ANNALS
OF THE
UNIVERSITY OF ORADEA

FASCICLE OF TEXTILES, LEATHERWORK

VOLUME XIV, 2013

No. 2

ISSN 1843 – 813X

ANNALS
OF THE
UNIVERSITY OF ORADEA

FASCICLE OF TEXTILES, LEATHERWORK

VOLUME XIV, 2013

EDITURA UNIVERSITĂȚII DIN ORADEA

No. 2

This volume includes papers presented at International Scientific Conference "Innovative solutions for sustainable development of textiles and leather industry", 24th-25th of May 2013, 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:
Ulrich's Update - Periodicals Directory
Directory of Open Access Journals (DOAJ)
Directory of Research Journals Indexing (DRJI)
SCIPIO

CNCSIS ACCREDITATION since 2007 "Clasa B"

CONTENTS

MASS CUSTOMISATION: *WHY IS THE APPAREL INDUSTRY SO LATE?*

Jocelyn Bellemare[1], Serge Carrier[2], Pierre Baptiste[3]

[1, 2, 3] *École Polytechnique de Montréal, Université du Québec à Montréal*

Corresponding author: Serge Carrier, E-mail: carrier.serge@uqam.ca

Abstract: In an ever more globalised world, the fashion industry is somewhat counter-trendy as consumers are demanding and expecting ever more personalized products which the apparel providers to their utmost to supply. One of the possible avenues, identified in the literature, offering this industrial sector the possibility to satisfy the consumers' needs is mass customisation. More specifically, we look into the possible implementation of product configurators as possible tools to make true mass customisation possible.
Yet whereas this approach is seen by some as this industry's safety net, by others as a panacea, very few apparel providers opt for this route. The current paper's aim therefore is to evaluate the situation, identify and discuss the possible causes of the slow adoption of mass customisation, its impacts, and possible avenues to correct this situation. It is based on twenty surveys conducted with apparel producers who had previously expressed interest in mass customisation and three in-depth interviews with technology providers. Our research points to a number of difficulties specific to the apparel industry when it comes to technological implementations such as: lower education of managers in the industry, poor integration of technologies, lack of specialised resources, etc.
Our research highlights the necessity for organisations looking at mass customisation to use both performance indicators and integration indicators to assess their performance.

Key words: Apparel, Mass customisation, Integration indicators, Technology

1. INTRODUCTION

Trade globalisation has led to ever more ferocious competition in the apparel industry. To this, the apparel company manager must add all the technological and managerial developments that have taken place in the last few years. Customers' expectations in terms of quality, cost, lead times, and services are constantly on the rise whereas profitability has regularly decreased in the last twenty years. To compete, businesses must find new approaches to product development and marketing such as reducing cycle times, improving productivity, and redefining customer service. Hence they turn to technology to identify potential new approaches to support their business strategies. Technology firms smell the kill and multiply their promises on « sure bet » new products. Yet reality often is more down-to-earth and businesses encounter a number of obstacles on their road to reinvention.

Our research looks into the factors and industry characteristics in large part explaining the apparel industry's difficulties and lateness in implementing on of the most important innovations: mass customization. We argue that one of the major difficulties arises from the lack of integration between the technologies presently used by the industry and those offered by the providers of new systems. The products offered do not meet the apparel manufacturers' and distributors' needs and expectations. Our interviews with different stakeholders point to: (1) a lack of technological fluency on the part of both managers and labor, (2) a strong resistance to change in a very traditional industry still relying on outdated work habits, (3) a lack of proactivity and use/implementation of strategic or technical watches, (4) minimal investment due in part to the difficulty in borrowing, and (5) the bad press often given to technology and mass customisation implementations by some of the important industry actors.

The above list of difficulties should trigger a wake-up call to the new industry reality: more demanding consumers, globalised markets, new technologies, etc. Apparel industry businesses must be proactive, adapt to, and adopt the mindset and management tools to take full advantage of information technologies. To successfully implement mass customisation, it is of the utmost importance that they emphasize analysis, decision making, performance evaluation, and added value. Flexibility is a must as the market expects it ever more.

2. LITERATURE

Ironically, at a time where the global key word, in most industries, is standardisation, the focus, in the apparel industry is on « uniqueness ». Fashion is first and foremost a subjective world; consumers are ever more focused on their own needs and expectation and are therefore resisting product standardisation [1]. Hence Piller [2] identified mass customisation as an important development axis. Ashdown [3] confirms that consumer demand for mass customised apparel is regularly growing; and that capacity to fulfil this demand is made possible by the new technologies and information systems available. Inala [4] states that mass customisation is now a highly competitive strategy for organisations offering personalised products. The more the product can be adapted to individuals' requirements, the more competitive the seller [5]. Yet this requires a thorough understanding of consumers' needs and wants.

Some confusion still exists between personalisation and mass customization [6]. When garments were tailor-made, each individual piece was cut and sown for the eventual wearer. The garment was fitted to the consumer [7]. As Pine [8] states, this was a hand-made and personalised production. Yet, to correspond to mass customisation [9], one needs high-volume manufacturing operations based on flexible processes enabling the producer to meet individual customers' demands. As Pine [8] states: the success of mass customisation is based on a complete integration of the value chain which must simultaneously perform on two opposing axes: quick turnaround times for products meeting individual clients' specifications.

Agrawal, Kumaresh and Mercer [10] see product adaptation to individual consumers' needs as mass customisation's main problem. Von Hippel [11] goes so far as to say that the consumer's lack of experience and knowledge makes him unable to know what he really wants/needs. One must therefore simplify and guide this demand. The information technologies used must transform the masses of data into meaningful and understandable information [3]. The objective clearly is to produce realistic garments; yet the constraints make the compromise between performance, realism, and technical characteristics difficult. Some say that a product configurator may offer the solution.

3. PRODUCT CONFIGURATOR

Brown and Bessant [12] highlight that product configurators, by determining the level of personalisation offered, play an important role in supporting the mass customisation paradigm. For Piller [2], the first objective of the configurator is to facilitate the consumer's experience when confronted with a web site. The configurator is the bridge between the producer and the consumer [4]. Over and above the product decision facilitating function, the configurator should also lead to cost reductions [13] as it allows for time savings when pacing/receiving and order.

A product configurator must be based on a strong technological platform in order to enable a consumer/producer product co-design and co-production. The product configurator is the interface between consumer and producer which should facilitate this co-creation offering both parties a value added proposition.

Figure 1 shows the configurator in an apparel mass customisation context:

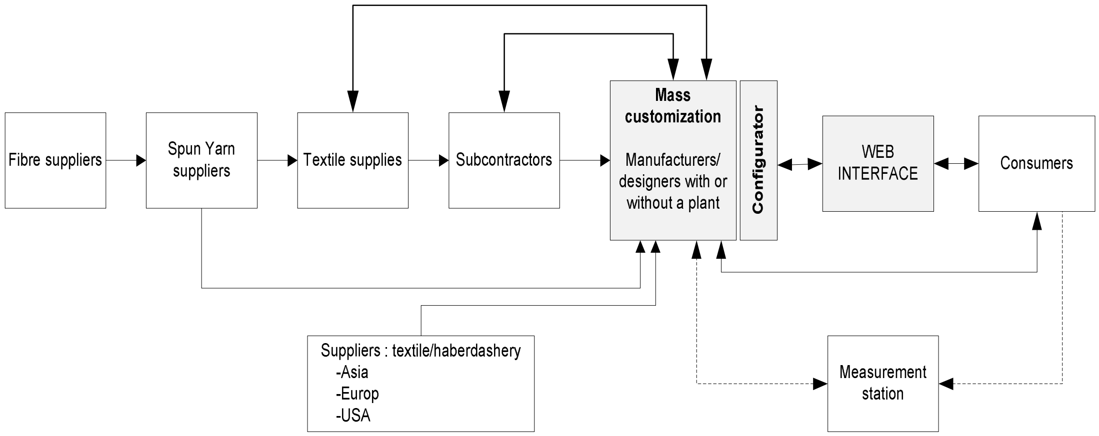


Figure 1. Configurator in an apparel mass customization context

At the present time, the configuration of a product that meets the client requirements is a complex task requiring a more and more substantial time and effort investments as the number of product options and components increases. Kincade, Regan and Gisbson [5] explain that, as the number of products variations increases, the danger/number of potential errors multiplies, production start-up and lead times extend, and therefore that the number and cost of potential errors skyrockets. This same observation led Ashdown [3] to underline the number of challenges one has to face to produce a mass customised garment. Rogoll and Piller [14], for their part, point to the fact that a configurator must fluently interface between different programming languages (different languages are often used in programming for data acquisition from the consumer on the internet, pattern making, laser cutting, etc.) yet be fully autonomous. All these human, technological, and product dimensions obviously make the development of an apparel configurator all the more difficult.

Yet development is only one component of the challenge: the apparel business must then implement it: at the consumer input end and in production processes. Henderson and Venkatraman [15] point to the fact that performance indicators become all the more important as they offer the manager the tools to evaluate whether the objectives are met (short and long term). Rogers [16] adds some precision to this point in identifying two types of indicators necessary to evaluate an implementation: performance indicators and integration indicators.

One must remember that an apparel producer may perform well yet be deficient in terms of integration of its technologies (i.e. using highly effective and efficient processes, offering well adapted product; yet arriving at this results due to the quality of its personnel, resources, and historical management approaches). Performance indicators (stock rotation, returns percentage, number of complaints, etc.) enable organizations to know if they meet their goals and objectives. They provide information on the efficiency, effectiveness of the use of resources whereas integration indicators provide a reading on the adjustment of the technologies used with the organization's goals and objectives. They help the technology suppliers in fine tuning their offers to the needs of the apparel producer.

Venkatraman [17] tells us that when business processes and technologies are well adjusted, managers and employees develop a better attitude toward new technologies and a greater openness to mass customization [13]. Hence our research focuses on the link between business processes (order management, production, distribution, etc.) and technologies currently in use, or intended. We purport that this will enable us to better comprehend the slowness of apparel producers in adopting technologies and more specifically mass customisation.

4. METHODOLOGY

Having observed that apparel manufacturers have, in spite of numerous opportunities, been rather reluctant to adopt mass customisation, our research aims at better understanding the apparel producers' use of the most up-to-date technologies in their overall business and decision-making processes. The basic selection criterion for such producers to participate in the research was an expression of interest in developing a mass customisation project within the next 10 years. Hence they must plan on coupling mass customisation technologies to their current processes and technologies. The research comprised 20 producers. The interviews and questionnaires used focused on understanding their current systems/technologies integration and the variation found on this aspect within the industry. The questionnaires were handed out on a one-to-one basis and/or sent via e-mail. We also conducted lengthy interviews with three technology suppliers in order to understand their perspective and points of view in terms of technology products/services currently offered to the market.

5. RESULTS

The first element of our research dealt with the producers' current use of technologies and the performance indicators used. Our results show that performance indicators perceived as the most significant are those focusing on data transfer technologies such as EDI, RFID and bar codes. Our respondents indicate that technologies better enabling sourcing, production and distribution operations management have an immediate impact on business processes and that both upstream (suppliers) and downstream (distributors, retailers) business partners require their use.

Yet our research results also show that the critical integration indicators focus on other technologies such as ERP, SCM, EMS emphasising internal processes optimisation. Our respondents confirm that implementing/using such technologies requires major changes within an organisation's management systems. Some state that this implementation often takes quite a bit of time yet does not bring the expected results.

Our results tell us that 61% of organizations use relatively non-integrated technological systems and that their performance indicators are inadequate. Moreover, 12% of them confirm that their existing technological systems are "heavy" and hard to manage; that they present a poor fit with the structure in place in terms of performance and process integration.

6. ATTITUDES TO TECHNOLOGY

Another aspect of our research deals with the producers' attitude toward technologies. Among other things, it shows that the industry' difficulty in attracting competent technicians and managers often originates in that few organisations offer candidates interesting long term potential. Small businesses cannot afford the attractive financial packages that would enable them to attract and retain high level resources. On the other hand, close to 70% state that mass customisation technologies are not quite fine-tuned enough yet and that one should wait another few years before investing; that one should wait and see the market's reaction to mass customisation before taking that route.

Technology products/services providers see the apparel industry's problem as a basic non-understanding of what mass customisation technology can bring them. They state that using this technology allows for a totally revamped planning process and that it drastically modifies the ways of doing things: hence a strong resistance on the producers' part. As the producers do not grasp the full value added by new business processes, managers soon abandon the newly implemented processes and revert to their old habits. Moreover the high personnel turnover experienced in the industry, due in great part to low salary bases, also hinders new processes implementation and improvement by making knowledge transfer inexistent (or at least more difficult).

Another characteristic of this subset of the apparel industry is the dirt of innovation; not limited to technologies but encountered throughout the organisations. High growth organisations generally combine efficient work methods with motivated staff. The lack of (or poor) information sharing on business processes within apparel organisations also constitutes an important problem. Decisions are often made at the last minute and management frequently is of the fire extinguishing type. Many apparel producers have serious management weaknesses, show a lack of control processes and little reactivity to their environment. All these traits lead to a lack of vision both within the organisation and in terms of the organisation within its market.

Symptomatically: only 2 out of 20 respondents claim to be satisfied with the systems implemented and to wish to pursue their mass customisation experience. Technology suppliers emphasise that managers must understand that the technology is not a goal in itself but part of a process to attain a goal that will require human as well as financial investments.

7. PERSPECTIVES AND LIMITS

Our research validates the idea that the use of performance and integration indicators has a direct and important impact on the implementation of a mass-customisation strategy. It also highlights that this observation is in great part due to a fundamental culture problem. The industry is comprised of a large number of family businesses, managed in an autocratic manner not very conducive to market adaptation and implementation of revolutionary technologies. Technological innovation seldom is a priority. The generally limited education level of the apparel producers' managers leads to a lack of competencies, market knowledge, and ultimately of leadership.

Our research shows that apparel producers seldom have a strategic plan and that even fewer invest in a strategic watch; the information systems in place are often deficient and poorly integrated with the rest of the firm's activities. One cannot help but notice a strong reluctance to change along with a lack of vision on the part of higher management.

We also have to underline that our research has a number of limits which, on the up-side, constitute future research avenues. First, our decision not to consider other producers' and/or managers' characteristics and traits which may have an impact on technology adoption (i.e. size of the organization, other market strategies, etc.). Second, the fact that our research looked at only one subset of one specific sector may undoubtedly impact on its external validity.

8. CONCLUSION

Mass customisation offers a number of innovation possibilities and may constitute and major opportunity for some apparel industry players. To take advantage of this opportunity, order givers will have to better understand what is possible in terms of product personalisation and on-demand garment production. They will need to rethink their marketing and production strategies. Mass customisation must start with the consumer, involving him in both product design and production.

Mass customisation must not be strictly seen as a short term marketing strategy. It may lead to important cost savings for the producer and greater supply chain integration. It may also provide producers with a better understanding of their consumers, their preferences and the opportunities for market segmentation. Taking the mass customisation route is an avenue to create new opportunities, give oneself a competitive advantage, and reposition the organisation in the global market.

It may be true that the western/ apparel industry cannot compete with the "emerging" countries producers in terms of costs, yet a strategy based on technology may offer definite advantages.

9. REFERENCES

[1] Wang, Q., Zhou, T., & Zhang, W. (2009), *Study apparel Made to Measure based on 3D body scanner: Obtain the area of the characteristic sections of body to classify body types,* Computational Intelligence and Design, ISCID '09 Second International Symposium, Changsha, Hunan, China, 493-496.

[2] Piller, F. (2004), *Mass customization: reflections on the state of the concept,* International Journal of Flexible Manufacturing Systems, 16 (4): 313-34.

[3] Ashdown, S.P. (2007), *Cambridge Sizing in clothing : developing effective sizing systems for ready-to- wear clothing*, Woodhead Publishing in association with The Textile Institute, Boca Raton : CRC Press: 384.

[4] Inala, K. (2007), *Assessing product configurator capabilities for successful mass customization*, University of Kentucky, theses.

[5] Kincade, D.H., Regan, C., Gibson, F.Y. (2007), *Concurrent engineering for product development in mass customization for the apparel industry*, International Journal of Operations & Production Management, 27 (6): 627-649.

