting eco-innovation through the European Innovation Partnerships foreseen under the Innovation Union (Action 7). [10]

5. ECO-INNOVATION INDEX

The European Commission's statistical service Eurostat has published the first-ever resource efficiency scoreboard, comparing European countries using a set of 30 indicators covering natural resource consumption. Among the indicators is the eco-innovation index / scoreboard from the Eco-innovation Observatory. This shows that in 2012, the EU eco-innovation leaders were Finland, Denmark and Sweden, while those with most scope to catch up were Lithuania, Poland and Slovakia. [11]

The Eco-Innovation Scoreboard is the first tool to assess and illustrate eco-innovation performance across the EU Member States. The 2012 version of the Eco-Innovation Scoreboard consists of 16 indicators from eight different data sources, grouped into five thematic areas:

1. Eco-innovation inputs
   - 1.1. Governments environmental and energy R&D appropriations and outlays (% of GDP) – EUROSTAT, 2010
   - 1.2. Total R&D personnel and researchers (% of total employment) – EUROSTAT, 2009
   - 1.3. Total value of green early stage investments – Cleantech, 2007-2009
2. Eco-innovation activities

2.1. Firms having implemented innovation activities aiming at a reduction of material input per unit output (% of total firms) – EUROSTAT, 2008
2.2. Firms having implemented innovation activities aiming at a reduction of energy input per unit output (% of total firms) – EUROSTAT, 2008
2.3. ISO 14001 registered organizations (per min population) – ISO Survey of Certifications, 2010
3. Eco-innovation outputs
3.1. Eco-innovation related patents (per min population) – Patstat, 2008
3.2. Eco-innovation related academic publications (per min population) – Scopus, 2011
3.3. Eco-innovation related media coverage publications (per min population) – Metwater, 2011
4. Environmental outcomes
4.1. Material productivity (GDP/Domestic Material Consumption) – EUROSTAT, 2009
4.2. Water productivity (GDP/Water Footprint) – Water Footprint Network, 1996-2005
4.3. Energy productivity (GDP/gross inland energy consumption) – EUROSTAT, 2010
4.4. GHG emissions intensity (CO2e/GDP) – EUROSTAT, 2010
5. socio-economic outcomes
5.1. Exports of products from eco-industries (% of total exports) – EUEOSTAT, 2011
5.2. Employment in eco-industries (% of total workforce) – Ecorys, 2008
5.3. Turnover in eco-industries – Ecorys, 2008

It thereby shows how well individual Member States perform in different dimensions of eco-innovation compared to the EU average and presents their strengths and weaknesses. The Eco-Innovation Scoreboard complements other measurement approaches of innovativeness of EU countries and aims to promote a holistic view on economic, environmental and social performance. [12]

Table 1: *European eco-innovation index 2010 – 2012 [12]*

	2010	2011	2012
EU (28 countries)	-	-	-
EU (27 countries)	100	100	100
Belgium	114.2	115.22	117.59
Bulgaria	57.69	66.57	79.61
Czech Republic	73.2	91.46	90.46
Denmark	154.92	138.31	136.21
Germany	138.57	122.88	120
Estonia	55.99	73.86	77.58
Ireland	101.45	118.22	112.85
Greece	54.76	59.32	67.39
Spain	100.74	128.39	118.15
France	96.3	99.41	96.13
Croatia	-	-	-
Italy	97.98	90.18	91.71
Cyprus	63.72	71.31	73.91
Latvia	59.76	77.31	70.69
Lithuania	45.17	52.47	52.78
Luxembourg	93.68	129.93	108.26
Hungary	69.64	82.57	73.3
Malta	65.77	81.5	72.13
Netherlands	110.42	108.67	111.23
Austria	130.97	125.29	111.6
Poland	53.58	50.39	54.39
Portugal	71.57	81.35	83.56
Romania	51.68	67	78.15
Slovenia	74.51	108.97	114.56
Slovakia	48.15	51.93	54.43
Finland	156.45	148.6	149.77
Sweden	128.17	141.73	133.59
United Kingdom	102.68	104.93	100.88
Iceland	-	-	-
Norway	-	-	-
Switzerland	-	-	-

6. ECO-INNOVATION IN TEXTILES AND LEATHERWORK

Like in all fields, in textiles and leatherwork field, appeared, also, in the last years, a lot of new expressions and concerns, such as eco textiles, green textiles, eco fashion, eco-friendly fashion, ecollection, sustainable style. There are a lot of tools available that measure environmental damage and help manufacturers and brands become more sustainable. On WebEcoist: a Global Resource, one of the most popular green websites in the world, in an articol, *Eco Fabric: 14 Strange and Amazing Textile Innovations*, are presented some of environmentally friendly fabrics which are already in use, like those made of coconut husks, recycled plastic bottles, wood pulp and corn, while others are strange and futuristic, sourced from hagfish slime, fermented wine, spoiled milk and genetically engineered bacteria. [13] In early 2010, several leading companies producing clothing and footwear in North America, Europe and Asia, along with NGOs and the Environmental Protection Agency in the United States have established a new entity, called *Sustainable Apparel Coalition*, which aims to reduce environmental and social impacts of apparel and footwear products, establishing an index to measure and evaluate sustainability of clothing and footwear products. The Higg Index is a tool to help organizations standardize how they measure and evaluate environmental performance of apparel products across the supply chain at the brand, product, and facility levels. In May 2013 the index covering 150 products from 63 companies. [14]

Greenovate! Europe, an independent expert group dedicated to the development of sustainable business, performed a study, "*Eco-innovation in cluster organisations in the chemical and textile-clothing-leather sectors"* which lead them to the following conclusions: eco-innovation activities are just starting and focus strongly on understanding the issues at stake, providing knowledge and promoting existing eco-technologies; the textiles-clothing-leather cluster organisations were interested in the use of eco-innovation to raise their competitiveness and to improve their image. [15]

To the level of European Union, through the ***Eco-Innovation Programme***, since the launch of the programme in 2008, from almost 200 projects, involving more than 650 organisations, 10 projects are in textiles and leatherwork field. [16]

Clothing project to explore the circular economy for textiles

EcoProFabrics will show that the old linear model in textiles, where garments are thrown away after use, can be replaced by a circular economic model, where used textiles are shredded into loose fibres then converted into new textiles without any loss in quality. According to Dutch aWEARness's calculations, compared to standard non-recycled textiles, Returnity can offer energy, water and carbon dioxide savings of 64%, 95% and 73% respectively. It cuts raw materials demand by 61% and, because it is fully recyclable, waste is eliminated entirely. The fabric should also compete on price with standard fabrics, and might even become cheaper if production volumes increase, because the cost of waste recovery will be outweighed by savings in raw material costs. [17]