[6] Duray, R. (2002) *Mass customization origins: mass or custom manufacturing?*, International Journal of Operations & Production Management, 22 (3): 314-328.
[7] Workman, J.E. (1991), *Body Measurement Specifications for Fit Models as a Factor in Clothing Size Variation,* Clothing and Textiles Research Journal, Vol. 10 (1): 31-36.
[8] Pine, B.J. (1993), *Mass Customization: The New Frontier in Business Competition*, Harvard Business School Press, Boston, MA.
[9] Zipkin, P. (2001), *The Limits of Mass Customization*, Sloan Management Review, 42: 81-87.
[10] Agrawal, M., Kumaresh, T.V., and Mercer, G.A. (2001), *The False Promise of Mass Customization,*The McKinsey Quarterly, 3 (1): 62–71.
[11] Von Hippel, E. (1998), *Economics of product development by users: The impact of sticky local information*, Management Science, 44 (5): 629-644.
[12] Brown, S., Bessant, J. (2003), *The manufacturing strategy-capabilities links in mass customisation and agile manufacturing – an exploratory study*, International Journal of Operations & Production Management, 23 (7): 707-730
[13] Piller, F., Walcher, D. (2006), *Toolkits for idea competitions: a novel method to integrate users in new product development*, R&D Management, 36 (3:June): 307-318.
[14] Rogoll, T. and Piller, F. (2004), *Product configuration from the customer's perspective: a comparison of configuration systems in the apparel industry*, Proceedings of the International Conference on Economic, Technical and Organisational Aspects of Product Configuration Systems, Lyngby (June): 28- 29.
[15] Henderson, J.C.,Venkatraman, H. (1999) *Strategic alignment: Leveraging information technology for transforming organizations*, IBM Systems Journal , 38 (2.3): 472-484
[16] Rogers, E. M. (1983). *Diffusion of innovations*. New York : The Free Press.
[17] Venkatraman, M.P. (1991), *The impact of innovativeness and innovation type on adoption, Journal of Retailing*, 7 (1): 51-67.

PROFOUND MUTATIONS WITHIN CURRENT INDUSTRIAL SYSTEMS

Sabina Gherghel[1], Marius Şuteu[2], Liliana Indrie[3], Adina Albu[4]

[1,2,3,4] *Faculty of Energy Engineering and Industrial Management, Oradea, Romania*

Corresponding author: Gherghel Sabina, E-mail: sgherghel@uoradea.ro

Abstract: Profound mutations in the current industrial systems are largely related to the process of change, mainly due to rapid and drastic changes in the environment in which they operate. The process of change is a very important one and current industrial systems are in a continuous state of renewal and efficiency at the same time. It is necessary to change the structure of industrial systems when its activities and values are deficient to some extent, and their results are different from what they have really set. The types of forces that lead to proffound changes in the industrial systems can be both external and internal to systems and of different intensities. At the same time there appears resistence to change, which in its turn also comes from two sources, namely organizational and personal. Because resistance to change is caused by several different factors, industrial systems management must act in time to control and minimize the undesirable effects. It is necessary to clearly establish the need for change and its implementation. The success or failure of such an action consists in clear identification of the problem, the proper analysis and choice of the plan for implementing the mutation. The paper deals with these important aspects of current industrial system and the crucial role of top management, which is responsible for the decision regarding the introduction of planned change.

Key words: mutations, industrial system, change, renewal, efficacy.

1. INTRODUCTION

In specialty literature, the classics in management of production systems considered the structure as the foundation of organizational effectiveness. Currently, the modern view, embraced by supporters of the conjectural current, do not give the same major importance to the structure, but nevertheless accept that this is one of the key variables that must be considered when designing a production system. The problem structure is important not only for academics but also for practitioners. [1].

Designing the organizational structure is one of the major priorities of any management team. The fact that the structure is designed by managers will make it reflect the managerial interests and values rather than those of other parties with an interest in the respective organization (employees, customers, shareholders). Another important thing to note is that the structure will promote corporate interests, rather than the individual or sub-group ones. In other context, any structure cannot be considered permanent, its continuous change to adapt to external requirements is imperative.

Profound mutations within industrial systems are related to the changing process, and industrial systems are in a continuous state of renewal and efficacy. In this situation aspects of opposition to change and ways in which to act in such situations cannot be neglected and should be taken into account. [2], [3].

2. CHANGE WITHIN CURRENT INDUSTRIAL SYSTEMS

In current industrial systems there is the need for a change when the manager notices that systems activities, goals and values are to some extent deficient, there is a clear difference between what the industrial system is trying to do and what it really does. In the next figure is shown this aspect under the form of a graph:

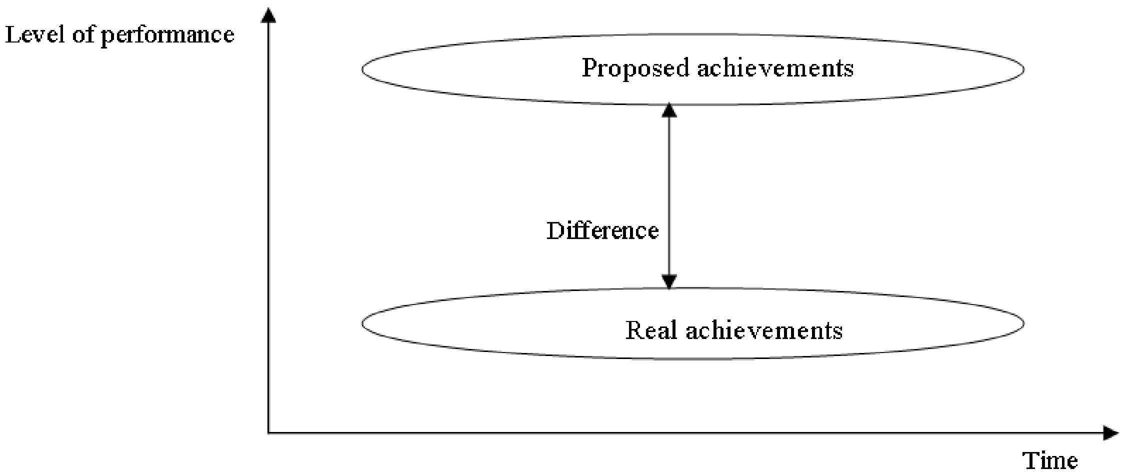


Figure 1: Industrial system status leading to change

Forces which determine major changes in the current industrial systems can be classified into two broad categories, namely external forces – caused by the environment in which the industrial system operates and interior forces – driven mostly by changing the managerial philosophy, but also the implementation of new technological advents, changes in organizational culture and for the ultimate goal of industrial system activities. [4]. Schematically [5], the two types of forces can be represented as follows:

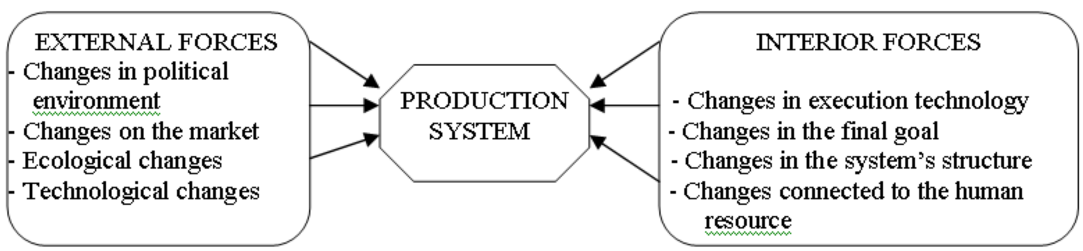


Figure 2: External and interior forces that contribute to changes in the industrial systems

3. THE RESISTENCE TO CHANGE

The resistance which appears to diverse mutations in current industrial systems come from two sources, namely:

- sources related to staff,
- organizational sources.

3.1 Resistance related to staff.

The reasons why employees of an industrial system present a considerable resistance to many change initiatives are manifold. Some of them have feelings of insecurity because until the moment of change they were performing their activities in complete safety and in well known existing conditions. Their fear is linked to the fact that with the change, interpersonal relations from their jobs will deteriorate, and their triumphs will be destroyed. From another point of view, some of the employees do not see the need for change, they do not see it as a rational thing. This is where the managers informing activity comes in, which is often not effective enough. A clear conclusion that emerges from all the types of resistance determined by the staff is the fear of the consequences of change, of the unknown in general. [6].

Among some concrete examples of sources for staff who oppose change in current industrial systems we can mention the following:

-habit,
-fear of the unknown,
-deterioration of existing social relations,
-misunderstanding of the benefits of change,
-fear of loss of personal status,
-various inconsistencies between the personal and the industrial system,
-lack of involvement in the process of change.

3.2 Resistance coming from organizational sources.

Industrial system, as a whole can often influence the manifestation of a certain resistance to change, but at the same time it can be a real support to attain change. Many times top managers are considered linked to old policies and procedures due to substantial investments they have made previously in certain products, technology or in different markets and they can not admit the fact that the environment and circumstances are totally different. [7]. Organizational sources of resistance can be summarized like this: [8]

-reducing costs due to past decisions and actions,
-internal conflicts between the different functions of the industrial system that will induce resistance in cooperation,
-rigid structure of the system,
-fear that change will alter the hierarchy of power between groups and functions of the system,
-past experiences regarding the failure of attempts to change and their unfavorable consequences,
-dominant organizational climate.

4. PLANNED CHANGE IN CURRENT INDUSTRIAL SYSTEMS

The success or failure of changes in current industrial systems consists not only in the clear identification of the problem and reducing as much as possible the resistance to change but also in choosing the appropriate method of implementing the change. Understanding the need for change is a necessary condition, but it is not enough. Thus, managers of industrial systems undergoing change should conduct a thorough analysis and a proper way for implementing it. [9]. Literature presents three different approaches regarding planned change, depending on the purpose, thus: modification of the industrial system structure, changing the organizational technology and the way to change employees.

Within industrial systems the three approaches listed above are in continuous interaction with the multiple activities developed, together creating conditions for efficient industrial systems. Schematically, these interactions can be read as follows: [10]

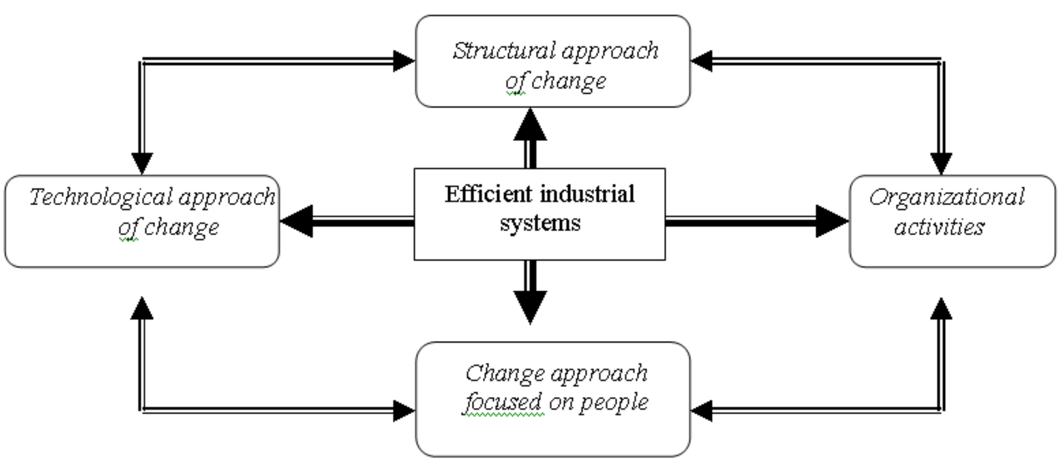


Figure 3: Interactions between activities and approaches to change

Structured approach to change takes different forms, such as those relating to classification of coordination mechanisms, achieving labor design, the increase or decrease of control area and also proper clarification regarding the perspectives, and the ultimate goal of structural change is to create new conditions, to achieve interdependence between activities and goals.

Technological approach to change leads to changes in the technologies used in performing the work in order to modernize production methods, engineering and technological processes and also the used equipment to obtain a new operator-machine interface.

Change approach focused on people tends to emphasize the improvement of skills and also motivation of individuals. This approach is found in several forms, including various training programs and personal training, decision-making and attitudes motivating. [11], [12].

4. CONCLUSIONS

Resistance to change encountered by industrial systems due to a big number of reasons, and management will have to be able to control and minimize its effects. Top managers will be responsible for setting the precise nature and need of change, followed by planning the main activities by carefully addressing the potential sources of resistance. The manner in which profound mutation is implemented is as important as real change to the success of the action.

The main responsibility of managers therefore remains to recognize the need for change in the industrial system, to diagnose the nature and severity of the problems that create this necessity and not least to implement the most effective method of change. In the absence of such a target, the industrial system's ability to respond to the multitude of internal and external threats regarding stability and continuity is strongly reduced, which reduces the capacity of the industrial system to operate efficiently and in the long term.

Managers who are aware that the basic processes are the ones involved in attempts to change people have more chances of success than those who ignore them. At the same time the manager concerned determines its own preference towards change. Moreover, as we move into the future, continuous change and development become more the rule than the exception, due to the dynamism of the powerful global environment.

5. REFERENCES

[1]. Boncoi, Gh., ş.a. (2002). *Sisteme de producție*, vol. III, Ed. Lux Libris, Braşov.
[2]. Petrescu, I. (2005). *Orientări şi comportamente în managementul total în firma secolului XXI,* Editura Lux Libris, Bucureşti.
[3]. Jaba, O., (2002). *Gestiunea producției şi operațiilor. Metode şi tehnici ale managementului operațional al producției*, Editura economică, Bucureşti.
[4]. Pritchett, Price (2002). *Shaping Corporate Culture: The Mission Critical Approach to Cultural Integration and Culture Change* Pritchett, LP. ISBN 0-944002-31-5.
[5]. Daft, R., L., (2010). *Organization Theory and Design,* South-Western CENGAGE Learning.
[6]. Ionescu, G., Negruşa A., L., (2006). *Change and dynamism in organizations*, Editura Todesco, Cluj-Napoca.
[7].Gary Johns (1996). *Comportament organizațional*, Editura Economică, Bucureşti.
[8]. Cummings, Thomas G. & Worley, Christopher G., (2005) *Organization Development and Change,* 8 th Ed. Thomson South Western, USA.
[9]. Leavitt, H., J., (1964). *Applied Organization Change in Industry: Structural, Technical and Human Approaches*, In Cooper, W. W. Leavitt, H.J. & Shelly, J.W.(Eds.) New Perspectives in Organizational Research. New-York: John Wiley & Sons
[10]. Gorski, H., (2004). *Managementul organizației viitorului: mutații în era informațională*, Editura Universității Lucian Blaga, Sibiu.
[11]. Nicolescu, O., (coord.) (2000). *Sisteme, metode şi tehnici manageriale ale organizației,* Editura economică, Bucureşti.
[12]. Rushton, A., Croucher, P., Baker, P., (2010). *The handbook of logistics and distribution management,* 4 th. Edition, Ed. Kogan Page, London.

PATHOLOGICAL STUDY OF IRANIAN TEXTILE INDUSTRY

Jalal Haghighat Monfared[1], Nika Vatankhah[2]

[1, 2] *Islamic Azad University Centeral Tehran Branch*

Corresponding authors: Jalal Haghighat Monfared, jhmonfared@yahoo.com
Nika Vatankhah, Nika.vatankhah@yahoo.com

Abstract: Although textile industry lies upon a long antecedent in Iran, it suffers these days from a critical circumstance.

The reasons, from which the existing problems of textile industry originate, must be recognized otherwise, there would be no possibility to find applicable solutions. Crisis discussion in this part is not new; this industry needs to be refashioned in many domains. In this way, pathological study of textile industry emerges as a vital investigational responsibility by which all systems and problems are carefully studied. As a goal this article seeks for, the role and importance of internal organizational factors are crystallized rather than external organizational factors. Also prioritization of these factors and offering some solutions and suggestions for departing from this situation to a suitable one are the other goals in this essay. We use an analytic model, which divide the problems of textile industry in two categories including internal and external organizational factors.

The problems from which this branch suffers are included into two genres of internal organizational and external organizational factors. In this article managerial dysfunction, machine depreciation, high cost price, disrespecting the standards and low quality of production, raw materials with low quality and, counter-productivity of working staff have been considered as six internal organizational factors. In addition, five external factors including lack of government support, decrease in market requirement, investor's lack of job security, high rate of banking interest and disabled system of banking facilities, and formal/informal smuggling of goods, have been noted as the most effective factors explaining crisis in this industry. We use a questionnaire, SPSS software and some appropriate statistical tests in order to evaluate these factors.

The results of factors assessment show that among internal organizational factors, machine depreciation besides smuggling of goods among external organizational ones, are the most important factors causing crisis in Iranian textile industry.

***Keywords**:* Textile, Pathological Study, Internal Organizational Factors, External Organizational Factors, managerial dysfunction.

1. INTRODUCTION

As we know textile industry includes all stages of production of both natural and man-made fibers, fibers in to yarn, yarn into fabric. It also includes all finishing processes done on fabrics such as dyeing and printing.

The industry was initially limited to the production of yarn, however later it included all kinds of garments. Considering clothing besides food and housing to be basic human needs, textile is one of the oldest human industries. Though developed in many cases, Iran's textile industry witnesses, now, many fundamental dependencies in different domains including machines, processes, raw materials that include fibers, dyes, and Chemicals [1].

It must be mentioned that this industry suffers these days from a critical circumstance in both inside and outside the organizations. The reasons, from which the existing problems of textile industry originate, must be recognized otherwise, there would be no possibility to find applicable solutions. In fact this industry needs to be refashioned in many domains. In this way, pathological study of textile industry emerges as a vital investigational responsibility by which all systems and problems are carefully studied.

2. LITERATURE REVIEW

The term 'textile' signifies everything that is weaved. In fact, textile is an art in which two distinct sets of yarns or filaments -called Warp and woof- are intertwined in order to produce fabric. Warps get to side to side in a piece of fabric in length besides woofs in width. Spinning of yarn is one of the first industries discovered by human. Over the years the industry has had significant improvements. Indeed these days textile industry is considered currently as one of the criteria and indicators evaluating development of a country. The importance of this industry is so that economic mutation and revolution of many countries takes root in. China is the most obvious exemplar in this way. In countries such as India and Pakistan, about thirty percent of the total labor force is employed in textile and apparel industry. Moreover, Turkey finds benefits of a large percentage of its annual exports in this field [2]. In fact, countries such as Japan, South Korea, Taiwan, Turkey, Pakistan and China can be mentioned as successful countries in textile industry, mostly in Asia. In this section, I discuss the situation of these countries and try to explain the reasons of their success.

Japan is a country that initiated the process of economic development after World War II with presentation of textiles and clothing. However, from 60s, due to the loss of cheap labor in Japan, the country invested in other countries where workers were plentiful in number and the wages were lower in amount. In this part, we note some of the factors that lead Japanese to success in this field:

1- Producing goods whit the highest possible quality accordance with the taste of customer
2- Delivering after-sales service
3- Delivering new and fashionable products
4- On time Delivery of goods to customers
5- Effort in marketing and recognition of markets and their needs
6- Serious consideration on complaints

In fact, most Japanese consumers are very careful about three criteria, i.e. quality, price, and fashion. The three criteria determine the fate of Japanese goods in the apparel market. As a result, Japanese are pioneers in supplying goods with high quality and high price. Also they have formed quality control groups in their workshops and factories.

Aiming at increasing textile exports in 2000 amounted to $ 30 billion, South Korea increased the rate of automation through replacing old machines with new machines and modern equipment from 25 percent in 1986 to 45 percent in 1989. Due to an increase in wages, compared with other competitors, Korea tried to maintain the quality of textile products because they did not want to hurt their world rankings in this field. Indeed, they try to decrease dependence to the United States and the European community but, on the contrary, increase the export of fashionable products.

Textile and Apparel Industry in Turkey play, as well, an important role in economy in terms of workforce, capital profit and export opportunities. Sixteen percent of industrial products, nineteen percent of the workforce and 32 percent of total exports are allocated to textile in Turkey. Textile and garment industry are in a great circumstance due to factors such as quality of raw material, suitable prices, cheap labor and low cost in per unit in Turkey.

Textile and apparel industry are known as the backbone of the Islamic Republic of Pakistan. Production of cotton textiles and apparel industry through the history of this country -bordered with China in north, India in east, by Afghanistan and Iran in west and leads to Oman Sea in southwestern- are recognized as a major focus of its industries. Pakistan has been classified as the fourth cotton producer and the third consumer of cotton in the world in recent years.

China's textile and apparel industry is considered as one of the most important and consistent economic sectors. Also the industry has a close relationship with Chinese life. In 2006, the production volume of fiber was over 30/7 million tones and 20 million people were employed in the textile industry in China. In fact, we can say China is the largest producer of cotton and man-made fibers in the world. It completed the building of the largest and most comprehensive textile industrial system. One of the measures the Chinese applied for boosting their textile and apparel industry was taking advantage of new technologies and a desire to attract foreign investment in this sector of the national economy. The low price of these goods has already helped a lot the boom of Chinese exports in the global markets. China has earned a first degree among all the textile-exporting countries to European markets. Undoubtedly if Chinese improve the quality of products, not only they will earn much money but also they can be successful in competition with their strong competitors in Eastern Asia.

Moreover, a raise in labor costs in countries such as Korea, Taiwan and Hong Kong, has provided China with a great opportunity for entering markets strongly through taking advantage of its cheap labor power. Hence, it can grow rapidly in this way.

If we are to bring some reasons for the success of these countries in textile industry they would be as follow; Their ability to adapt to new international conditions, produce with high quality, offer new and fashionable products besides their effort in recognizing markets and their needs, manufacturing according to the taste of customer. Moreover, low amount of state tariff and interest, reduction in production costs that came into possibility via advanced automation and competitive prices, creating a safe environment for productive activities and investment should be noted. Reasonable and planned support for productive activities and export, increasing diversity in productions, and membership in WTO that helped them no to pay tariff for machines and raw materials have also played an important role [3].

However, in the case of a country such as Iran though developed in many cases, textile industry witnesses, now, many fundamental dependencies in different domains. In fact, if we categorize textile industry into two, machines production and production lines of goods, unfortunately we cannot find any place for Iran in the world or even in a local region. This is because producing textile machinery and production lines are under the ownership of countries such as Germany, Italy and France. In recent years, due to the lack of economic benefit in Europe, it is gradually transferred to countries such as Turkey and China. However, Iran's main activity in this domain is focused on the final textile products, which has many problems in this way [2]. Researches done in this area to deal with the problems of the industry are currently not sufficient, even in Iran. Those rare studies done in this regard, unfortunately, have not gained as much attention as urgent the case is. This is how a study such as the present investigation that aims to assess the problematic condition of textile industry finds no antecedent. As a result lack of background research on this subject, is considered as one of the limitations this study suffer from.

3. PROBLEMS OF TEXTILE INDUSTRY OF IRAN

Textile industry challenges many problems because of indiscriminate importation of textiles and some problems concerned with supplying raw materials, Production and cash, which is required for rebuilding[4]. Moreover, the industry suffers lack of raw materials with high quality, high cost price, poor management, etc.

Some internal organizational factors which are considered as the most important problems in textile industry of Iran:

1- Managerial dysfunction
2- Machine depreciation
3- High cost price
4- Disrespecting the standards and low quality of production,
5- Raw materials with low quality
6- Counter-productivity of working staff

Some external organizational factors which are considered as the most important problems in textile industry of Iran:

1-Lack of government support
2- Decrease in market requirement
3- Investor's lack of job security
4- High rate of banking interest and disabled system of banking facilities
5- Formal/informal smuggling of goods

We can see these factors in an analytic model:

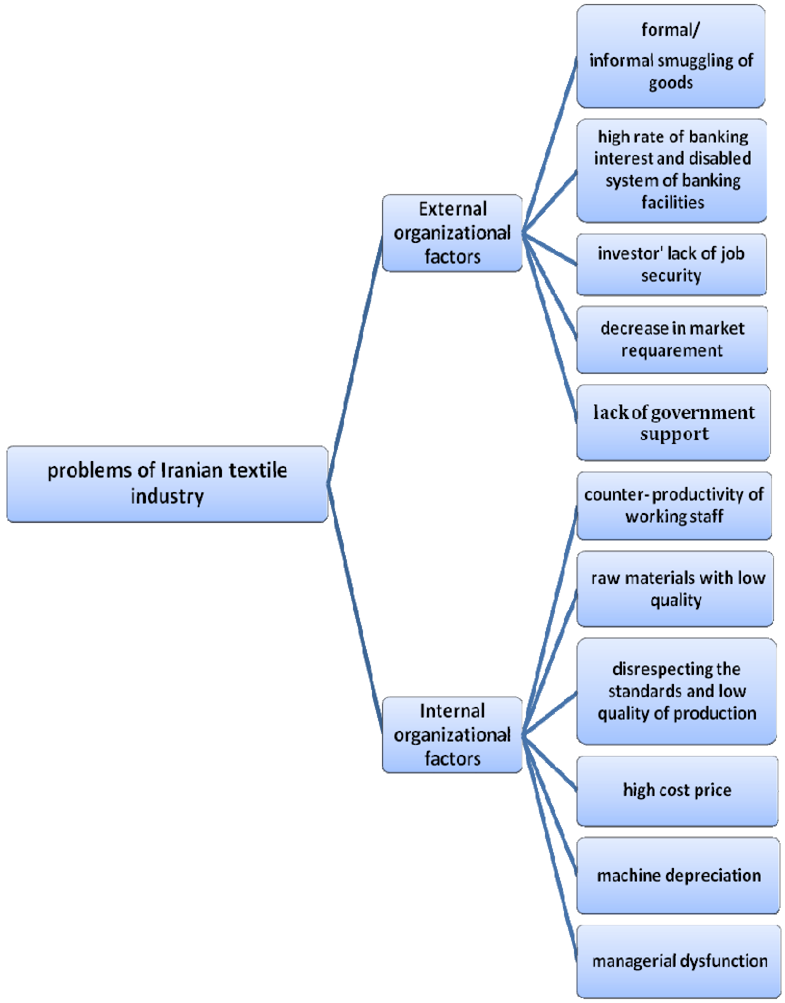


Figure 1. Internal and external organizational factors

3.1. Managerial dysfunction

As mentioned before, textile industry needs to be refashioned in many domains. This also applies to the management of the units and companies. This is because many textile companies suffer from the lack of experts in this field. It is clear that weakness in performance of managers of the textile

3.2. Machine depreciation

Machine depreciation is one of the internal organizational problems of textile industry in Iran. Unfortunately, a lot of machines which are used by some textile factories in Iran are old and outdated. Certainly, using low-tech machines reduces the quality of products. This case can severely affect the competitive sharpness of Iran in global markets.

3.3. High cost price

Increase in production costs such as raw material prices, salaries, wages, energy and fuel production, various taxes and duties, packing and shipping costs, banking interest rates, exchange rate fluctuations increase the cost of productions. [5].

3.4. Disrespecting the standards and low quality of production

The purpose of standard is a proof, which is based on consensus standards published and adopted by a well-known organization. It includes a set of rules, guidelines for activities or their results with the goal of achieving a good degree of discipline in a particular field [6]. In addition, quality has always been an integral part of all products and services. However, our awareness of its importance, i.e., the introduction of formal methods for quality control, is gained through an evolutionary development. The management system of an organization must be organized to a proper direct in order to achieve the overall quality improvement philosophy and ensure its deployment in all aspects of the business [7]. Unfortunately, many production units currently do not address this issue properly. In fact, the lack of standards is a reason for the low quality of manufactured goods in the textile industry in Iran.

3.5. Raw materials with low quality

Although the circumstance of producing man-made fibers is suitable, there are a lot of problems for producing natural fibers in Iran. Because the government does not support farmers, they are not interested in planting the valuable product. In addition although Iran has got Cotton fiber with suitable length and good fineness, because of the traditional methods of harvesting cotton and the Process of separating cotton fibers from the seeds, Iranian Cotton fibers have a high fracture. Wool is another important fiber which is used in textile industry but unfortunately its fineness is not suitable. Silk is another fiber that is really valuable but unfortunately it is not produced these days in Iran as gone. It should be added that weaving fabrics from silk is really difficult. All these cases can decrease harvesting and producing of these fibers.

3.6. Counter-productivity of working staff

Employee is the main source in the process of improving productivity. Skills, education, training, motivation, attitudes, values and human health affect productivity directly. Lack of any of these cases might cause a decreasing in productivity.

3.7. Lack of government support

There exists a view according to which the problems arise because of the Non-efficient governmental management. In fact this government caused a big crisis in textile industry. Although the economic problems are not confined merely to government policies, we have to say due to this government use some Non-efficient policies, the situation of industry in particular and the situation of textile industry in general got worse [8]. In fact, this government does not have a useful and efficient program for textile industry. We have to say it promises instead of act.

3.8.Decrease in market requirement

While most of the textile goods are produced with low quality and high price in Iran, foreign textiles with high quality and reasonable prices can enter Iran. So in this situation old factories which their productions have low quality and high price cannot compete in Iranian and global markets. Therefore, many products remain unused with no demand from the market [5].

3.9.Investor's lack of job security

As far as most banking rules are old-fashioned and non-efficient in Iran, There is no investor interested in investment in industry especially in textile industry. In fact old-fashioned and retrogressive rules have made critical situation for Investors. In deed, the situation these days is unsafe for investment in Iran.

3.10. High rate of banking interest and disabled system of banking facilities

It is obvious that Iran suffers these days from a critical economic circumstance that affects banking system so the situation of banking facilities is not suitable. Also the rate of banking interest is very high and the return on investment now has high risk in this industry. As a result people who are responsible in banking system do not give required facilities to textile companies.

3.11. Formal/informal smuggling of goods

It was mentioned before that one of the problems of textile industry is indiscriminate imports which happens from both formal and informal channels. In fact false policies enacted by the government in recent years for controlling inflation not only does not cure inflation but also inflicted serious damage to domestic production. Besides others, smuggling of goods caused the situation that textile industry cannot use the full capacity of its manufacturing. As a result production cost increases and competitive of these products reduced in markets [8].

4. CONCLUSION

Aiming to assess organizational factors, in this article, I distributed 40 questionnaires to industry experts and scholars. According to respondents and using one-sample T-test, I evaluated the importance of these factors. The results of the analysis show that among internal organizational factors, machine depreciation besides smuggling of goods among external organizational ones, are the most important factors causing crisis in Iranian textile industry. So people who are responsible in this way should pay attention to the factors before others. Studying and understanding the problems of the textile industry can help us to find and offer the right solutions for removing these problems. It seems that government has the highest authority in this way. I offer some suitable solutions for improving the circumstance of the industry. Making serious decisions for status necessary legislation In order to combat smuggling for instance will contribute textile industry. To improve market demand, textile companies must take special measures. In fact, not only textile companies should be familiar with the taste of their customers but also they have to plan for producing goods with high quality. Using the proposed system can be very useful in this regard.

Another case that is effective in improving the external factors is supporting investors who want to invest in textile industry. This is because if they are supported, they will have motivation for great investments in this area. As far as machine depreciation is the most important factors among internals, textile companies have to equip their systems to high technology and advanced equipment. Taking advantage of modern equipment, not only boost the amount of producing but also increase the quality of manufactured goods. Governmental bureaucracy which governs textile factories should be reduced. Moreover, government effort for stabilizing the inflation rate is another way to help the industry. In order to support the production of textile industry, government adopts some special and useful methods.

5. REFERENCES

[1] Hajisharifi,M; Sasannejad,J; Properties Of Textile Fibers, Center for Academic Publication, fourth Edition, 2004.
[2] http:// ertebatesanat.ir
[3]Roshan,A; Bakhtiyari,K ; Assessment Of Textile Industry In Iran, Textile Industry Journal, page 28, 2011.
[4] http://Hamshahrionline.ir
[5] Shafioun,Gholamreza, Assessment Of the Crisis Reasons In Iranian textile industry, thesis, Islamic Azad university, Central Tehran Branch, Tehran, 2005.
[6] Yusefizadeh, Zahra, Standard Position and Its Importance In Industry, Prosperous Textile Journal, Vol. 4, Issue 13, page 49, 2012.
[7] Montgomery, Douglas C. A Modern Framework For Achieving Enterprise Excellence. School of Computing, Arizona State University, Tempe, Arizona, USA. (2010).
[8] http: //niaknameh.blogfa.com

STRATEGIC ANALYSIS OF A ROMANIAN TEXTILE COMPANY

Zenovia Cristiana Pop[1]

[1] *Babeş -Bolyai University of Cluj-Napoca, Romania*

Correrspondіng author: Zenovia Cristiana Pop, E-mail: pzenovia@yahoo.com

Abstract: In this article we present the results of a market research, with the purpose to give an answer to the following fundamental question namely what are the main needs of the customers, of a textile company. The data collected should provide a clear view of the customer requirements and customer expectations, and especially the degree of fulfillment of these. The customers are the only ones who know their own needs and have at the same time expectations with the company, their products and their after sale services. Therefore, we tried to see the assortment of this textile company with the eyes of its customers. The answer to these questions should provide approaches on how to increase customer satisfaction and loyalty. The research highlighted the need of introduction of several models, because the potential of the market. Each question provides the necessary information to establish the wishes and expectations of customers and especially their degree of fulfillment by the company. Customers are the only oes able to know their own needs and at the same time, they have been in contact with the company, its products and marketing style. In conclusion, we tried to observe the assortment of the company in terms of the buyer. The answers to these questions should provide benchmarks for the company in order to assure customer satisfaction and loyalty. Least a SWOT analysis is developed and presented in.

Key words: loyalty, quality, quality management, process, customer.

1. INTRODUCTION

The Romanian textile industry has tried desperately during this last twenty years to survive due to higher labor force costs, financing sources, clients low purchasing power and although they ware some instances of internationally gained recognition.

We live in a market in which globalization affects all market players, the clothes in our wardrobe were sown in Asia, Eastern Europe, and Latin America and throughout the world. It is obvious that it will be increasingly difficult for national and international companies to sell their products and make a profit. Competition is increasing because of the internationalization of markets, the opening of Eastern Europe, and dissolution of trade barriers. Due to increased competition, pressure of high costs, market saturation a firm must do everything possible to ensure their economic survival. Such trials are taking place in the textile sector, perhaps the most affected sectors. Industrialized countries are beginning to move production centers in developing countries. The amount earned from the difference in salary costs should be higher, compared to the transport and transfer costs for the companies to be profitable. The fact that transaction costs have decreased significantly due to technical developments made a closer economic integration possible. The textile sector in Romania is one of the most important economic sectors. This form of production is preferred because it does not require large investments.