Recycled footwear products enter the market

The main objective of the project was to analyse if marketable products (from old footwear collected in El Naturalista branded stores) could be produced from waste polymeric material, thus diverting waste from landfill, and reducing the need for production of new polymers. More than 12,000 pairs of shoes with recycled insoles have been sold. [18]

Ecofriendly Leather Tanned with Titanium - TiLEATHER

The main project objective was to introduce into the European market leather produced using environmentally friendly titanium-tanning techniques, which has been registered by INCUSA as SANOTAN® leather, shoes that are comfortable for the wearer and the planet. Through this novel process, chromium salts are replaced. The main environmental improvements achieved over the two years of the project are the reduction of the use of chromium compounds amounting to 25.5 tonnes; reduction of CO_2 emissions by 35 tonnes, and the elimination of chromium contamination in wastewater. [19]

7. CONCLUSIONS

States and governments of the world, different institutions and organizations actively involved and aware in public policies, strategies and actions, reaffirm their commitments and reassess actions in order to achieve a truly sustainable development.

A sustainable future can only be built decreasing waste of natural resources and energy, producing and consuming moderate and responsible. Today's consumers, better informed and becoming more interested in the quality of their lives and their children's, have become sensitive to environmental issues and diminishing resources, demanding, increasingly more bio or eco products.

In these conditions eco-innovation is not just a trendy concept but a reality and a necessity nowadays, a way to achieve a sustainable future for ourselves and future generations.

REFERENCES

[1] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, *Innovation for a sustainable Future - The Eco-innovation Action Plan (Eco-AP)*, **[**COM (2011) 899 final**],** Brussels, 15.12.2011

[2] *Report of the United Nations Conference on Sustainable Development*, Rio de Janeiro, Brazil, 20–22 June 2012

[3] Communication from the Commission, *Europe 2020 A strategy for smart, sustainable and inclusive growth* [COM (2010) 2020 final], Brussels, 03.03.2010

[4] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: "*Youth on the Move*" [COM (2010) 477 final], Brussels, 15.09.2010

[5] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: "*Europe 2020 Flagship Initiative: Innovation Union*" [COM (2010) 546], Brussels, 06.10.2010

[6] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: "*An integrated industrial policy for the globalisation era: Putting competitiveness and sustainability at centre stage*" [COM (2010) 614 final], Brussels, 28.10.2010

[7] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: *"An Agenda for new skills and jobs: A European contribution towards full employment*", [COM (2010) 682 final], Brussels, 23.11.2010

[8] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: "*A resource-efficient Europe – Flagship Initiative under the Europe 2020 Strategy*", [COM (2011) 21], Brussels, 26.01.2011

[9] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: *Partnering in Research and Innovation*, [COM (2011) 572 final], Brussels, 21.09.2011

[10] Communication from the Commission to the European Parliament, the Council, the European economic and social committee and the committee of the regions: "*Innovation for a sustainable Future - The Eco-innovation Action Plan (Eco-AP)*", [COM (2011) 899 final], Brussels, 15.12.2011

[11] http://ec.europa.eu/environment/ecoap/about-eco-innovation/policies-matters/eu/17122013-eurostat-publishes-first-resource-efficiency-scoreboard_en.htm

[12] www. eco-innovation.eu, Eco-Innovation Observatory, accessed on April 06, 2014

[13] http://webecoist.momtastic.com/2012/11/12/eco-fabric-14-strange-and-amazing-textile-innovations, accesed on April 09, 2014

[14] http://www.apparelcoalition.org, accesed on May 15, 2013

[15] Sarine Barsoumian, Rossella Riggio, Astrid Severin, Titus van der Spek. (2011, July 1). *Eco-innovation in cluster organisations in the chemical and textile- clothing-leather sectors*. [Online]. Available: http://www.greenovate-europe.eu/sites/default/files/publications/ECO_Greenovate! Europe eco-innovation in clusters (2011).pdf

[16] ec.europa.eu/environment/eco-innovation/showcase, accesed on April 09, 2014

[17] http://ec.europa.eu/environment/ecoap/about-eco-innovation/good-practices/eu/20140318-clothing-project-to-explore-the-circular-economy-for-textiles_en.htm, accesed on April 08, 2014

[18] http://www.eco-naturalista.eu, accesed on April 08, 2014

[19] http://www.tileather.eu

ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

FRANCHISING AS A GROWTH STRATEGY. EVIDENCE FROM ROMANIA

TRIPA Simona [1], CUC Sunhilde [2]

[1, 2] University of Oradea, Romania, Department of Engineering and Industrial Management in Textiles and Leatherwork, Faculty of Energy Engineering and Industrial Management, University Street no. 1, 410087, Oradea, Romania,
E-Mail: textile@uoradea.ro

Corresponding author: Tripa Simona, E-mail: tripasimona@yahoo.com

Abstract: *There are many ways in which businesses can growth. Aim of this article is to make the business owner aware of the scope of the franchise and business opportunity law and how they may affect growth strategy tried to be employed by the business owner. For this purpose we present a list of advantages and disadvantages of franchising for the franchisee and for the franchisor and examined the status and trends of the Romanian market franchise, especially in clothing, which are available for prospective franchisees in Romania. We find out that although it is increasing its level of development is much lower than in EU, (according to Romanian Franchise Association in Romania are slightly over 400 franchises, with various business fields, while in the Europe there are about 10,000 franchise networks). Reasons for slower development of the textile franchise business in Romania can be found in the effects of economic crisis on the Romanian economy, which shifted the structure the consumer spending of the people of Romania, expenditures for clothing and footwear have decreased and have reached at 5.3% of total household expenditure. In these conditions, the clothing franchises who had suffered most in Romania were those whose offer to address at high-income consumers (Escada, Esprit, Etam) and medium (Debenhams, Gap). Less affected were franchises for which targets are low-income consumers and who besides the low price of products offers a wide range of products and models with a very short life cycle (fast fashion). The information for this paper was gathered from literature, from the analysis financial indicators of the different companies and by Internet.*

Key words: *economic, development, franchisor, franchisees, brands*

1. FRANCHISING AS GROWTH STRATEGY

Franchising is being used as development and growth strategy in numerous contexts across the globe, ranging from its use as market entry to an expansion mode and a strategy to secure competitive advantage. [1] In the last decades, strategy of franchising has played a vital role in small and medium business development and has become an important growth option, so for many companies, franchising is a means of expanding business and for individual entrepreneurs, is a method of opening a business. Franchising is the fastest way to guarantee that entrepreneurs adhere to the high standards required for successful business management.

Because of the economic importance franchising has captured the attention of a wide range of researchers. From the perspective of entrepreneurship, franchising is a vehicle for entering business ownership [2], from the perspective of marketing, franchising is an important distribution channel [3], from the perspective of economics, franchising is a leading venue for understanding the structure of contracts [4] and from the perspective of strategic management, franchising is an important organizational form. [5]

Franchising is a business relationship in which the franchisor (the owner of the business providing the product or service) assigns to independent people (the franchisees) the right to market and distribute the franchisor's goods or service, and to use the business name for a fixed period of time. The International Franchise Association defines franchising as a "continuing relationship in which the franchisor provides a licensed privilege to do business, plus assistance in organizing training, merchandising and management in return for a consideration from the franchisee".

2. ADVANTAGES AND DISADVANTAGES OF FRANCHISING FOR THE FRANCHISEE AND FOR THE FRANCHISOR

Franchise system is designed to work well for both the franchisor and the franchisee. Franchise agreement is a formal relationship between the franchisor and franchisee to work together to build mutually beneficial business operations.

The "commercial marriage" between franchisor and franchisee is ultimately a legal relationship, with the full obligations and responsibilities of both parties outlined in a highly detailed franchise agreement. This commercial contract varies in length and conditions from one system to the next, such that it would be almost impossible for any two franchise systems to have identical agreements. [6]

By nature of the relationship, the franchise agreement will be imbalanced in favor of the franchisor, as the franchisor must at all times remain in control over certain standards critical to the ongoing success of the business format.

Nevertheless the development of this system is due to the numerous business benefits not only for the franchisor but also for the franchisee. Franchising is an entrepreneurial activity that plays a crucial role in the creation of new jobs and economic development. [7] According to Bond & Bond franchisees have a 77% chance of survival after five years of operation compared with 8% for new independent business ventures. [8]

Also, Franchising is an important part of the economy and a central phenomenon in entrepreneurship. Michael S.C. recommend franchising as a method that entrepreneurs can use to assemble resources to create large chains rapidly, especially for entrepreneurs who can create big franchise chains. [9] In return, the franchisee pays an up-front fee and ongoing royalties to the chain operator. [10] The franchisee obtains from the chain operator the right to market goods or services under its brand name and to use its business practices. [11] From this collaboration creates economic value.

Menekse and Orkide Salar used the SWOT analysis to identify the advantages, disadvantages, threats and opportunities of franchising. [12] This is shown in table 1 below:

Table 1: *SWOT analysis of franchising*

Strengths	Weaknesses
• Brand Recognition • Lower Risks for Failure • Easy Setup • Ready Customer Portfolio • Easy to Find Financial Support	• High Cost - Initial Cost - Ongoing Costs • Dependency • Strict Rules
Oportunities	**Threats**
• Entrepreneurs have chance to become their own boss • It offers some market opportunities like discovery and exploitation	• Continuing growth of existing franchised competitors • Other new franchise competitors entering market place • The decline of branding in market • The publication of New Business Models

According to *The International Franchise Association (IFA)* franchise businesses are important to the overall economy, generation in USA more than \$800 billion in annual sales, representing 40.9% of all retail and franchised businesses create more than 170,000 new jobs each year. Today more than 8 Million people are employed by franchise businesses. Total franchise sales over 1 Trillion.

Growth franchises is indicated also by the data published by IFA that looks like 1 in 12 business establishments is a franchise, a new franchise opens every 8 minutes of every business day and there are approximately 1500 Franchisors and 550,000 Franchisees.

3. STATUS OF THE FRANCHISING SYSTEM IN ROMANIA

Franchising has grown rapidly in Europe in recent years, but the industry is largely unregulated. The European Union has not adopted a uniform franchise disclosure policy. Only six European countries including Romania, have adopted pre-sale disclosure obligations. They are France (1989), Spain (1996), Romania (1998), Italy (2004), Belgium (2005) and Sweden. In addition there are a number of countries that have general "good faith" type laws that can give rise to franchise disclosure obligations ("Good Faith Laws"). These countries are Germany, Austria, Portugal and Lithuania. [13]

In Romania, the franchising is regulated by Law no. 79 April 1998. Regarding the Legal Status of Franchise under the Romanian law, a franchise is defined as a marketing system where the franchisor grants to the franchisee the right to operate or develop a business, product, technology or service. In addition to requiring minimum provisions of the franchise agreement and regulating the post-sale franchisor-franchisee relationship, the Romanian act requires certain pre-sale disclosures. Among these disclosures are:

a) the financial terms of the proposed franchise agreement, including royalties to be paid and purchases the franchisee is obligated to make,

b) a description of franchisor's gained and transferable experience,

c) the franchisee's area of granted exclusivity,

d) the duration of the agreement, and

e) the terms of the agreement governing renewal, termination and assignment.

There is no requirement under Romanian law for the registration or filing of franchises with the government.

The first classic franchise appeared on Romania market is "McDonald's" which opened a unit franchise in 1995. Among the earliest companies that have entered the market in Romania in the franchise are Pepsi and Coca-Cola.

Because business expansion in the franchise system in Romania and to enforce standards of a favourable business environment as franchising, in early 2006, was established Romanian Franchise Association, a non-governmental, apolitical and non-lucrative. One of the goals of this organization is to identify and resolve specific problems of franchise, to promote franchise as a way business in the Romanian market and initiating action against illegal franchises, to combat counterfeiting and theft of know how.

According to Romanian Franchise Association in Romania are more than 438 franchises, with various business fields. Across Europe there are about 10,000 franchise networks, 4,000 in China, 2,200 in USA, 1200 in Japan and 1000 in Australia. Analysis of the 2633 franchise units active in Romania in mid 2012 highlighted the areas most popular franchises:

Table 2: *Fields of activity with most franchises*

Field of activity	**Percentage of total units**
Personal services	30.54%
Retail	28.29%
Fast food	25.07%
Services companies	6.57%
Interior Arrangements	2.66%
Clothing and Accessories	2.47%
Food	1.63%
Real Estate	1.06%
Construction	0.65%
Restaurants & Coffee shops	0.65%
Hotels	0.42%

In the field of clothing and accessories, there are over 100 companies that have opened franchises in Romania, companies dealing with the production and sale of clothing and accessories or just dealing with marketing of these products (which are predominant). These companies cover all segments of the fashion & beauty area: collections of classic, elegant and casual collections of underwear, sports outfits and various complementary accessories to eyewear, watches, perfumes and cosmetics for men, women and children.