2. RESEARCH METHOLODLGY

This study has important implications for every textile company because it identifies the main characteristics of quality, price and service needed that is associated with the established organizational performance that everyone is looking for.

In order to attain the research objectives, we studied: the company's evolution and politics, regarding quality, price and service at manager's level.

We developed a questionnaire that helped us gather qualitative and quantitative information, the demographic structure of respondents, one of the questions being structured on a Likert Scale.

The data collection took place in various stores of the textile company over a period of 2 weeks. The sample of 50 valid questionnaires, point out to a response rate of 47 %.

The textile factory we have chosen was a textile workshop, which operated since 1948, founded on 15 November 1949. In 1949, the first production capacity developed through the construction of 1232 m$^{2.}$ There were also added industrial areas and social facilities for instance a canteen and a medical treatment building. In 1969, 1973 and 1986, the first investment stages take place.

During this period, the production focused at the beginning of its activity and during various periods, on clothing for the military even clothing for women, men and children, for export. In 1989, it had 2500 employees and approximately 50% of production was mainly for Eastern Europe, USA and Canada.

3. THE ANALYZED TEXTILE COMPANY

During our research, we focused on establishing whether the targeted customers really belonged to the middle class and over. Therefore, we chose to analyze their income. The majority of the customer's 26 women so 52% and 24 men (48%) belong to the income category between 1000 RON-2000 RON and 30% to the income bracket 390-1000 RON, which means that in fact, the company has been reaching his target group. As we can notice in the next few answers, most customers do not agree with the prices of the garments despite the relatively high income. Therefore, the pricing strategy [1] should be edited and adapted to the customer. Between 25-35 years are 26% of respondents and 28% of those were between the age of a 45 and 55 years. Since the dispersion is quite wide, they should try to provide models that are suitable for the two age groups. A 26-year-old customer will not dress like a 50-year-old customer. The age group that the least occurs is the one situated under 25 years. The very young people have been not targeted; the rather conformist style does not fit their profile. If they want to appeal to this target group, less than 25, then they should perform a greater segmentation of the market [2]. In order to respond not only to persons who prefer classic models, but also people who value trend and innovation. Most respondents, so 40% have visited the store only one time per year. This means that they had made little advertising to attract customers. The used form of advertising is the single advertising [3]. The company has used in addition to the above-presented office equipment both graphical advertising such as newspaper ads in Adevărul, posters in the store, as well as commercials on local radio stations and television stations like Antena 1, Prima @ TV. The commercial used as an incentive element, has been recorde in a luxurious house, with a fireplace, and a valuable picture in the background. All these elements are evidence of a refined taste, and the wealthy financial position of the target customers. This advertisement awakens the needs of refinersness, worldliness, and blamelessness.

The number of those, which are weekly or monthly visiting the store, equals the number of people who just do it quarterly, 30%. Only 12% of respondents come weekly to see what is new. Consequently, either the models are not so interesting, or for the new collection, the company does not advertise enough. Therefore, a change in advertising strategy is needed for instance: advertising in the newspaper Ziarul Financiar, or on websites that are visited constantly by the target customers. Regular customers represent only 22% of respondents; the proportion of those that have never shopped is very close to the 24% and therefore slightly higher. This means that the company has no clear pricing policy, advertising policy, product policy, etc., fact that would have allowed the company to attract the customers to their store increase the share of regular customers, and reduce the proportion of those who never shopped. Still we ought to mention the fact that the store atmosphere is customer friendly, very functional and complemented by a classical and modern music. An architect did the design of the interior. This is very important because it creates an atmosphere and simultaneously transmits the room an individual character. The interior is determined, not only by the physical size 40 m^2 of the room, but also by the light in the store. The light is, however, in this store, not particularly good. What is a negative aspect, particularly for shops in which one is selling clothing. Because the ceiling was painted with green color, this has an effect and can create reflections on the complexion

The clients prefere to spend theire laisure time with the family next with friends and last reading books. The results concerning the age were presented as follows: under 25 years, 4 were women, between 25-35 years, 9 women were between 35-45 years, 3 men and 6 women between 45-55 years, and with over 55 years were only 4 women. The results of the men: a) under 25, 1 mann, b) zw.25-35 years 4 men, c) between 35-45 years, 6 males, d) between 45-55 years, 8 males and e) 5 men over 55 years. Because of these findings regarding the age distribution (28% between 45-55 years of age) should the textile company focus on two target age groups, namely between 25-35 years and between 45-55 years. We ware also interested in researching how often are the clients visiting the store.

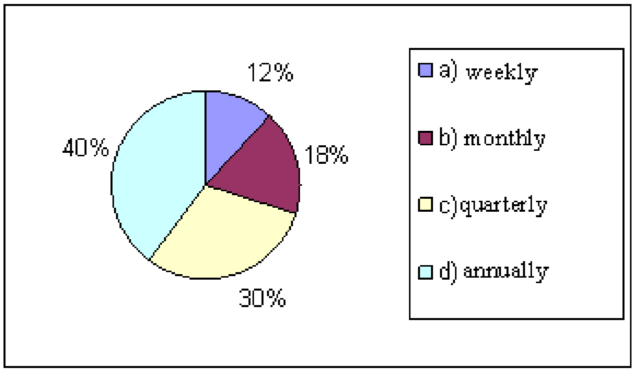


Figure 1: Figure caption

Particularly for customers are the after-sales or the retouch performance very important. Unfortunately, most customers did not know about it. On one hand, it can mean that they did not need it and then the fact can be seen, positive or they did know and then the company has gained another problem of communication. The fact, that 62% appreciated the service as being good indicates that the first version is valid. The company provides customers with a product line for man treated with nanotechnology. Nanotechnology analyzes very small structures, hence the name nano, which comes from the Greek and means dwarf. The molecules of a material can be determined to organize themselves independently by means of electricity, magnetism or chemicals and the material gains new properties [4]. The new method was also used in the garment industry, where fabrics are used that are dirt and oil repellent, but also easy to maintain and vapor and air permeable. In a test with 50 wash cycles at 60 degrees, the material retained its properties and also filled the Oeko-Tex Standard 100 a dry cleaning would still be questionable.

The price-performance ratio is also very easy to use ratio but only in term of comparison with the ratios registered of others companies. The fact that the products are not clearly standing out in the comparison with the competition can be dangerous, especially in a competitive environment

One of the most inexpensive and effective ways for any company to advertise is to advertise through their customers [5]. Because of that, the company organizes promotional events such as modes chows (even abroad) and distributes advertising sales aids, such as on umbrellas and calendars. Unfortunately, the advertising has a low level of awareness. Consequently, we focused on the possibility of recommending further products commercialized by the company. 56% of the questioned customers would recommend the collection in any case. In addition, the assessment of the company's logo was very good and 46% believed it to be good.

In the case of textiles, the best selling mode is to permit the customer to have free access to the products [6], because the customer needs time to evaluate his personal needs to decide whether the product is suitable or not. In this situation, the role of the sales staff is very important because the sales staff must decide after watching the customers, when counseling is unnecessary or undesirable.

The sales staff at the store is very friendly, helpful and has excellent product knowledge. It wears a uniform consisting mostly of several garments like a jacket, vest and pants and a white shirt. The colors used are black and that "dignity and respect" and expresses yellow gold, so festive colors that go well for upcoming occasions such as Christmas and New Year. The uniform is constantly changing after the collection. For the spring and summer, collection the sales staff wears an orange shirt, black pants and vest. Orange is a warm color and means optimism and love for life. This color has built on the human psyche, tonic and health promoting effects. Orange is the color of the young and those that are dynamic in everyday life. Happiness and creativity characterizes these people. Therefore, this color suits the target group between 25, 55 years, and the need to be dynamic in their lives to continue to develop both professionally as well as privately.

When asked what kind of products they would want to see offered by the company, respondents have had the following suggestions: skirts, coats, more summer dresses, summer blouses, suits, trousers in a casual style, shirts, shoes and supplement offerings such as accessories, long skirts, wedding dress, articles of linen and cotton, and skirts with larger sizes. Most suggestions of the women were special offers, discounts, richer offer, and air conditioning in the store, trendier models, and models for overweight people.

The men's responses when asked what they would want for an item found in the collection mentioned: costumes, jackets, belts, ribbons, larger sizes models, bright colors in the costumes, sports shoes, sports clothing more recommendations were: Discounts, Specials.

There are computer-based POS and inventory management systems [7] that are not used in the business, although they allow clarity of stocks and the movement of goods. As a result, you can quickly make a purchase planning and optimize the assortment. If the customer couldn't find a particular item in his size, he should not be sent to other store, but should be provided with the data that the computer checked. Unfortunately, this option is not used. This is a sign of the good fit of the models, and the activity of the testing laboratory [8] hat prevents of using non-quality fabrics. For a high quality service, the retouching is done in their own studio, but only for sleeves and seams and the receipt is valid for 30 days. If something happens, the product is replaced. Most of the complaints relate to the sometimes-difficult fitting of clothing, as it is very hot and the fact that some models had buttons with corners that customers wanted to change. This problem was solved rapidly.

3. CONCLUSIONS

We recommended also more sales training, for the vendors, in order to serve better the customers, regarding the care of textiles and to underline the existence of testing laboratory, and to use it as a competitive advantage. That means, they can use a resource-based reasoning and thus lift both the features and usage possibilities of textiles.

To have an accurate description of the customer demands on the services or products offered, you have several market surveys carried out; otherwise, the term "customer orientation" remains empty. The range of models is not complete, because not all products are in all sizes. The sizes are missing the edge sizes, namely the size 38. Models should be adapted to a larger bust and wider hips and should cover the problem areas simultaneously. As a result, the company will be able to meet the needs of the particular customer group. The models are unique but at a price equal to or less than the price of competitors. They could establish a better market position by using there good connection with the suppliers by computer and the level of awarenessof theire brand. Important is the constant monitoring of transactions in order to adapt to consumer preferences, entering markets such as Moscow finding qualified employees in the area of pattern design, using ISO 9001 quality management and only high quality raw materials and the use of nanotechnology in the mans costumes. The strategic location of the stores, located in one of the most modern department stores on one of the main roads of the city with traffic and easily accessible is one of the key elements of the competitive advantage and the second is the own testing laboratories, which has allowed the number of reclamations to fall down. As weaknesses we point out the weak advertising, and a low adaptability of the management regarding the demand and supply of sizes such as 38, 40, 42, 56, 58, low communication and coordination between the two stores. A not to miss opportunity is the expansion, of the testing laboratory so that multiple test procedures are being performed. The risks shouldn't be undrestimeted like strong foreign competition, reduction of the number of workers, depreciation of the RON against the foreign currency, adjustment to inflation, which has led to higher wage costs, increase in the tax and increase in the cost of gas, water and electricity;

4. REFERENCES

[1]. Lachenmann G. (1993) Warenverkaufskunde, Winklers Publisher
[2]. Balaure V. (2000) (coordonator) *Marketing*, Publisher Uranus, Bucureşti
[3]. Mihuță S. (2005) *Fibre textile: analize fizico-mecanice şi chimice*, Mirton, Timişoara

[4]. Birk F. (1993) *Verkaufsorientierte Textilwarenkunde*, Publisher Gehlen, 1993
[5]. Cersovsky H. (1999) *Wirtschaftslehre Blickpunkt Kunde Warenverkaufskunde im Einzelhandel*, Publisher H. Stam BmbH, Köln
[6]. Corsten H. (1994) *Handbuch Produktionsmanagement. Strategie-Führung-Technologie-Schnittstellen*, Gabler Publisher, Wiesbaden
[7]. Preda C. (1996) *Metode si aparate pentru controlul calitatii materialelor textile destinate confectionarii produselor de imbracaminte*, Publisher Bit, Iaşi
[8]. Baker M.J. (1997) *Marketing*, Publisher Societatea Ştiinţifică şi Tehnică S.A., Bucureşti

ANALYZING COMPARATIVE ADVANTAGE AND COMPETITIVENESS: THE CASE OF ROMANIAN TEXTILE AND CLOTHING INDUSTRY

Simona Tripa[1], **Sunhilde Cuc**[2]

[1, 2] *Faculty of Energy Engineering and Industrial Management, University of Oradea, University Street no. 1-5, Oradea, Romania*

Corresponding author: Simona Tripa, E-mail: tripasimona@yahoo.com
Sunhilde Cuc, E-mail: sunhilde_cuc@yahoo.com

Abstract: Given the importance of Romanian textile industry in the Romanian and European market, this study examines data on textile and clothing sector. The paper estimates the comparative and competitive advantage of the textile and clothing industry using different indicators to measure it. We used the Revealed Comparative Advantage Index (RCA) and Revealed Competitive Advantage Index (CA) as two objects to study the international competitiveness of Romanian textile trade. The analysis is based on the annual time series data on textile and clothing exports and imports, obtained from the World Trade Organization (WTO) Total Merchandise Trade over the period 1990 to 2011. This period was selected as being long enough to permit longer-term trends to be identified, and based on the availability of a complete data set for both of the product groups – textile and clothing. We found out that Romania still has a comparative advantage industry in the world market their clothing but that advantage is dwindling in recent years - since 2002. Regarding the textile industry is a slight diminishing of competitive disadvantage decrease mainly on export growth (especially in textile and nonwoven fabrics impregnated) and the reduce Romania's textile imports in recent years. This reduction of Romania's textile imports was driven mainly by lower apparel exports in recent years - knowing that in Romania most of the production of clothing is made in the tallies.

Key words: Romanian textile and clothing industry, market, comparative advantage, competitiveness, national competitiveness

1. INTRODUCTION

The literature review regarding the analysis of the success of the textile and clothing sector among the principal producers and exporters of textile and apparel products has focused based line on the life cycle of the industry and latest at the level and organization in the linkage and value chains of the sector.

There are studies [1,2,3] that support the idea that, while textile production is likely to raise in relative importance during the early stages of industrialization, its share in industrial output cannot be maintained over the very long run. Entrepreneurs in developing countries are attracted to textile and apparel because they are generally short of capital, labor and utilities are relative low-priced.

With the globalization of apparel production, competition between the leading companies in the industry has intensified as each type of lead company has developed broad global sourcing capabilities. [4] In the recent world of globalization, the value chain of textile industry has become an important scholar topic. The clothing value chain is organized in the order of five key parts: raw material supply, provision of components, production networks, export and marketing networks at the retail level.

After 2005, the textile industry is affected by a drastically changing economic environment as global free trade initiatives provide for unrestricted competition. Most modern approaches on international trade support the necessity of reconsidering the rule of Ricardian point of view regarding comparative advantage and consider more appropriate current economic developments, notions as:

competitive advantage, competitiveness, national competitiveness, etc. [5] As a result, there are a number of studies who have proposed to quantify the competitiveness of this industry.

Many current studies used the Balassa index - Revealed Comparative Advantage (RCA) index and relative Export Advantage (RXA) Suggested by Vollrath - this being the reason behind the choice of using them in our study. Some of these are listed below.

Havrica and Permasiri analysed Australia's comparative advantage and competitiveness in textile and clothing using both metods. The analysis based on Balassa's indices shows that Australia has a strong comparative disadvantage in textiles and clothing as aggregate commodity groups, but there is comparative advantage in sub–categories of „special textile products", „floor coverage, tapestry etc", and „fur clothing" while the analysis based on Vollrath's indices shows that Australia is not competitive in the world market with respect to aggregate commodity groups of textiles and clothing. [6]

Conrad P. Lyford and Welch evaluated the competitiveness of U.S. manufacturers of cotton yarn products compared to international rivals by analyzing the competitive state of this industry and by identifying competitive trends. Using Balassa's RCA they found out that the production of textile products, as a percentage of all manufacturing, is significantly higher in China, Indonesia, and Pakistan than in the United States but also indicated a competitive advantage for the U.S. textile producer in the area of raw material procurement. [7]

YUAN, Tao & XU, Fu presented the powerful advantage of textile industry of China regarding textile trade compared to the world's major developed countries in terms of RCA.. In comparison with developed countries, superiority in China's textile industry is based on traditional comparative advantage rather than competitive advantage, the majority of China's exports in textiles are medium and low quality products, which are labor intensive, low technological and low value added. Developed countries' textile industry's incessant progress in technology, management and productivity will depreciate the advantage of China's competitive advantage of the textile industry. [8]

Utku Utkulu and Dilek Seymen [9] analysed the competitiveness of Turkey with respect to the EU15 state and Karaalp and Yilmaz presented the comparative advantage of the Turkish Textile and Clothing Industry in the Enlarged EU Market, including Romania. [10] Using Balassa's revealed comparative advantage (RCA) index for the period 2000-2010, they also analyzed four countries in the world: Bangladesh, China, Germany and Turkey with respect to the US and the EU-15 textiles and clothing markets. They found that Bangladesh, China and Turkey have a dominant comparative advantage in both the textile and clothing markets of the world, the US and the EU-15, while Germany has no significant comparative advantage in any of these markets. [11]

2. REVEALED COMPARATIVE ADVANTAGE INDEX AND RELATIVE EXPORT ADVANTAGE INDEX

Revealed comparative advantage (RCA) was first formulated by Balassa, in 1965 [12]. RCA is sometimes called the Balassa index. RCA is the ratio between the export share of a given commodity or sector in a country and the export share of that commodity or industry in the global market, as shown in next equation:

$$RCAij = (Xij / Xit) / (Xnj / Xnt) \qquad \textbf{(1)}$$

where X is exports, i is the country, j is the commodity/industry, n is the world or a set of countries, and t is all product groups.