A study by ThinkBig Franchise Consultants and supplement "Money & Business" revealed the most expensive luxury retail clothing franchise foreign presence in Romania. The top ranking franchise is Max Mara, a luxury brand in Italy, known for its haute couture. Landscaping costs are the 1000-1500 euro/sqm, plus the cost of the stock plus the costs of launching and others. Ranked II Escada is a brand of luxury clothing for women. Rankings continue with Zara, part of Inditex, one of the largest retail groups in the clothing industry in the world. Zara products follow the newest trend in the fashion industry, its stores were opened in major shopping centers in Europe, America and Asia. Besides these firms is also found Hugo Boss, Marks & Spencer, United Colors of Benetton, Mexx, Morgan etc.

Is noteworthy that in this top are present companies which represents different segments of customers: from out couture and high fashion (Max Mara, Escada) that targets are high-income customers at fast fashion addressed to middle-income customers (Hugo Boss, Mexx) and small (M & S, Zara, Benetton).

On the Romanian market, besides these international brands can be found Romanian companies who make franchising business - Jolidon, MEXTON, ID Sarrieri, Tina R, etc.

The first Romanian company which is selling international franchise is Jolidon - since 2008. Currently it has its own network of 87 stores in Romania and distribution in over 60. [14] The company has opened 10 stores abroad in Budapest, 33 stores in Italy and 10 in France. Besides these shops Jolidon lingerie distribute articles in the United States, Canada, Africa and Japan. Cost of opening such a store are between 60,000 and 90,000 Euro. [15]

Mexton is a Romanian brand of casual and elegant clothes, founded in 1997. Currently has a network of over 45 stores in many cities: Bucharest, Pitesti, Ramnicu Valcea, Sibiu, Deva, Arad, Timisoara, Oradea, Targu Jiu, Targu Mures, Iasi, Craiova, Braila, Galati, Brasov, Cluj Napoca. The costs of a Mexton franchise is: franchises fee - 5000 Euro and 3% royalty, total investment is 30,000 Euro. [16]

I.D. Sarrieri was launched in 1992, as a company producing indoor clothing (homewear and nightwear) and since 2002 is one of the most popular brands of luxury underwear market. Created by Iulia Dobrin and his team, with over 500 employees, this firm manufacture underwear. Collection I.D. SARRIERI are now sold in the finest lingerie boutiques around the world, from Paris to New York from London to Tokyo, from Brussels to Shanghai.

TINA R brand, was founded in 1994, became one of the leading brands on the Romanian market pret-a-porter. This brand, Tina R, is well known by most girls in Romania and includes the area of clothing (jackets, trousers, skirts, blouses, shirts) and all the accessories genres (bags, shoes, scarves, gloves, hats). The first franchise Tina R was selled in 2006. Opening a franchised store TinaR requires an initial investment of 100,000 euros, the franchise fee is 0.

Theory says that amongst the best Businesses in during crisis are franchises and distribution.

An example in this sense is the Mexton company, who despite all the difficulties succeeds in the last years to increase considerably turnover and profit obtained, especially in the last year analysed.

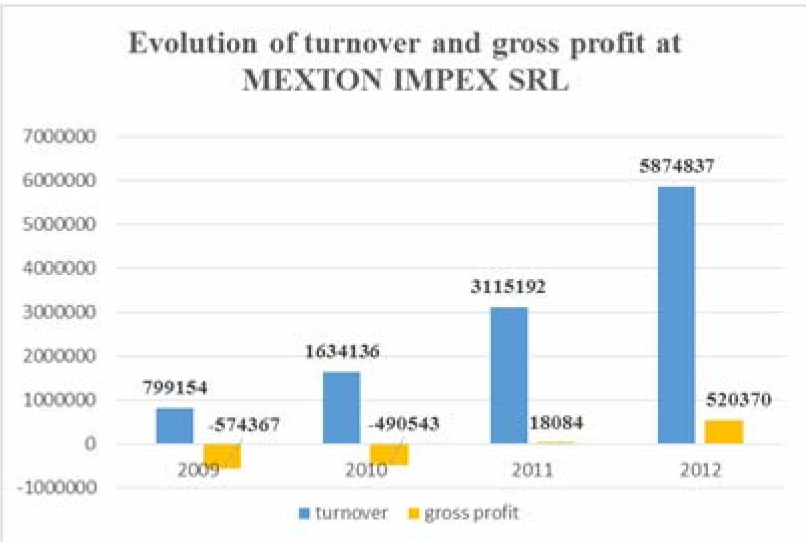


Fig. 1: *Evolution of turnover and gross profit at MEXTON IMPEX SRL [17]*

Reality highlights that not in all cases are recorded sustained success theory. For example companies Debenhams, Gap, Esprit, Etam, Celio, Mandarina Duck, Kipling, Olsen and Bally are some of the fashion brands that have permanently left Romania. [18, 19, 20]

Not only international companies have registered losses in this period of crisis but among Romanian companies. For example is entering in insolvency of the company Tina R Distribution, one of the companies in the group clothing retailer Tina R.

Reasons for slower development of the textile franchise business in Romania can be found in the effects of economic crisis on the Romanian economy in general, with its implications: reducing consumer purchasing power through the salary cuts that took place in the budgetary system, reduction or cancellation of various premiums or salary bonuses (spore of PhD, the XIII salary, various bonuses during granted the Easter holidays and Cristmas holidays or other events), closure of many companies and therefore job losses for those employed in them.

All this have determined modification of consumption expenditures of the population in Romania. Main uses of the household expenditures in the second quarter of 2013, are the consumption of food, non-food, services and the public administration and the private and social insurance budgets in the form of taxes, contributions, fees, and expenses necessary household production. The expenses for clothing and footwear representing only 5.3% of the total. [21]

Another factor that determined the market exit of these brands has been developing extremely aggressive in recent years some brands extremely competitive as Zara, Massimo Dutti, Pull and Bear, Stradivarius, Bershka, H&M, which by offering very diverse and the prices charged were able to conquer larger market share at the expense of clothing products companies mentioned above.

In these conditions, the clothing franchises who had suffered most in Romania were those whose offer to address at high-income consumers (Escada, Esprit, Etam) and medium (Debenhams, Gap). Less affected were franchises for which targets are low-income consumers and who besides the low price of products offers a wide range of products and models with a very short life cycle (fast fashion). Besides these, an important contribution in maintaining these companies on the Romanian market have had the discounts awarded to loyal customers and the significant price discounts (up to 90%) when were changed the collections - these measures have contributed to increasing sales in the periods of their application.

4. CONCLUZION

The theory that the best Businesses in the time of crisis are franchises and distribution is not check completely. Reality has shown that it is not enough to have and promote a well known brand for to succeed on all markets.

Reasons for slower development of the textile franchise business in Romania can be found in the effects of economic crisis on the Romanian economy in general, with its implications: reducing consumer purchasing power through the salary cuts that took place in the budgetary system, reduction or cancellation of various premiums or salary bonuses, closure of many companies and therefore job losses for those employed in them. All this have determined modification of consumption expenditures of the population in Romania, spending on clothing and footwear decreas and reaching only at 5.3% of total household spending, with direct effects on trade with textile products.

In these conditions, the clothing franchises who had suffered most in Romania were those whose offer to address at high-income consumers (Escada, Esprit, Etam) and medium (Debenhams, Gap). Less affected were franchises for which targets are low-income consumers and who besides the low price of products offers a wide range of products and models with a very short life cycle (fast fashion). Besides these, an important contribution in maintaining these companies on the Romanian market have had the discounts awarded to loyal customers and the significant price discounts (up to 90%) when were changed the collections - these measures have contributed to increasing sales in the periods of their application.

REFERENCES

[1] Khan, Muhammad Rahatullah. "*The Franchisee Perception of Achieving Success in Entrepreneurial Businesses",* Entrepreneurship Research Journal, 3.4, 2013, pp. 505-525.

[2] Shane, S. A., & Hoy, F. Franchising, "*A gateway to cooperative entrepreneurship*", Journal of Business Venturing, 11, 1996, pp. 325–327.

[3] Kaufmann, P. J., & Rangan, V. K., "*A model for managing system conflict during franchise expansion*", Journal of Retailing, 66, 1990, pp. 155–173.

[4] Lafontaine, F., "*Agency theory and franchising: Some empirical results*", RAND Journal of Economics, 23, 1992, pp. 263–283.

[5] Combs, J. G., & Ketchen, D. J.,”*Can capital scarcity help agency theory explain franchising? A test of the capital scarcity hypothesis”,* Academy of Management Journal, 42, 1999, pp. 196–207.

[6] Fagboun Lawrence Ige, “*Business Pursuit Through Franchising In Nigeria*”, Journal of Science and Science Education, Ondo Vol. 4(1), 25 December, 2013, pp. 17 –27.

[7] Falbe et al; Falbe, C., Dandrifge, T. and Kumar, A.,”*The Effect of Organizational Context on Entrepreneurial Strategies in Franchising”*, Journal of Business Venturing, 14, 1988, pp. 125–140.

[8] Bond, R. E., & Bond, J. M. “*The source book of franchise opportunities*”, Business One Irwin Professional Publishing, Homewood, IL, 1994.

[9] Michael, S. C., “*First Mover Advantage Through Franchising*”, Journal of Business Venturing, 2003.

[10] Combs et al; Combs, J., Michale, G. and Castrogiovani, G., Franchising, “*A review and Avenues to Greater Theoretical Diversity”*, Journal of Management, Volume 30, 2004, pp. 907-931.

[11] Barthélemy, J. “*Agency and Institutional Influences on Franchising Decisions*”, Journal of Business Venturing, 2011.

[12] Menekse Salar, Orkide Salar, “*Determining pros and cons of franchising by using swot analysis*”, Procedia - Social and Behavioral Sciences, 122, 2014, pp. 515 – 519.

[13] *** Franchise disclosure items in Europe, 2009, Field Fisher Waterhouse LLP, London EC3N 2AA, available on http://www.ffw.com/pdf/Franchise-disclosure-in-Europe.pdf

[14] http://www.jolidon.ro/companie/cifre-cheie/ accesed in 10.03.2014

[15] *** Cat costa o francize Jolidon, [Online]. Available: http://www.wall-street.ro/articol/Start-Up/39983/Cat-costa-o-franciza-Jolidon.html #ixzz 2xFEpMTcz

[16] *** Franciza Mexton, [Online]. Available: http://franciza.ro/Franciza_Mexton-845-ad.ashx

[17] http://www.mfinante.ro/infocodfiscal.html, accesed in 14.03.2014

[18] *** Se închid definitiv magazinele de haine din România ale unei cunoscute francize, [Online]. Available: http://www.b365.ro/se-inchid-definitiv-magazinele-de-haine-din-romania-ale-unei-cunoscute-francize_189002.html#sthash.zHtf2npG.dpuf

[19] *** Gap, al treilea cel mai mare retailer de modă din lume, a plecat din România, [Online]. Available: http://www.zf.ro/zf-news/gap-al-treilea-cel-mai-mare-retailer-de-moda-din-lume-a-plecat -din-romania-12244062

[20] *** Ce branduri de modă au părăsit definitiv Romania, [Online]. Available: http://www.businessmagazin.ro/analize/comert/ce-branduri-de-moda-au-parasit-definitiv-romania-9169513/?p=2

[21] *** Veniturile şi cheltuielile gospodăriilor populaţiei în trimestrul II 2013, Comunicat de presă, Nr. 243 din 07 octombrie 2013, [Online]. Available: http://www.insse.ro/cms/files/statistici/comunicate/abf/ABF_II_r13.pdf

CHARACTERISTICS BRANDING & BRAND MANAGEMENT IN THE FASHION INDUSTRY

UROŠEVIĆ Snežana[1], ZAVRŠNIK Bruno[2]

[1] *University of Belgrade, Technical Faculty in Bor, Management Department, Vojske Jugoslavije 12, Bor, Serbia, E-mail: surosevic@tf.bor.ac.rs*

[2] *University of Maribor, Faculty of Economics and Business, Slovenia, E-mail: bruno.zavrsnik@uni-mb.si*