An RCA index greater than 1 (RCA > 1) indicates that the country has a comparative advantage in the commodity/ industry and has a comparative disadvantage when RCA < 1.

There is some criticism of this method of analysis of competitiveness. The RCA has been criticized for taking only the exports into consideration while ignoring the imports. Another objection is the fact that if the country has a "comparative disadvantage" the index ranges from zero to one, whereas if it has a "comparative advantage", the index ranges from one to infinity. [13]

RCA was modified by Vollrath (1991) in order to avoid double counting between pairs of countries. Vollrath's modified version is called the relative export advantage (RXA) measure, as it is based on exports. This calculates the ratio of a country's export share of a commodity in the international market to the country's export share of all other commodities.

$$RXAij = (Xij / Xit) / (Xnj / Xnt) \quad \textbf{(2)}$$

Vollrath offered alternative measures of revealing a comparative advantage which include the effects of both the imports and exports of a country. The relative import advantage (RMA) index is similar to the RXA, but relates to imports (M) rather than exports:

$$RMAij = (Mij / Mit) / (Mnj / Mnt) \quad \textbf{(3)}$$

In this case, an RMA index of less than 1 indicates revealed comparative advantage and thus higher competitiveness.

The difference between the indices is called the relative trade advantage (RTA), a more comprehensive indicator of revealed comparative advantage:

$$RTAij = RXAij – RMAij \quad \textbf{(4)}$$

A positive value of RTA is an indication of comparative advantage.

When RXA and RMA are compared in logarithmic form, they are symmetric at the origin. Their difference is called the revealed competitiveness (RC):

$$RCij = ln\ (RXAij) – ln\ (RMAij) \quad \textbf{(5)}$$

According to Vollrath a positive values of the indices reveals a comparative advantage, while a negative value reveals a comparative disadvantage.[14]

3. METHODOLOGY

The analysis is based on the annual time series data on textile and clothing exports and imports, obtained from the World Trade Organization (WTO) Total Merchandise Trade over the period 1990 to 2011. This period was selected as being long enough to permit longer-term trends to be identified, and based on the availability of a complete data set for both of the product groups – textile and clothing.

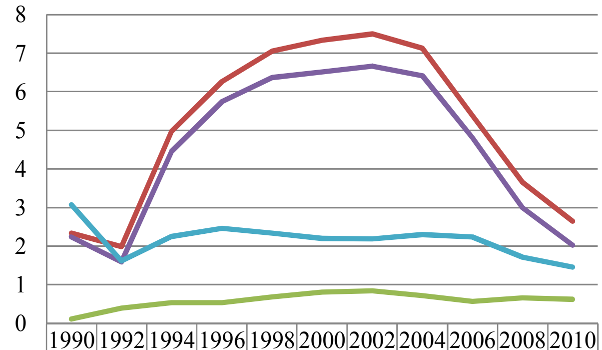
4. APPLICATION OF BALASSA'S AND VOLLRATH'S INDICES TO ROMANIAN TEXTILE AND CLOTHING INDUSTRIES

In this section was calculated comparative advantage in the textile and clothing industries using indexes of developed by Balassa and Vollrath.

Period of our study begins with the start of the Romanian economy transition from a centrally planned to a market economy. Starting with this date begin the privatization of companies in the two sectors analyzed, leading all firms that currently to be privately owned.

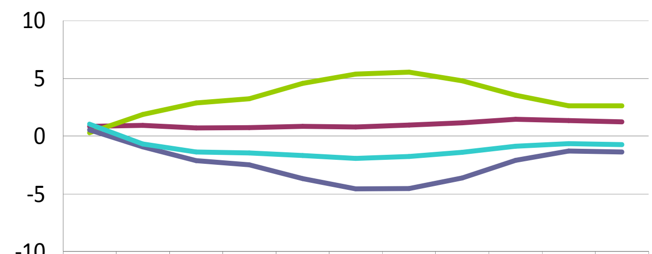
Because the clothing industry is more labor-intensive compared to the textile sector, which is relatively capital- intensive [13] these sectors develop in different directions namely while in the garment sector, private investment significantly increased, investment in the textile sector are insignificant in the early 90s, most of them made by state.

Geographical locations of the Romanian country, cheap and qualified workforce are just some of the factors that favored increased lohn production of clothing and implicit export growth. In this context the garment sector indices recorded annual increases competitiveness by 2004. In the same period is recorded significant increases in textile imports (while exports almost stagnated), which highlighted the values of competition and showing that Romania has the textile industry at a competitive disadvantage in the global market them.



	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010
RCA (BALASSA), RXA (VOLLRATH)	2,33	1,99	4,97	6,27	7,05	7,33	7,5	7,12	5,38	3,65	2,65
RMA (VOLLRATH)	0,11	0,4	0,53	0,53	0,68	0,81	0,84	0,72	0,57	0,66	0,62
RTA (VOLLRATH)	2,23	1,59	4,45	5,74	6,37	6,52	6,66	6,41	4,81	2,99	2,03
Rc (VOLLRATH)	3,07	1,62	2,25	2,46	2,34	2,2	2,19	2,3	2,24	1,71	1,45

Figure 1: Indices for Comparative Advantage and Competitiveness of Romanian Clothing Industries - Balassa's RCA, Vollrath's: RXA, RMA, RTA, Rc



	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010
RCA (BALASSA), RXA (VOLLRATH)	0,83	0,92	0,71	0,73	0,84	0,79	0,95	1,14	1,45	1,34	1,23
RMA (VOLLRATH)	0,29	1,87	2,86	3,23	4,55	5,37	5,51	4,77	3,53	2,64	2,63
RTA (VOLLRATH)	0,54	-0,9	-2,1	-2,5	-3,7	-4,6	-4,6	-3,6	-2,1	-1,3	-1,4
Rc (VOLLRATH)	1,05	-0,7	-1,4	-1,5	-1,7	-1,9	-1,8	-1,4	-0,9	-0,7	-0,8

Figure 2: Indices for Comparative Advantage and Competitiveness of Romanian Textile Industries - Balassa's RCA, Vollrath's: RXA, RMA, RTA, Rc

China's trade liberalization in textiles and clothing in 2005, was reflected in Romanian exports of clothing products - they continuously decreasing after this date.

There are problem due to diminishing of orders or a reduction in their number from foreign clothing firms determining some shift towards the domestic market. Also, by 2008 has occurred an increasing of incomes that support the development of the internal market of garments. This orientation also increased imports of textiles - in the same period.

Moreover, the price of Chinese products resulted in increased imports of clothing from this country and exerting a pressure on domestic firms in the industry.

The global economic crisis began in August 2008, which has spread from the United States around the world, contributed to lower exports and imports both Romania and textile garments. In this context, competitiveness indices of garment industry, continues to fall without someone to do something.

After Balassa and after Vollrath, Romania has a competitive advantage in continuously decreasing since 2002, for clothing products.

Regarding textiles, considering only exports as Balassa RCA Romania recorded since 2004, a slight increase in Romania's comparative advantage in the global market - until then our country with a market disadvantage of these products. Analyzing in terms of Vollrath, both imports and exports of textile of Romania registers a relative disadvantage textile trade throughout the analyzed period, slightly decreasing in recent years.

5. CONCLUSIONS

The comparative advantage of Romania's competitiveness in the global market for textile and clothing products were analyzed by light and Vollrath Balassa indices developed between 1990 and 2010. All indices underline the fact that Romania had a comparative advantage and competitiveness of the clothing products growing up till in 2002 and declining steadily after this year. Regarding the textile products, considering only exports, according to Balassa RCA, Romania registered after 2004 a slight increase Romania's comparative advantage in the global market - until then our country with a market disadvantage of these products. Analyzing in terms of Vollrath, analyzing both imports and exports of textile Romania registers a relative disadvantage textile trade throughout the analyzed period, slightly decreasing in recent years.

From year to year variations in clothing competitiveness indices were higher than those of textiles. After a strong development of the garment sector immediately after the transition to market economy, by 2004, the phenomena appeared during that period have determined competitiveness indices uptrend change of clothing in one descendent. Unlike the garment industry, in the textile industry the growth rate and the decrease rate are moderate, indicating that in this area there were no the spectacular changes from year to year.

Increasing competition from low cost countries, the elimination of quotas and restrictions on textiles and clothing by the WTO and a strong trend in the currency depreciation influenced indices comparative advantage and competitiveness in the world market of Romania of the two sectors.

Textile and clothing industry from Romania should increase productivity in both sectors, produce under its own brand and to specialized production to move towards higher value-added production through innovation and research - development and design.

Romania should capitalize more of its geographical position, membership of the EU market, infrastructure in garment sector, highly skilled workforce.

6. REFERENCES

[1]. O'brien, Patrick; Griffiths, Trevor; Hunt, Philip, Political components of the industrial revolution: parliament and the English cotton textile industry, 1660-1741. *The Economic History Review*, 44. Jg., Nr. 3, pp. 395-423, ISSN 1468-0289, 1991

[2]. Heertje, Arnold, and Mark Perlman, eds. *Evolving Technology and Market Structure: Studies in Schumpeterian Economics*. University of Michigan Press, 1990.

[3]. Singleton, John. *The world textile industry*. Vol. 1. Routledge, 1997.

[4]. CUC, Sunhilde, Simona TRIPA, USING THE GLOBAL VALUE CHAIN APPROACHES IN THE CLOTHING INDUSTRIE, *ANNALS of the ORADEA UNIVERSITY. Fascicle of Management and Technological Engineering*, Volume VII (XVII), pp. 2086-2090, 2008

[5]. Cosmin MARINESCU, Gabriel STAICU, Avantajul competitiv: judecati, economice si implicatii politice, Revista oeconomica, pp.91-109, Anul XV, nr.2/2006

[6]. Havrila, Inka and Gunawardana, Pemasiri, Analysing Comparative Advantage and Competitiveness: An Application to Australia's Textile and Clothing Industries, *Australian Economic Papers*, Vol. 42, pp. 103-117, 2003

[7]. Conrad P. Lyford, J. Mark Welch, Measuring Competition for Textiles: Does the U.S. Make the Grade?, Selected Paper prepared for presentation at the Southern Agricultural Economics Association Annual Meeting in Tulsa, Oklahoma, February 18, 2004, availble at http://ageconsearch.umn.edu/bitstream/34616/1/sp04ly01.pdf, Accessed: 14/03/2013

[8]. YUAN, Tao & XU, Fu, China's Textile Industry International Competitive Advantage and Policy Suggestion, *Journal of the Washington Institute of China Studies*, Vol. 2, No. 1, pp. 84-97, Spring

2007
[9]. Utkulu, Utku, and Dilek Seymen. Revealed Comparative Advantage and Competitiveness: Evidence for Turkey vis-à-vis the EU/15, *European Trade Study Group 6th Annual Conference, ETSG* Nottingham, September 2004, availble at: http://www.etsg.org/ETSG2004/Papers/seymen.pdf, Accessed: 18/04/2013
[10]. Karaalp HS, Yilmaz ND, Assessment of Trends in the Comparative Advantage and Competitiveness of the Turkish Textile and Clothing Industry in the Enlarged EU Market, *FIBRES & TEXTILES in Eastern Europe,* 20, 3(92), pp. 8-12, 2012
[11]. Karaalp HS, Yilmaz ND., Comparative Advantage of Textiles and Clothing: Evidence for Bangladesh, China, Germany and Turkey, *FIBRES & TEXTILES in Eastern Europe*, Vol. 21, No. 1 (97), pp.14-17, 2013
[12]. Balassa, B., Trade liberalization and revealed comparative advantage, *The Manchester School of Economic and Social Studies*, Vol. 33, No. 1, pp. 99-123, 1965
[13]. Chi T., Kilduff P., An assessment of trends in China's comparative advantages in textile machinery, man-made fibers, textiles and apparel, *Journal of the Textile Institute*, Volume 97, Issue 2, pp.173-191, 2006
[14].Vollrath, T.L., A theoretical evaluation of alternative trade intensity measures of revealed comparative advantage, *Weltwirtschaftliches Archiv*, Vol. 130, pp. 265-279, 1991

COMPOSITE POLYACRYLONITRILE NANOFIBERS POSSESSING POTENTIAL USE IN FILTRATION

O. B. Berkalp[1], U. K. Sahin[1], I. Gocek[1], R. Keskin[2], N. Acarkan[3], S. Ozkan[1], C. D. Dikmen[4], E. Daskaya[1], H. Saglam[1]

[1] *Istanbul Technical University, Dept. of Textile Engineering, Istanbul, TURKEY*
[2] *Pamukkale University, Dept. of Textile Engineering, Denizli,TURKEY*
[3] *Istanbul Technical University, Dept. of Mineral Processing Engineering, Istanbul, TURKEY*
[4] *Istanbul Technical University, Dept. of Food Engineering, Istanbul, TURKEY*

Corresponding author: U. Kivanc Sahin, E-mail: sahinumut3@itu.edu.tr

Abstract: Electrospinning process is utilised to fabricate submicron level fibrous mats that can be easily used as filter media due to their high filtration efficiency and low air resistance. Therefore, the goal of this study is design and fabrication of electrospun composite-structured polyacrylonitrile (PAN) nanofibrous mats possessing small pores and well-dispersed nanoparticles in the polymeric matrix. For the fabrication of these composite nanofibrous mats, fiber grade PAN was utilised as the polymeric matrix. 8 wt.%, 10 wt.%, 12 wt.% and 14 wt.% solutions of PAN were prepared in N,N-dimethyl formamide (DMF), and mixed with different weight percent coal nanoparticles such as 0, 0.5, 1, 1.5 and 2%. PAN was selected as the polymer for the fabrication of the nanofibrous mats due to its versatility to easily fabricate electrospun mats, hydrophobicity, and also insolubility in a wide range of solvents. After submicron level coal particles were blended mechanically with the PAN solutions prepared, ultrasonication was used to better disperse the filler particles in the solution of the polymeric matrix. Voltage, polymer solution flow rate and the distance between the syringe and the collector during electrospinning were considered as constant parameters. Twenty different nanofibrous nanocomposite mats were manufactured for assessing the manufacturability of PAN nanofibers containing coal particles and analyses were conducted on these electrospun nanofibrous mats for demonstrating their potential application as filter media.

Key words: Filtration, electrospinning, coal, nanocomposite, polyacrylonitrile, nanoparticle reinforcement.

1. INTRODUCTION

Nanotechnology is one of the fastest developing disciplines of science because of its high potential to fabricate new advanced materials and to bring out new applications to these novel materials in the fields of science and engineering such as polymer science, materials science, electronics, textile science, mechanical engineering etc.

There are numerous studies in the scientific literature covering electrospinning process and its applications to different fields. Electrospinning is the process capable of producing submicron fibers by the use of electrostatic forces applied on the polymeric solution. It is a versatile technique to utilize wide range of polymers to produce fibers with a consistency in obtaining these fibers at submicron level. When the fiber diameter decreases, surface area of the fibers becomes higher than that of regular fibers and the surfaces obtained by these fibers have smaller pores compared to the surfaces obtained by regular fibers, which helps to create new applications in nanocatalysis, biomedical applications (tissue scaffolds, bandages, drug release systems), protective clothing, filtration, as well as optical electronics, photonic crystals, flexible photocells [1- 9].

Fibrous materials are utilized in filtering applications with the advantages of high filtration efficiency and low air resistance. Filtration fineness is one of the considerable measures of filter media performance. One of the ways of fabricating highly efficient and effective filter media is to utilize submicron scaled fibers in the structure of filter having porous structure that can capture the particles or droplets by its similar sized pores with the size of these particles and droplets. Since fibers in the structure of filters possessing electrospun nanofibrous webs have very high surface area-to-volume ratio and as a result high surface cohesion, very small particles having size smaller than 0.5µm can be captured by these filters, which results in improvement of the filtration efficiency [3, 5- 9].

Studies in the literature reveal that electrospinning is a promising technology to fabricate high performance nanoparticle filters. In one of the studies, filtration characteristics of electrospun nanofibers were analysed after producing nanofiber webs of different area weight on the spunbonded and meltblown sublayers. The results of the measurements of the experimental work regarding fiber diameter, pore diameter, filtration efficiency and filtration resistance of nanofibers revealed that fiber diameter of nanofibers, pore diameter of nanofibers and coefficient variation of pore diameter of nanofibers were much lower than those of sublayers. Also, filtration efficiency and filtration resistance for nanofiber mats were found to be higher than those of sublayers [3]. In one other study, 3D filtration model for nanofibrous filters was developed and tested with experimental results. By utilizing electrospinning technique two polyurethane nanofiber web layers were fabricated with identical average fiber diameter and different average pore sizes in order to produce nanofiberbased filters and filtration properties of these filters were analysed in the ultrafine particle size range (20–400 nm). The proposed model was tested according to the measured filtration efficiency, pressure drop and quality factor for entire tested filter samples [10]. Another research includes production of polystyrene (PS) nanofibers from recycled expanded PS (EPS) by using electrospinning technique. Glass fibers in micron scale were used to be blended with these nanofibers for the modification of glass fiber filter media. This modified filter was analysed for water-in-oil emulsion separations which can be encountered in petrochemical industry. The nanofibers obtained in that study with a diameter around 600 nm were found not only to enhance the separation efficiency (coalescence efficiency) of the conventional micron sized fibrous filter media but also to increase the pressure drop of the filters [11].

PAN is a polymer widely used in filtering applications as the filtering media raw material especially in electrospun filters due to its versatility to easily fabricate membranes, hydrophobicity, and also insolubility in a wide range of solvents [12]. There are different studies in the scientific literature regarding electrospinning of polyacrylonitrile (PAN) polymer. In one of the studies electrospinning was utilized to manufacture PAN fiber mats having mean fiber diameters in 270–400 nm range as filter media and the produced fiber mats were assessed in terms of their filtration performance by experimental analysis with the help of nanoparticles. For the performance analysis penetration of monodisperse NaCl nanoparticles that were below 80 nm in size were measured through the filters. The calculations regarding the size distribution of electrospun fibers, pressure drop across the filter media, hydraulic permeability, nanoparticle penetration, quality factor, and single fiber collection efficiency were done by analyzing the electrospun filters of different thickness, and also the fabricated electrospun filters were compared with commercial filters according to the results of these calculations. Fiber diameters of the produced filters were found to be more uniform than the fiber diameters of the commercial filters produced from polyolefin and glass. According to the results of this study when the filter thickness was increased by the control of collection time during the electrospinning process, the penetration of nanoparticles through the electrospun filter media was found to decrease. It was also found that collection of nanoparticles by electrostatic forces could be ignored for electrospun filtering media, and for the electrospun filters it was obtained that filter quality factors and single fiber collection efficiencies were not dependent on filter thickness [12]. In another study, PAN was electrospun into nanofibers by adding LiCl into the electrospinning process in order to analyze the effect of the addition of LiCl to the PAN solution on the diameter. According to the results of the study the radius of jet was found to be dependent on the content of LiCl added to the solution due to the higher sharpness of the decrease of the electricity potential with high content of LiCl than with low content of LiCl during the movement of charged fibers. In the experimental work done in this study not only the jet instability was found to occur earlier but also the stability length of electrospinning jet was found to decrease with the higher content of LiCl [13]. The other study involves production of nanofibrous membranes with different fiber diameters, diameter distributions and membrane thicknesses to observe the influence of electrospun nanofibrous structures on the filtration performance for water purification. The membrane produced was analysed on the removal of the micron-sized particles and E. coli from contaminated water. According to the results a strong correlation was obtained between the structural parameters of the web (i.e. average fiber diameter, fiber diameter size distribution, membrane thickness and porosity) and microfiltration performance. The membrane had a composite structure possessing electrospun polyacrylonitrile (PAN) barrier scaffold layer and non-woven polyethylene terephthalate (PET) substrate layer. These materials provided good mechanical and thermal stability as well as solvent resistance to the membranes. According to the comparison of the produced PAN/PET electrospun membrane with commercial microfiltration (MF) membrane having the identical mean pore size, the membrane fabricated was shown to have better performance with two to three times higher flux meaning that they were suitable materials for high-flux MF applications [14]. In one of the studies PAN nanofibrous mats were produced and functionalized with polyhexamethylene guanidine hydrochloride (PHGH) to make the mats gain applicability in the area of water filtration systems and medical devices. Antibacterial and easy-clean performances of the nanofibrous mats were assessed. According to the results of the study, nanofibrous mats modified with PHGH were very effective against both Gram-positive S. aureus and Gram-negative E. coli. In addition to this, mats immobilized with PHGH displayed pure water fluxes and relative flux recovery meaning that the produced membrane had multifunctionality of antibacterial efficacy and easy-cleaning property providing it a potential to be used in water filtration systems, medical devices and protective textiles [15].

2. EXPERIMENTAL

2.1 Materials

Coal was supplied in nanometer size, and used as supplied. High molecular weight fiber-grade PAN was kindly supplied by Aksa, Turkey and used as received. DMF was supplied by Merck.

2.2 Preparation of Nanoparticle Reinforced Polymer Solutions

Selected concentrations of polymer were separately dissolved in DMF by vigorously stirring at room temperature for at least one hour, depending on the concentration. After observation of total dissolution, pre-determined amount of coal was added portionwise into the solution while stirring at room temperature. In order to increase dispertion of coal throughout the solution, ultrasonication was applied for 15 minutes at selected levels of agitation.

Table 1: Concentrations of PAN and coal in solutions

Sample ID	PAN (wt%)	Coal (wt%)
1	8	0
2	8	0.5
3	8	1.0
4	8	1.5
5	8	2.0
6	10	0
7	10	0.5
8	10	1.0
9	10	1.5
10	10	2.0
11	12	0
12	12	0.5
13	12	1.0
14	12	1.5
15	12	2.0
16	14	0
17	14	0.5
18	14	1.0
19	14	1.5
20	14	2.0

2.3 Electrospinning of PAN Mats

Electrospinning uses an electric field to draw a polymer melt or polymer solution from the tip of a capillary to a collector. A voltage is applied to the polymer, which causes a jet of the solution to be drawn toward a grounded collector. The fine jets dry to form polymeric fibers, which can be collected as a web. In this study, 18-20kV of voltage, 13-15 cm of distance between the syringe and the collector, and 1mL/hr polymer flow rate were applied.

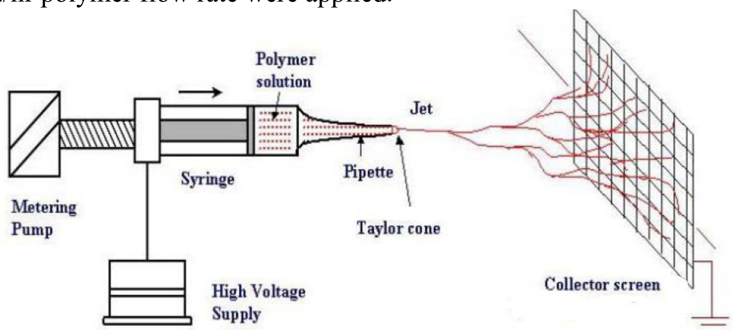


Figure 1: Schematic view of the electrospinning set-up used [2].

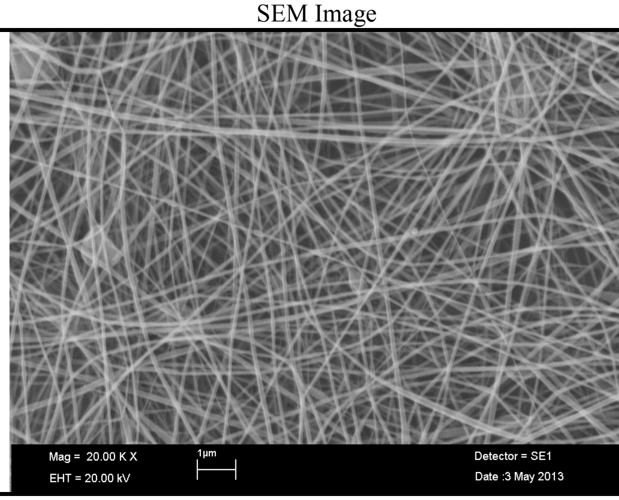
2.4 Characterization

Since the main focus of this study was to investigate the distribution of coal in PAN to show its potential use in filtration applications, all samples were thoroughly investigated under SEM, and images were taken where a clear general representation of distribution was observed. Also for the verification of coal incorporation to the structure of nanofibrous membranes, other characterization techniques were utilised.

3. RESULTS AND DISCUSSION

Some of the images out of those taken from different samples were selected in order to represent the distribution of coal among PAN, which are given in Table 2 below. It is apparent from the images that a very good distribution was achieved throughout the experimental levels applied, i.e. from 0.5 to 2.0 % of coal concentration in PAN. Moreover, it appears that coal particles are covered well with the polymer resulting in a continuous matrix without causing significant increase in the thickness of the nanofibers.

Table 2: SEM images to represent distribution of coal

Sample ID	SEM Image	Coal (wt%)
1		0

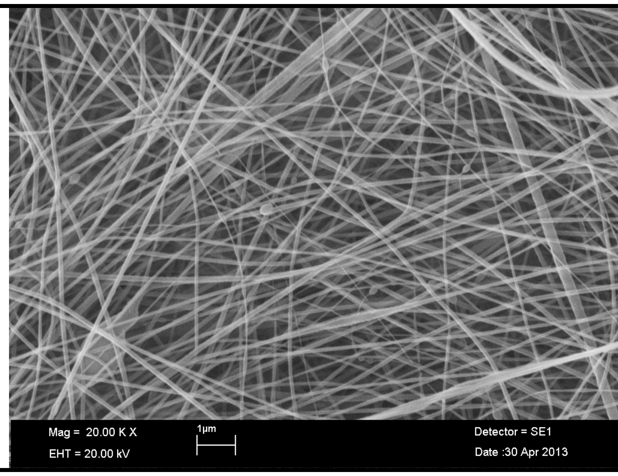
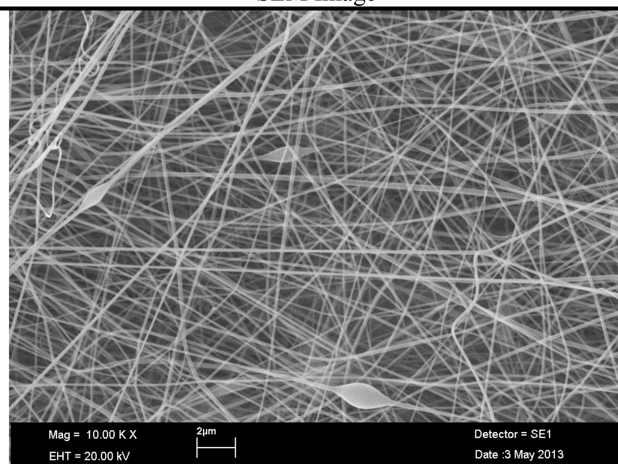
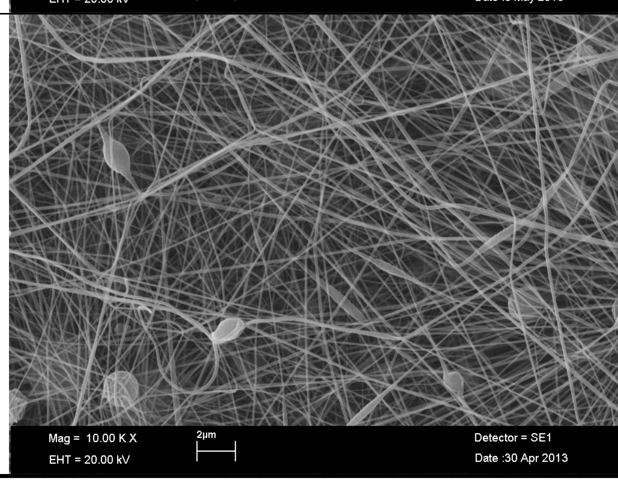
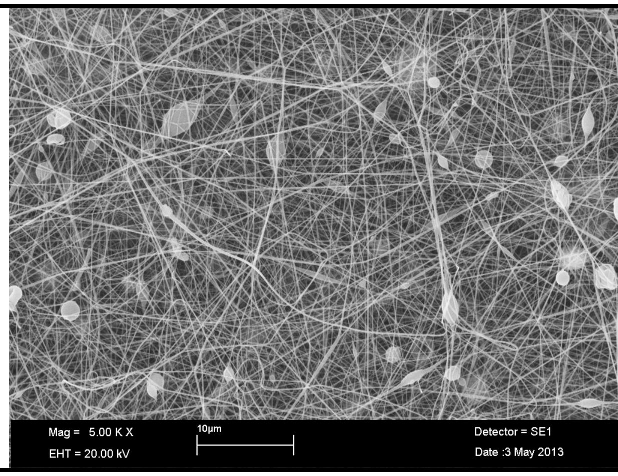
2		0.5

Table 2: SEM images to represent distribution of coal (continued)

Sample ID	SEM Image	Coal (wt%)
3		1.0
4		1.5

5		2.0

4. CONCLUSIONS

PAN nanofibrous mats were fabricated by electrospinning process. Electrospinning process parameters were chosen as constants. Polymer and coal concentrations were varied and their effects were investigated in this study. SEM images showed that a very good distribution was achieved throughout the experimental levels applied. Moreover, it appears that coal particles are covered well with the polymer resulting in a continuous matrix without significantly increasing the thickness of the nanofibers.

5. REFERENCES

[1]. Subbiah, T., Bhat, G. S., Tock, R. W., Parameswaran, S. & Ramkumar, S. S. (2005). Electrospinning of Nanofibers, *Journal of Applied Polymer Science,* 96, 557–569.

[2]. Grafe, T. & Graham, K. (2002). Polymeric Nanofibers and Nanofiber Webs:A New Class of Nonwovens, *Proceedings of INTC 2002: International Nonwovens Technical Conference (Joint INDA – TAPPI Conference)*, Atlanta, Georgia.

[3]. Qin, X.H. & Wang, S.Y. (2006). Filtration Properties of Electrospinning Nanofibers, *Journal of Applied Polymer Science*, 102, 1285–1290.

[4]. Hellmann, C., Belardi, J., Dersch, R., Greiner, A., Wendorff, J.H. & Bahnmueller, S. (2009). High Precision Deposition Electrospinning of nanofibers and nanofiber
Nonwovens, *Polymer,* 50 (2009) 1197–1205.

[5]. Bhardwaj, N. & Kundu, S.C. (2010). Electrospinning: A fascinating fiber fabrication technique, *Biotechnology Advances,* 28, 325–347.

[6]. Subbiah, T. (2004). *Development of Nanofiber Protective Substrates,* M.Sc. Thesis, Graduate Faculty of Texas Tech University.

[7]. Huang, Z.M., Zhang, Y.Z.,Kotaki, M. & Ramakrishna, S. (2003). A review on polymer nanofibers by electrospinning and their applications in nanocomposites, *Composites Science and Technology*, 63, 2223–2253.

[8]. Grafe, T. H. & Graham, K. M. (2003). Nanofiber Webs from Electrospinning, *Proceedings of Nonwovens in Filtration - Fifth International Conference,* Stuttgart, Germany.

[9]. Graham, K., Ouyang, M., Raether, T., Grafe, T., McDonald, B. & Knauf P. (2002). Polymeric Nanofibers in Air Filtration Applications, *Proceedings of Fifteenth Annual Technical Conference & Expo of the American Filtration & Separations Society*, Galveston, Texas.

[10]. Sambaer, W., Zatloukal, M. & Kimmer, D. (2012). 3D air filtration modeling for nanofiber based filters in the ultrafine particle size range, *Chemical Engineering Science,* 82, 299–311.

[11]. Shin, C., Chase, G.G. & Reneker D.H. (2005). Recycled expanded polystyrene nanofibers applied in filter media, *Colloids and Surfaces A: Physicochem. Eng. Aspects*, 262, 211–215.

[12]. Yun, K.M., Hogan, C.J., Matsubayashi, Y., Kawabe, M., Iskandar, F. & Okuyama, K. (2007). Nanoparticle filtration by electrospun polymer fibers, *Chemical Engineering Science,* 62, 4751 – 4759.

[13]. Qin, X.H., Wang, S.Y., Sandra, T. & Lukas, D. (2005). Effect of LiCl on the stability length of electrospinning jet by PAN polymer solution. *Materials Letters,* 59, 3102 – 3105.
[14]. Wang, R., Liu, Y., Li, B., Hsiao, B.S. & Chu, B. (2012). Electrospun nanofibrous membranes for high flux microfiltration, *Journal of Membrane Science,* 392– 393, 167– 174.
[15]. Mei,Y., Yao, C., Fan, K. & Li, X. (2012). Surface modification of polyacrylonitrile nanofibrous membranes with superior antibacterial and easy-cleaning properties through hydrophilic flexible spacers, *Journal of Membrane Science,* 417–418, 20–27.