Corresponding author: Snezana Urosevic, *E-mail:* surosevic@tf.bor.ac.rs

Abstract: *Brand allows for market offer to be identified and differentiated from the competitive offers. The very essence of brand is based not only on potential sales figures, but on the philosophy that makes it posssible for a customer to identify with the brand. Faced with the plenty of market offers customers undoubtedly prefer well-known companies and brands, thus minimizing risk and time consuming activities of gaining futher knowledge concerning alternative offers. The consumers often wonder whether the branded goods are more worth from the other, similar goods without any famous trademarks. There are many questions and theories but only one is undeniable: one should never doubt the companies that invest great amount of assets, ideas, talents, love and risk, intend to risk previously stated items with bad design, services or products' quality. Brand building in textile industry differs from branding of market offers targeting general public. Branding in textile industry requires more focused approach. Fashion companies are facing with bigger challenges when fighting to attract and keep new consumers who are offered new products and markets. In order to create strong brand, it is necessary to possess expert planning and long-term capital investment. Successful brand is actually an excellent product or service, with creatively designed and conducted marketing. Branding has become marketing's priority, because successful brands achieve higher prices and gain over loyalty, and attract both consumers and financiers. Marketing agents of the successful 21st century brands must be extremely efficient in strategic brand management, which assumes implementation of marketing activities and programmes in order to build brands, as well as brand management to increase its value. Brands and its value must be regarded and recognised as strategic capital.*

Key words: *brand, brand management, branding, fashion industry, marketing strategy*

1. INTRODUCTION

The fashion phenomenon has always captured people's attention, but this issue has never been as tangible as in the time we are living. Fashion industry pervades all aspects of the human society and illustrates the time we are living in the best way. Domestic fashion industry producers want to win even stronger position on domestic and international fashion market by introducing some new images. Domestic companies have decided to build the image of a market-oriented fashion company. The business strategy implies continuous investment in the development of trade marks – brands. From the consumers' point of view, there no such thing as just a product. A product does not come alone, but it takes, with the help of marketing strategies and techniques, the image or status. The consumer expects to identify or locate a product according to type, name or label. Fashion companies are facing with the growing challenges how to attract and retain new consumers when new products and markets are concerned. This paper is designed in a way it point out the importance of a brand management and it appliance in the fashion industry.

Fashion companies are facing with bigger challenges when fighting to attract and keep new consumers who are offered new products and markets. In order to create strong brand, it is necessary to possess expert planning and long-term capital investment. Successful brand is actually an excellent product or service, with creatively designed and conducted marketing. Branding has become marketing's priority, because successful brands achieve higher prices and gain over loyalty, and attract both consumers and financiers. Marketing agents of the successful 21st century brands must be extremely efficient in strategic brand management, which assumes implementation of marketing activities and programmes in order to build brands, as well as brand management to increase its value. Brands and its value must be regarded and recognised as strategic capital. It is important to adjust brand and business strategy, and this can be performed successfully if brand is carefully monitored and improved by company's top leadership and if employees are in good connection with the organisation and its brands. In order to make a consumer loyal to a fashion industry product – brand, the consumer must purchase the product sufficiently and there must be cognitional obligation to do that. A brand must have sufficient meaning for the consumer, which means, he buys not only complacency or propitiatory but also what brand represents, that is, important benefits for the consumer (in contrast to mass-consumption products). Being loyal to a brand represents consumers' inner commitment to repeat purchase of certain brands. Even though people from marketing sector attempt to make consumers loyal to a brand, they must be interested for usage rate of some products on different markets and in different consumers.

2. THE TERM BRAND AND ITS IMPORTANCE IN CREATING COMPETITIVE ADVANTAGE

The word brand became synonym for something good at the end of 20th century. The simplest definition of a brand is an expression that products and services of high quality are called, and according to wider definition, concept of a brand becomes synonym of the highest universal value due to globalisation and fast society development. The word brand was used daily, and some brands have become more powerful than some world's countries, because a good brand brought big income. To create a good brand and manage it during its lifetime is not a process conducted over night but it takes years, decades and sometimes, even centuries.

One of many brand's definitions is it is beloved trademark. When will you fall in love a person, or something, or anything? Answer to the question is only when his/hers personal characteristics suit you entirely.

If the brand's essence is more about the consumers than the product or service itself, it is clear that the brand formation should be based on the brand's function perceived by the consumers rather than on what does the brand represent for the company [1], [2].

There are many suggested brand models, but one thing that they have in common is that the brand is based on three components – functional component, comparative component and emotional component [3]. When analysing the components, it is necessary to answer the questions:

1. What does the brand do for the consumers? (functional component)
2. What makes the brand different form the competition's brand? (comparative component)
3. What feelings does the brand evoke in the consumers? (emotional component).

Brand can be defined as a promise given to the consumers, composed out of group of relevant products' features, that their needs would be satisfied when buying the products [4]. Very illustrative explanation says that most top managers does not see symbols, brands and names simply as *icing*, but as *yeast that contributes to the cake's growth* [5]. Table 1 resumes some of the key brands' advantages.

Table 1: *Brand advantages [6]*

• **Helps consumers to identify supporting brand**
• **Speeds up the purchase process**
• **Provides status and psycho-social identification**
• **Helps in quality and product price evaluation**
• **Shrinks the purchase risk**
• **Alleviates anew purchase**
• **Enables wider acceptance of new products within the same brand**
• **Causes consumers' loyalty**

It can be said that the brand's development is in range from recognition to complete loyalty. It can be presented graphically as in Figure 1.