ACKNOWLEDGMENT

The authors would like to sincerely express their highest appreciations and gratitudes to Dr.Filiz Altay for her support during the conduction of this study.

ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

ULTRAVIOLET PROTECTION OF SEAWEED THREADS IN TEXTILES

J. Campos[1], P. Díaz-Garcia[2], I. Montava[3], M. Bonet[4], E. Bou-Belda[5]

[1, 2, 3, 4, 5] *Departamento de Ingeniería Textil y Papelera, Escuela politécnica superior de Alcoy, Universidad Politécnica de Valencia, ESPAÑA*

Corresponding author: Pablo Díaz García, E-mail: pdiazga@txp.upv.es

Abstract: Solar radiation that we perceive has increased in recent times and especially during the last years. This is due largely to changing lifestyles and the decrease of the ozone layer. For this reason has increased social awareness about the need for protection against ultraviolet radiation. Since 20 years ago, and especially during the last years, the research of textiles protection has increased exponentially. The main areas under investigation are the structure of the fabric, the materials used, the weight of the fabric, the title of the yarns, the color of the fabric, and some finishings which are subjected the fabric to improve their characteristics.
Also, the different ways to evaluate the UPF are under research. The most used system is the spectrophotometric method, although in vivo method and dosimetric systems are used too. In recent years, the dosimetric methods are being studied depth with new photo-sensible materials.
In this paper an evaluation of different weft density and materials is done. First of all a weft density study is made to test what importance has as structural parameter. Then is made a study of three different materials like cotton, polyester and seaweed. That study concludes that the most important material of those three is the last one.

Key words: UPF, ultraviolet, UV lamp, seaweed.

1. INTRODUCTION

For some time, especially in the last 30 years a change in lifestyle and aesthetic standards has been. This has increased significantly the exposure time outdoors and therefore the skin exposure to solar radiation. Exposure to small doses of sun is beneficial for the body and it helps to build bones and vitamins assimilation, but prolonged exposure increase the risk of permanent damage to the skin caused by ultraviolet radiation.

Therefore, to take into account measures of protection against ultraviolet radiation, several organizations among which is the World Health Organization (WHO), recommend the use of garments with a high protection factor, which do not adhere to the body and cover it completely [1-4].

Ultraviolet radiation is the only factor which has shown a direct relationship with skin cancer, and although there are various artificial sources that emit ultraviolet radiation, the most important source of this type is sun radiation. For that reason a lot of studies have been developed. Those studies are related to research about alternative methods for determining the ultraviolet protection factor. The most used method is the spectrophotometric method because is reproducible and internationally accepted. [5] Other studies employ chemical dosimeters to obtain the amount of radiation absorbed by the textile [6, 7], and other methods are performed in vivo using persons in the tests. [8]

In the previous paper, an alternative method was explained. That method decreases the measurement error, and was totally reproducible because the measurement area is 100 times bigger than the spectrophotometric method. [9]

2. OBJECTIVE

The first norm that shows the importance of protection against ultraviolet radiation from the sun is the standard AS / NZS 4399:1996. From that date until today a lot of studies have been done to know the parameters of the fabric that have the most influence.

The parameters studied extensively are the inherent to textiles such as the structure of the fabric, the materials used, the weight of the fabric, the title of the yarns and the color of the fabric. More recently, the research groups has started to study the different fibers and finishings that can be applied on textiles to modify its properties and increase the amount of ultraviolet radiation that can be absorbed.

The main objective of this work is to perform a study of seaweed as a new material that could be used in garments with ultraviolet protection.

3. EXPERIMENTAL

3.1. Materials

In this study a total of 18 samples have been evaluated. These samples were chosen by varying the composition, and weft density in order to obtain a large sample range. The construction of the fabric is the same for all samples. The three materials evaluated are cotton, poliester and seaweed. The weft density employed was 10 and 5 weft/cm.

Table 1: Samples description

Weft/cm	Material	Composition (%)
10	Poliester	100
5	Poliester	100
5	Seaweed/ Poliester	50/50
10	Seaweed / Poliester	50/50
10	Seaweed / Poliester	70/30
5	Seaweed / Poliester	70/30
5	Seaweed / Poliester	80/20
10	Seaweed / Poliester	80/20
10	Cotton	100
5	Cotton	100
5	Seaweed/Cotton	50/50
10	Seaweed/Cotton	50/50
5	Seaweed/Cotton	70/30
10	Seaweed/Cotton	70/30
10	Seaweed/Cotton	80/20
5	Seaweed/Cotton	80/20
5	Seaweed	100
10	Seaweed	100

3.2. Methods

The method to evaluate the ultraviolet protection factor was exposed in previous paper [9] and it is composed of an UV lamp, a digital detector of UV radiation and an opaque box. The UV-lamp irradiates at 312 and 365nm, which belongs to UVB and UVA radiation severally. The detector of ultraviolet rays is found perpendicular to the UV-lamp and the fabric is above it. The system is into an opaque box to avoid lighting interferences.

4. RESULTS AND DISCUSSION

It is well known that the most important parameters are the structure of the fabric, the weight of the fabric and the title of the yarns. Hence the most important parameters are those related to the structure of the fabric. But there are a lot of constraints because at the summer when is more necessary a huge ultraviolet protection, the garments are lighter. Therefore is necessary to find new materials or finishings that could improve the ultraviolet protection factor of the garments.

In that paper is under study seaweed as a new material that could improve the ultraviolet protection factor against common fibers like cotton or polyester.

Firstly is made a study of weft density. As others papers conclude the most important parameters in the ultraviolet protection factor are related to the textile structure. In that paper weft density is studied. There are two different densities, 10 and 5 weft/cm. As can be seen in the figure 1, all samples provide more protection against ultraviolet radiation whit the high density.

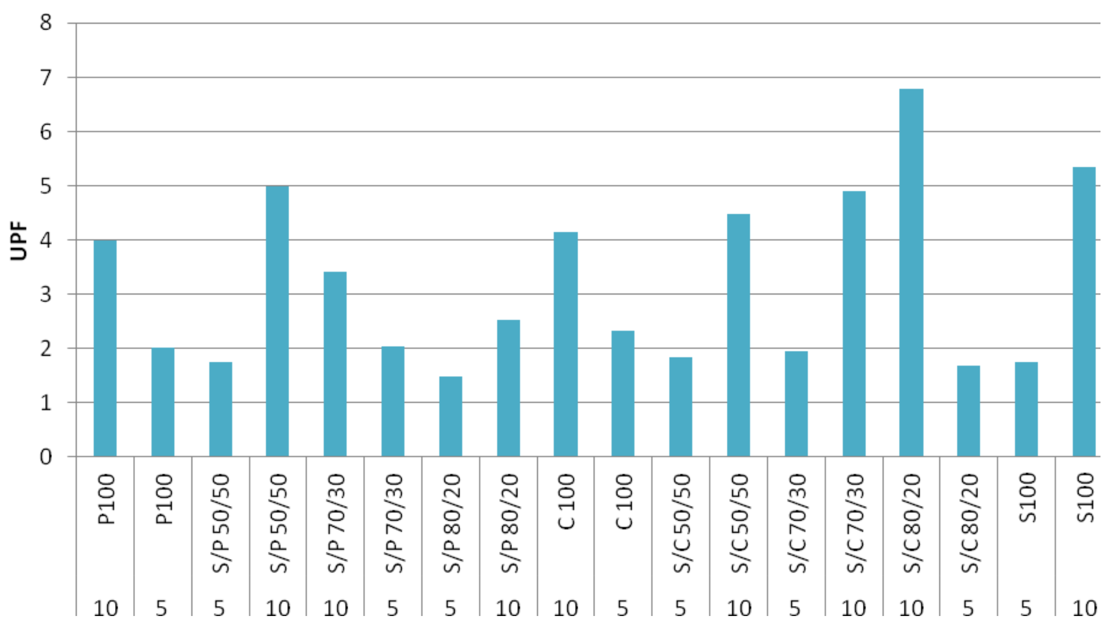


Figure 1. Comparison of weft density.

Once it has been found that structural parameters have the most influence on the UPF, the aim of that study is prove that the seaweed as a thread could increase the UPF value of the textile.

To test that hypothesis is necessary compare the samples with the same structural parameters, so the next test will be performance with the same weft density. For that purpose it has to be separate the samples into two groups.

As figure 2 shows there is a correlation between the material used and the UPF value. The samples which have greater composition of seaweed have the greater values of UPF. The samples with a composition 100% of the same material have serious differences between them. The material wich has the higher UPF value is seaweed and then cotton and polyester have similar values. As can be seen in the figure, the sample composed 100% of seaweed has an UPF value around 6 while the samples composed completely of cotton and polyester have an UPF value around 3,5. The seaweed sample has an UPF of approximately twice than the samples composed by cotton or polyester.

Pointing the samples with highest UPF values, as can be seen in figure 2, the combination of 80% seaweed with 20% cotton improves the protection against UV radiation a little than a sample 100% seaweed.

Although seaweed absorb more quantity of UV radiation than cotton or polyester, a combination of materials including seaweed in it, could improve the absorb properties of the seaweed. The combination seaweed/cotton has bigger UPF values than the combination seaweed/polyester. Besides is important the percentage of mixed fibers in each sample because the more quantity of seaweed it has, the higher values of UPF it has.

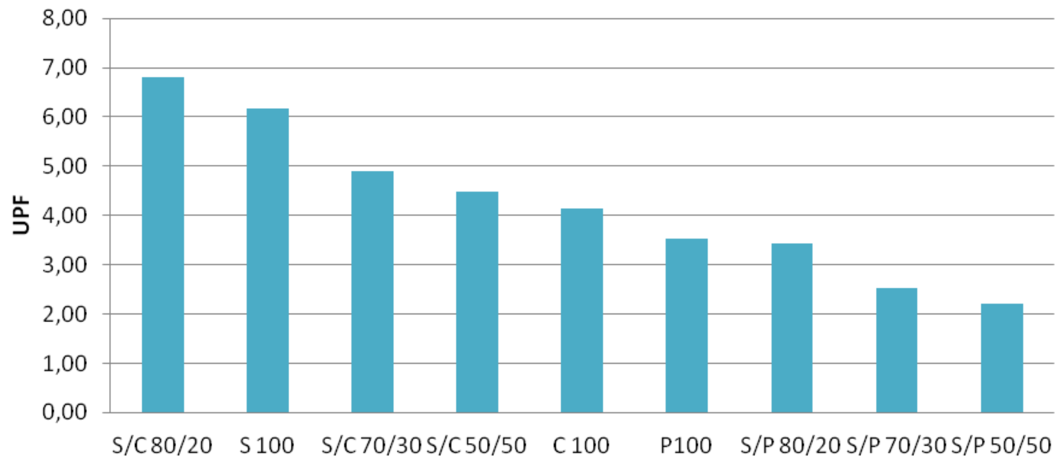


Figure 2: Material comparison in textiles with high weft density (10weft/cm)

As figure 3 shows, the results are similar to the results obtained with the high weft density samples. At high weft density samples, the seaweed samples have bigger UV protection than other materials. Low weft density samples confirm that results because the sample composed 100% of seaweed has an UPF value around 2,3 whilst the samples composed 100% of cotton and polyester have an UPF value around 1,75. Therefore composite samples of seaweed have greater protection than other material samples.

As can be seen in figure 3, the samples composed of seaweed/cotton have bigger UPF values than the seaweed/polyester composition so could be an addition effect of UV protection with seaweed and cotton mixed. Furthermore, the more percentage of seaweed the textiles have the higher values of UPF they have.

There is a difference between two figures, at high weft density textiles the highest UV protection is provided by a composition 80/20 Seaweed/cotton, while at low weft density samples the highest protection is provided by the sample 100% seaweed.

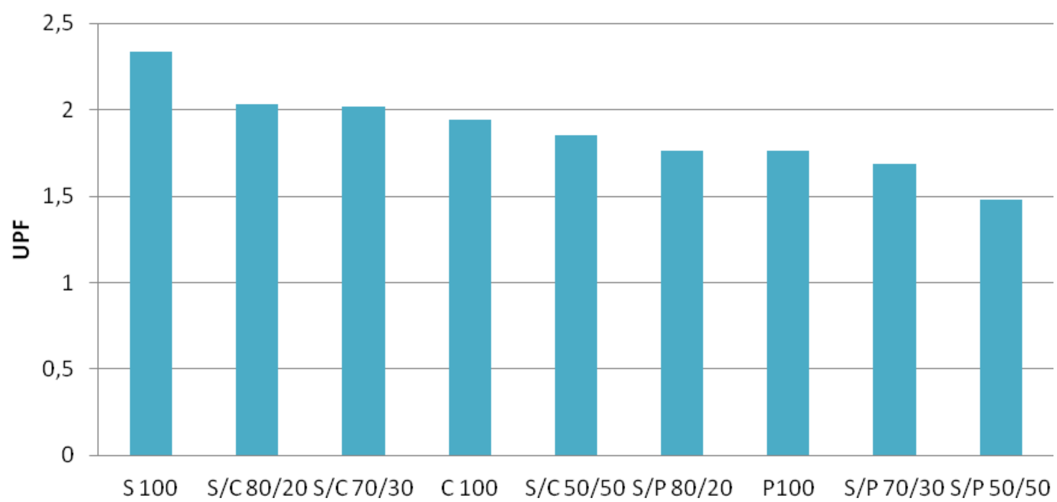


Figure 3: Material comparison in textiles with low weft density (5weft/cm).

5. CONCLUSIONS

- The parameters which have the most influence on ultraviolet protection are the structure of the fabric, the weight of the fabric, and the title of the yarns.
- Due to structure constraints materials and finishings are two of the most areas under investigation.

- There are fibers that have an important rol because those materials could improve the protection factor against the ultraviolet radiation. Those fibers could absorb more UV radiation than common fibers.
- At high weft density the protection against UV radiation is bigger tha a low weft density because the textile is thicker. Hence the structure of fabric is one of the most important parameters that influencing on UPF.
- The extent of protection against UV radiation obtained by the samples with no mixed composition, follows the decreasing order: seaweed>cotton>polyester.
- Textiles with no mixed composition made by cotton and polyester have similar values of UPF.
- The samples with mixed composition wich contain at least 70% of seaweed combined with cotton shows bigger UV protection than other samples. So seaweed has more influence on UPF than other materials, and in addition mixed with cotton the samples increase their UV absorbing ability.

6. REFERENCES

[1] Ferrini R.L., Perlman M, Hill L., Skin Protection from Ultraviolet Light Exposure American College of Preventive Medicine Practice Policy Statement, *Available from:* http://www.acpm.org, Accessed: 11/02/2012

[2] Gambichler, T., Altmeyer, P., Hoffmann, K. Comparison of methods: determination of UV protection of clothing, *Recent Results Cancer Research*, Nº160 (2002) pp.55-61.

[3] Tenkate, T.D., Ultraviolet Radiation: Human Exposure and Health Risks, Environmental Health, Vol 61 (September 1998), nº 2, 9-15.

[4] World Health Organisation, Protection Against Exposure to Ultraviolet Radiation, *Available for:* http://www.who.int, Accessed: 23/01/2012

[5] Textiles - Solar UV protective properties. EN 13758-1.

[6] Wilson, C.A. y Parisi, A.V. Protection from Solar Erythemal Ultraviolet Radiation – Simulated Wear and Laboratory Testing, Textile Research Journal, Vol. 76(3),2006, pp.216–225

[7] Kozicki M., Sasiadek E., Textile UV detector with 2,3,5-triphenyltetrazolium chloride as an active compound, Radiation Measurements, Vol 46,2011, pp. 510-526

[8] T. Gambichler, K. Sauermann, M. A. Altintas, V. Paech, A. Kreuter, P. Altmeyer, K. Hoffmann, Effects of repeated sunbed exposures on the human skin. In vivo measurements with confocal microscopy, Photodermatology, Photoimmunology & Photomedicine, Vol 20, 2004, pp. 27-32.

[9] Campos J., Díaz P., Montava I., Bonet M., Comparison of two methods for determining UPF, Annals of the University of Oradea fascicle of textiles-leatherwork, Oradea, 2012.