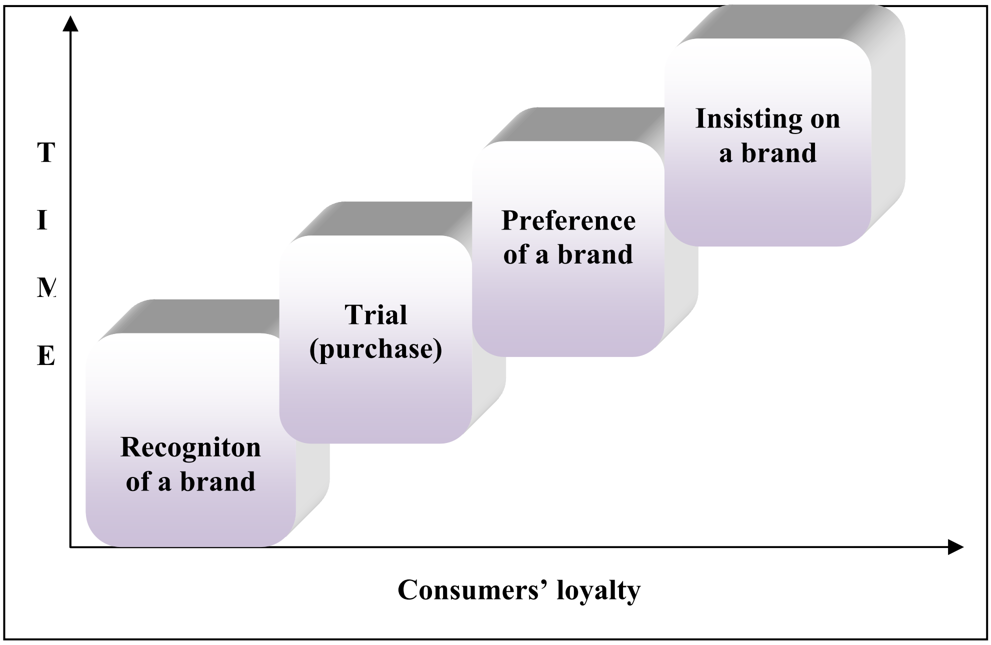


***Fig. 1:** Brand's development – from recognition to insisting [6]*

Value of a brand is usually called brand's equality. The other way to view brand's equality is to consider marketing and financial values connected with brand's position on market. Brand's equality is usually connected with awareness of brand's name, loyalty and quality. Even though it is difficult to measure brand's equality, it can be said it represents brand's value for an organisation [6].

The brand has important influence in creating competitive advantage of a company on market and in environment which are becoming more demanding and more turbulent. It can be said with certainty that the brand is more than just a product and more than just a service and it is of priceless value to both consumers and the company which owns it. From the consumers' point of view, the brand eases choosing the market and making decisions on purchase, guarantees performances of a certain level, gives information, security and recognition of a service. Brand is important for a company because it contributes to the competitive advantage on the market, management of the intellectual capital, quality and the value of the company. That is why the creating and development of a brand represents one of the greatest challenges for every company. According to Kotler, brand provides numerous competitive advantages:

- The company has advantage in decreasing the marketing expenses due to awareness and loyalty of a brand's consumer,
- The company has greater opportunity to choose when negotiating with the distributors and dealers,
- The company can increase the price unlike the competition,
- The company can easily expand the brand because the brand's name offers high authenticity,
- The brand defends the company against the price competition [7].

On the fashion market suvived only organizations with the capability of continuons and rapid adjustment to modern conditions. Today, the customer expects exceptional quality apparel producs, modern design, while being willing to pay a price that is more than elements of competition in the market constantly fashion industry.

The brand and its strategy have become one of the important sources of the fashion industry competition, and immediate benefits from it are:

- Standing out from the competition,
- Increasing the product's value with the consumers,
- Better and faster launching of new fashion products.

The brand's success, as one of the basic features of a fashion product, depends upon the feelings and opinions of the competition's consumers. Due to great changes in fashion trends, the development of a trade mark exists in all parts of the textile-clothing chain.

The existence of a trade mark has several advantages:

- Greater profit,
- Ability to plan the offer,
- Creating the image of a production-business system,
- Better correlation between the production and sale,
- Greater level of information and identification.

3.CHARACTERISTICS BRANDING IN THE FASHION INDUSTRY

Even though there are some texts about product branding in domestic literature, there were not many of them which said anything about effective and efficient brand management. Construction and maintenance of a brand is one of the key tasks for marketing manager [8]. Due to great deal of choices of products and brands in almost every area, the consumers are now facing with huge number of potential suppliers, too huge to be familiar with all of them and thoroughly checked. When the market choice becomes bigger, the consumers prefer well-known companies and brands because they do not have to waste time on exploring, and they put themselves to lower risk.

The main difference between fashion industry market and other mass-consumption products markets is in the products and services' nature and complexity, in demand's nature and variety, in considerably smaller number of consumers, in greater products quantity per consumer and, the last but not the least, in closer and long-lasting relations between the producer and consumer. Holistic approach to branding is necessary in order to see that everything, from development, design to realisation of marketing programmes, processes and activities, is connected and intervened between one another [7]. Branding represents more than putting the brand's name and logo on product or service. Brand is intangible concept. In order to simplify and easier understanding, brand is often equalised with material elements of marketing communications used as its support – advertising, logos, slogans, jingles and so on – but brand is far more than that: 'brand is a promise – total perception' [7].

Brand has special place in consumer's conscience due to previous experiences, associations and future expectation. Brand is abbreviation for the attributes, advantages, beliefs and values which differentiate, shrink complexity and simplify the decision making process in marketing and management. Brand with clear purpose is like a compass with two sides, one directs the consumer towards the right products, and the other side directs product designers, people in charge of marketing and promotion when the new versions of their products are developed and improved on the market. Brand creation enables the company to create benefit, differing one brand from the other. Successful brands are those, which create a set of brand values superior in relation to competition brands. Brand creation involves good understanding and functional (easy use) and emotional (trust) values that a consumer uses when choosing between the brands. Company's ability to combine them in a unique way is necessary to create extended product preferred by the consumers – the real marketing value strategy.

If a company accepts the brand concept as a promise given to its consumers, it is obvious it can exist only if it constantly fulfils the given promise. Of course, the promise given by a brand must be clearly defined, relevant and meaningful, and it should not be mixed with excessive marketing promises. Consumers are engulfed with imposing offers on many markets. Brands represent abbreviation for the attributes, advantages, beliefs and values. They contain almost everything the company and its product or service represent. Branding triangle shows visually marketing connections between the company as an organisation, its co-workers and its consumers.

Brand manager's monitoring of the efforts invested in branding as a usual short-term business within a company is not enough to make those efforts successful. A duty of everyone employed in a company, starting from the top management to workers is to build, support and protect strong brands within a company. Brands and its value must be understood and recognised as the strategic capital (especially in fashion industry), which they actually are, and basis of concurrence advantage and long-term profitability. The key point is to adjust brand and business strategies, and this can be performed successfully if brand is carefully monitored and improved by a company's top leadership.

Strong brands provide the companies faster recovery after the economy crisis. Companies can have huge benefit from strong "alive" brand and its implicit promise of the quality since it can impose premium price to the consumers, and to provide the highest price of shares to the investors. The companies with the good positioned brands benefit because they are clearly focused, therefore more effective, efficient and more competitive in the business.

The brand's development aims to create long-term non-material property, not just short-term increase of sale. Industrial branding does not give solutions to all problems which the companies face with. Decision whether to brand a product, product line or company is based upon the evidence that the brands are more that just a product – it is an abbreviation which comprises feelings of a person towards a company or a product. Brand is emotional, it has "personality" strength and it wins hearts and minds of its consumers and because of that, the great brands survive the attacks of the competition's and market trend.

World's fashion scene is full of small and big brands, and of those, which keep their positions by nourishing quality and tradition, and which plan to spread, extend their business and charm new consumers. Introduction of various approaches in fashion, exposing the new ideas and fashion vision are always interesting and inspiriting. Many fashion brands will never occur here, but therefore it is interesting to get to know them.

Both consumers and producers are able to monitor the world's situation by global sources, and seek for the suppliers or consumers that suit the best their specific needs and demands. Relationship development process is expensive and quite complex and therefore only the best partners are searched for, because the quality demands high quality partners. Regular identification of any inefficiency in relation to sales and purchase must be in focus in order to eliminate them. The most efficient channels of sales representatives and consumers will survive. Any inefficiency of both soft and hard costs is identified and removed form the relation. Companies ready to make strategic but not cosmetic changes, in a way that they cooperate with the consumers/suppliers, have the possibility to succeed, and efficient application of marketing strategies becomes significant.

Brand's lifetime planning in marketing is based upon the needs, because many companies are to blame for brand's aging. The connection with the experts who know 'the worst practices' and know how to avoid it is necessary. Brands should not be changed frivolously, but companies should keep the ones desired by the consumers – and not by the subjective owners or extremely aggressively brand managers. Quitting from the inefficient brands is easier if the managers in charge of the consumers segment controlled company's marketing resources. This type of wide reinvestments is possible only if it fundamentally changes the executive team sector. Changes barely perceived at the beginning but essential in time, will be seen if those regulations are applied serially. People in a company will understand the brands are their ultimate goal, and the company's ultimate goal is creation and nourishment of profitable and long-lasting relations with the consumers.

The consumer easily identifies the company of the market brand producer, which makes it easier to locate responsibility for possible oversights and deficiency. Brand simplifies and makes easier decision making process of a consumer when purchasing. Brand is a symbol of a partnership agreement between the dealer and consumer. The consumer shows its loyalty and trust, and brand has to guarantee the quality, recognizable performances, consistency, continuity and awareness. Brand decreases the time and effort of seeking the desired product and risk of wrong purchase. Brand is of huge information importance for the consumers, because it gives information on the desired product profile and its basic usage and function features. Brand has huge communicative significance for the consumers because it brings with it significant status and associative features. Status and image of a brand intersect with the status and image of the consumers but also of the employees.

To make a consumer loyal to a fashion product – brand, it is not enough just to buy the brand but it is also necessary to create cognition commitment to do so. Brand must be significant enough for the consumer, that when buying a brand, the consumer buys comfort and all that the brand represents is of great importance for the consumer (unlike the consumer goods). Loyalty towards the brand represents inner commitment of a consumer to repeat the purchase of certain brands. Even though people from marketing department tend to make the consumers loyal to a brand, they should be interested in usage rates of some products on different markets and with different consumers. Brand management is the process of planning, organizing, performing and controlling marketing activities focused on profiling the brand type and turning its identity into desired image and market reputation as well as creating positive goodwill and real property value of a brand. Nowadays branding is more methodical and it requires strategic planning, efforts and money to be successful in creating awareness and associations within the consumers. Exceptional reputation is mainly the consequence of branding process.

To make a consumer loyal to a fashion product – brand, it is not enough just to buy the brand but it is also necessary to create cognition commitment to do so. Brand must be significant enough for the consumer, that when buying a brand, the consumer buys comfort and all that the brand represents is of great importance for the consumer (unlike the consumer goods). Loyalty towards the brand represents inner commitment of a consumer to repeat the purchase of certain brands. Even though people from marketing department tend to make the consumers loyal to a brand, they should be interested in usage rates of some products on different markets and with different consumers. Brand management is the process of planning, organizing, performing and controlling marketing activities focused on profiling the brand type and turning its identity into desired image and market reputation as well as creating positive goodwill and real property value of a brand. Nowadays branding is more methodical and it requires strategic planning, efforts and money to be successful in creating awareness and associations within the consumers. Exceptional reputation is mainly the consequence of branding process.

There is danger in fashion industry for a brand to become old-fashioned or run by the competition. Branding, as a continuous process, which applies more types of developed brands, enables to increase the productivity and sale of the branded fashion products. Successfully conducted activities of strategic image brand management can significantly influence on creating desired corporative image and reputation, conquering new products and retaining the existing markets, establishing good relationships with the business partners, consumers'/buyers' loyalty and easier decision making process with the consumer.

4. CONCLUSIONS

Brand can lead to significant increase of the profit and it can help the companies to become really special. Brand should be used as a management tool, because branding can influence the way a company shall be led, the way it shall do business, its market position and the direction of its growth and development. Strong brand will have useful effect on relations with the interest groups in the business. Branding should connect both the entire marketing area and the company's business process. Brand management is an integral and dynamic concept of the marketing guidance and coordination of the market expression process, behaviour and recognizable appearance, with the aim to actively control market position and to create more favourable competitive and financial effects of the specific brand.

Successful fashion clothing brand in the consumer must inspire positive feelings, must build trust, quality, reliability and prestige. Therefore, companies need to design and build a strong brand with a clear identity. In the fashion industry, the brand especially important, because the competition is high and companies need to attract new customers and retain them. For a successful fashion brand requires good understanding of consumers and their purchasing processes.

REFERENCES

[1] D.A. Aaker, „*Building strong brands*“, Simon&Schuster Adult Publishing Group, New York, 1995.

[2] D.A. Aaker, „*Managing brand equity*“, Simon&Schuster Adult Publishing Group, New York, 1991.

[3] P.Fisk, „*Marketing Genius*“, Capstone, Mankato, MN, 2006.

[4] M.Stamatović, K Kurij, „*Uvod u strateški menadžment*“, Savez inženjera i tehničara, Centar za razvoj, Beograd, 2003.

[5] M. Kocić, „*Uloga simbola i imena u jačanju identiteta*“, Direktor, Beograd, No 3, pp. 29-32, 1998.

[6] M. Stamatović, S.Vukotić, „*Upravljanje marketingom*: *Strateški pristup*“, Cekom Books, Novi Sad, 2009.

[7] Ph.Kotler and. K. Keller, „*Marketing menadžment*“, Data status, Beograd, 2006.

[8] Ph. Kotler and V. Ferč , „*B2B Brend menadžment*“, Asee, Novi Sad, 2007.

The editors take no responsibility of the results, opinions and conclusion expressed in the published papers