THERMAL CONDUCTIVITY OF THE REGENERATION WASTE TEXTILES USED TO THERMAL INSULATION

Gheorghe Horga[1], Mihaela Horga[1], Ioan Hossu[1], Dorin Avram[1], Florin Breaban[2]

[1] « Gheorghe Asachi » Technical University of Iaşi, Faculty of Textiles,Leather Engineering and Industrial Management, Iasi, ROMANIA
[2] Univ Lille Nord de France, F-59000 Lille, France, UArtois, LGCgE,IUTB-CRITTM2A /S2T-EHVL F-62400 Béthune, FRANCE,

Corresponding author: Gheorghe HORGA, E-mail: horga_gheorghe@yahoo.com

Abstract: This paper presents theoretical and experimental studies on the behavior thermal conductivity of textiles made from regeneration fiber used to make the shells for insulation of pipelines. Was investigated the behavior of textile fibers regeneration at densities, temperatures and different layer thickness, in two structures: material in the form of fibers in the form of flock, named blanket and textile material in the form of fiber layer consolidated named, no woven material.
Measurements were carried out with modern equipment of high precision and standardized methods, in the laboratory LGCgELaboratoireGénie Civil et geo-Environnement, Université d'Artois, Faculté des Sciences Appliquées Béthune, France.
Measurement of thermal conductivity is through "flow meter method" governed by ISO 8301: 1991
“Thermal insulation - Determination of steady-state thermal resistance and related properties - Heat flux meter apparatus”. Flux meter method is based on determining unidirectional heat flow density, constant in time and uniform in space, which crossing simultaneous measuring the center of the test piece plane, between two flat surfaces isothermal, with temperatures set T_1 and T_2, such as $T_2 < T_1$.
Textile materials which have been tested, the layer obtained from regeneration fibers in the form of flock and the consolidated fiber layer used in the insulation thermic, may be a basic resource as the raw material which comes in large part from recycled textile and have thermal conductivity more little than 0,06 [W/mK].

Key words: thermal conductivity, textile fibers regeneration, consolidated textile layer, insulation of pipes, heat transfer.

1. INTRODUCTION

In the context of sustainable development textile reuse, regeneration by the technological process of the fibers used in insulation will play an important role in environmental protection.
Rests of clothing and consumer goods on textile base are a hardly recyclable waste that is generally burned at present. After sorting and tearing of waste textile it is possible to obtain a high quality secondary raw material that can be used at production of thermal insulating materials of very good utility properties [1].

The main criterion in choosing a material used in thermal insulation of pipes carrying fluids with maximum temperature of 100^0C is on thermal conductivity, denoted λ. This is a physical quantity, which characterizes the ability of a material to transmit heat when are subjected to temperature difference.

Thermal conductivity, λ, insulating materials can be determined using Fourier law published in the paper “Théorie Analytique de la Chaleur”, published in 1822. Consider a homogeneous construction element, such as an exterior wall, the quantity of heat transmitted in steady state and unidirectional (perpendicular component) can be estimate on base Fourier’s equation (1) [2]:

$$Q = \lambda \frac{S(T_{si} - T_{se})\tau}{d} \quad \textbf{(1)}$$

Where: Q is quantity of heat transmitted by conduction (J or Wh);
λ – coefficient of thermal conductivity (W/mºC);
S– element surface area through which the heat transfer perpendicular to the direction of propagation of heat (m^2);
Tsi, Tse – interior surface temperatures, respective outer element (ºC or K);
τ – time (h);
d– sample thickness (m).

The coefficient of thermal conductivity, sometimes called the λ-factor, is expressed as the quantity of heat that passes through a unit cube of the substance in a given unit of time when the difference in temperature of the two faces is one degree [3].
From formula (1) resulting thermal conductivity is equal to:

$$\lambda = \frac{q \cdot d}{\Delta t} \left[\frac{W}{m^{o}C}\right] \quad (2)$$

Where: q - conductive heat flow stationary (W/m^2);
d - sample thickness (m);
Δt - temperature difference between the plate surfaces (°C).
Knowing the thermal conductivity and thickness of the sample can be calculated thermal resistance:

$$R = \frac{d}{\lambda} \left[\frac{m^2}{W^0C}\right] \quad (4)$$

where: λ= thermal conductivity (W/m^0C) and d= sample thickness, (m).

2. EXPERIMENTAL

Measurements were carried out with modern equipment of high precision and standardized methods, in the laboratory LGCgELaboratoireGénie Civil et geo-Environnement, Université d'Artois, Faculté des Sciences Appliquées Béthune, France

2.1 Measurement equipment and method

Measurement of thermal conductivity is through "flow meter method" governed by ISO 8301: 1991 "Thermal insulation - Determination of steady-state thermal resistance and related properties - Heat flux meter apparatus". Flux meter method is based on determining unidirectional heat flow density, constant in time and uniform in space, which crossing simultaneous measuring the center of the test piece plane, between two flat surfaces isothermal, with temperatures set T_1 and T_2, such as $T_2 < T_1$.

The device for measuring thermal conductivity is composed of: two plates heat exchangers, superior plate (Ps) and bottom plate (Pi), connected to two thermostatic baths (1), type 240 Huber CC3 ministries, with the role to control and maintain the desired temperature plates with an accuracy of ± 0,1^{0}C in a interval 10 - 60^{0}C used without condensation, measuring temperature and heat flow using two flux meters (4) with tangential gradient. Flux meters are placed on the plate Ps, above sample, and on the plate Pi, under sample (7). For accurate temperature measurements using an external thermocouple reference Pt 100 (5), very stable to temperature variations [4]. All these are connected to the recording device (2) which through acquisition station (3) transmit data to a computer (8). Experimental collecting data was performed on a discrete time step of 15 seconds.

Thermal conductivity (λ) was determined using the relation (3), depending on the quantity of heat flow and temperature difference acting on the sample,

$$\lambda = \frac{\sum q \cdot d}{2 \cdot \Delta t} \left[\frac{W}{m^0C}\right] \quad (3)$$

where: Σq – sum of heat flows, (W/m^2);
Δt- temperature difference, (^oC);
d– sample thickness, (m).

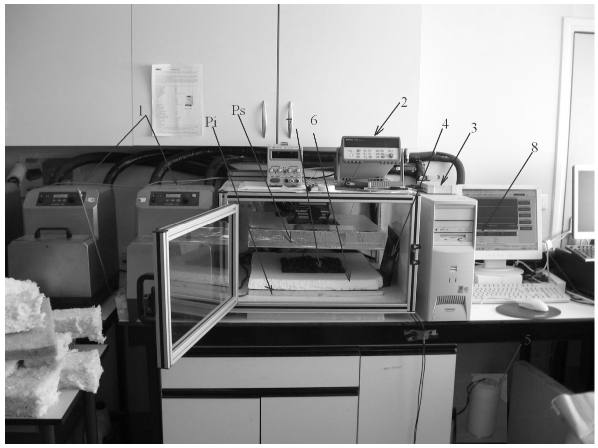


Figure 1: The installation for measuring thermal conductivity

2.2 Textile materials tested

The raw material is made from textile waste processing as fibers, yarns, fabrics and knits, obtained from textile manufacturing processes as: spinning, weaving, knitting and confection. Raw material used is for producing to two structures, figure 2. Technology flows to obtain these structures are shown in Figure 2 [5].

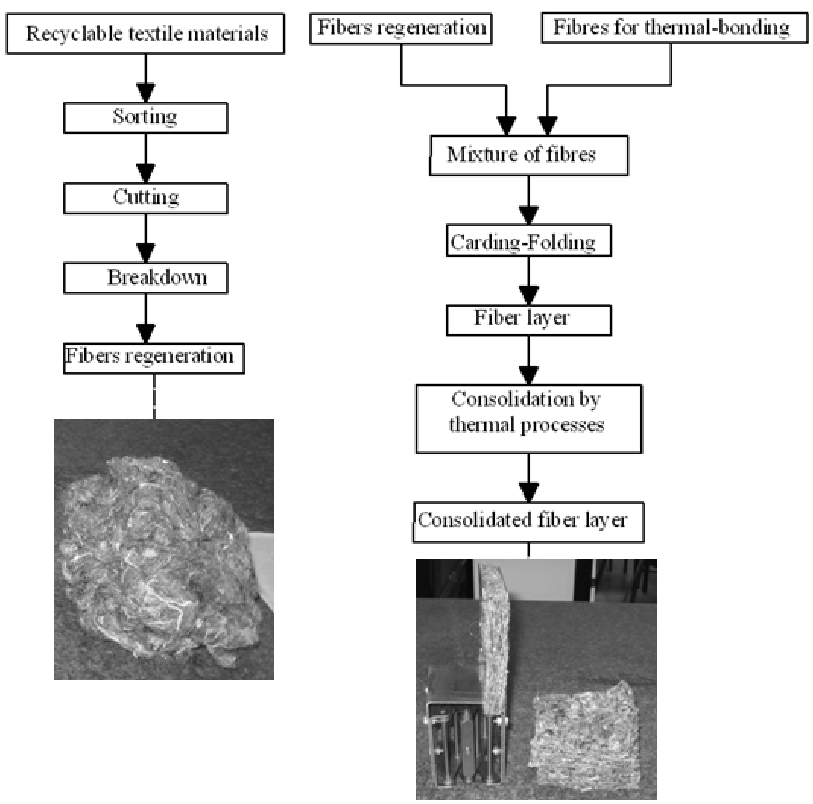


Figure 2: Technological flow for obtaining textile insulation materials

Regeneration textile involves use of technologies as: sorting, cutting, opening and result regeneration fibers, in the form of flock [6].

Regeneration fibers in form of flock formed a blanket with the following characteristics: the specific masse of 8 [kg/m^2], 1,2 [kg/m^2], 1,8 [kg/m^2], and densities of 20 [kg/m^3], 30 [kg/m^3] and 40 [kg/m^3].

The second technology is accomplished by a process of carding-folding and consolidation by thermal processes, resulting structure with a very good stability for use in thermal insulation.
Regeneration fibers results from the technological flow, were used at of the second technological flow and the fibrous layer obtained, contains bonding fibers, having role for consolidation, in the proportion of 20 %.

3. RESULTS AND DISCUSSION

The thermal conductivity, λ, was determined at steady state, with temperature at upper plate (Ps) = 60^{0}C and the temperature at bottom plate (Pi) = 25^{0}C.
Dimensions of the sample were of 25x25 cm. For to reduce heat loss, used a guard ring, having the role to ensure unidirectional transfer conditions, having low thermal conductivity compared to the sample tested.

3.1 Thermal conductivity of the structure composed of flock (blanket)

For test piece of layer flock (blanket) measurements were performed with three different densities: 20 [kg/m^3], 30 [kg/m^3] and 40 [kg/m^3], keeping the thickness of 0,04 m.
By analyzing of the variation of the heat flux passing through the sample mass is observed that after 1000 s, for sample 30 kg/m3 and 1800 s, for sample 40 [kg/m3], heat flux is constant. Both have a good homogeneity of the layer. For the sample with a density of 20 kg/m3, there is difference in heat flow due to variations in the content of air from blanket, figure 5.

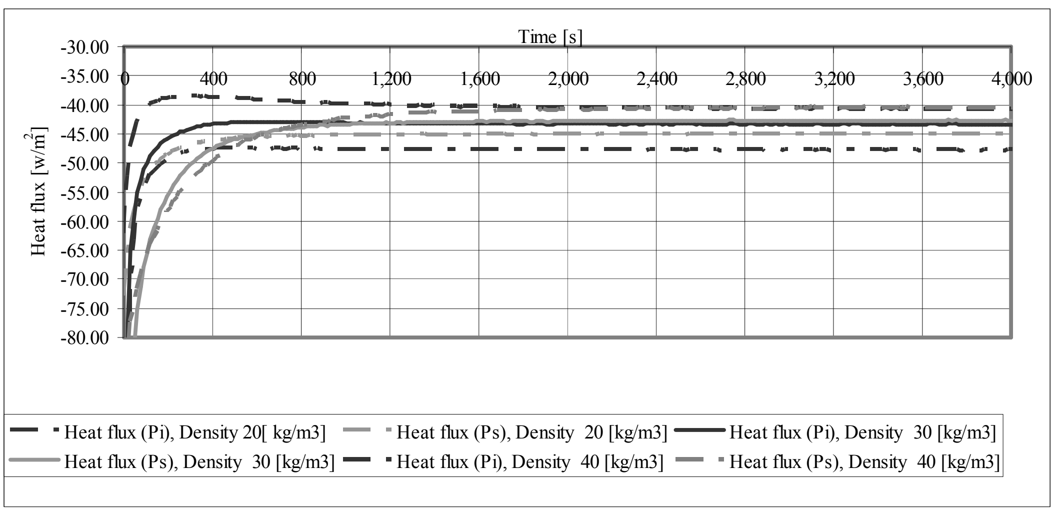


Figure 3: Variation of heat flux a function of time and density for layer flock (blanket)

In Figure 4 is represented variation of thermal conductivity as a function of the density layer.

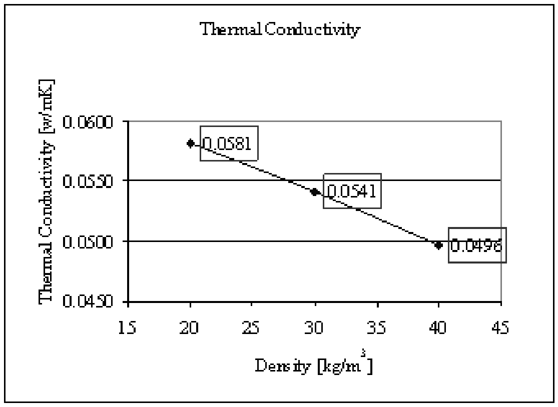


Figure 4: Variation of thermal conductivity function density for layer flock (blanket)

From figure 4 we can see that the thermal conductivity decreases with increasing density, as follows: at 20 [kg/m^3] is λ = 0,0581 W/m^{0}C; at 30 [kg/m^3] is λ = 0,0541 W/m^{0}C and for 40 [kg/m^3] is λ = 0,0496 W/m^{0}C.

Because, the content of air of the layer is lower, when the density is high, he is better established in the structure of layer, which makes that air to act as a thermal insulator better.

3.2 Thermal conductivity for structure made of the consolidated fiber layers

For the sample from layer from consolidated fibers were made two measurements with different thickness of 0.034 m and of 0,068 m, while maintaining the constant density of the 60 [kg/m3].

Analyzing curves of variation of heat flow, which passes through the sample mass, observe a constant difference for the two samples tested, showing a good homogeneity of the samples. For the layer thin, the heat flow for the two plates is constant after 1600 s, but he has a variation little, while at the thick layer, the flows of heat are constant after 2400 s, after which the variation is little, too. Measurements for insulation thermal were made after 4000 s, when the heat flows were constant.

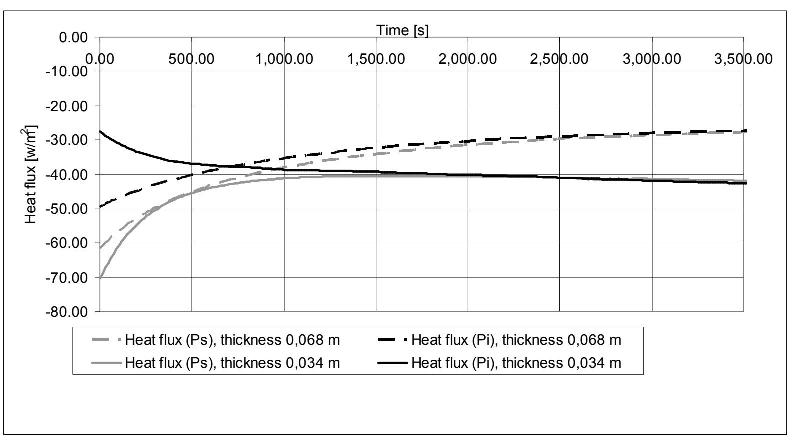


Figure 5: Variation of heat flux a function of time for structure made of the consolidated fiber layers

Thermal conductivity is the best resulting at layer thickness of 0.034 m (λ=0.0419 W/m^{0}C) versus layer thickness of 0.068 m (λ=0.0419 W/m^{0}C).

Because the coefficient of thermal conductivity depends on the sample thickness was calculated the thermal resistance, using the formula (4). Such thermal insulation is better for samples with larger thickness. This shows that, at same density of the sample, the quantity of air no influences thermal insulation, but the stability of the air in the layer is more important.

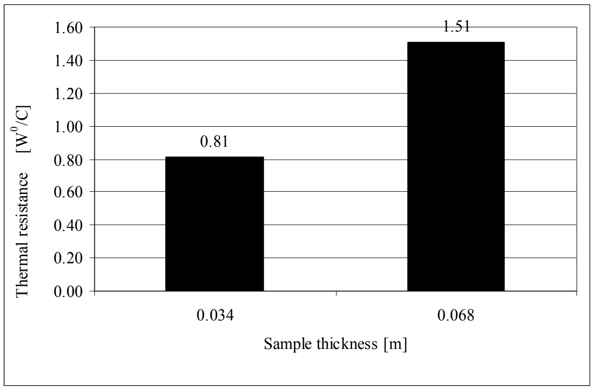


Figure 6: Thermal conductivity for consolidated fibrous layer

4. CONCLUSIONS

After measurements, the behavior from the point of view of thermal conductivity, the samples analyzed from textile regeneration fibers have factors, which influence them. Thus, for the same raw material, structure, density and thickness of the layer can be parameters of influence.

Analyzing variation heat flux passing through the mass of sample, the structure composed from flock revealed blanket density influence on thermal conductivity, which decreases with increasing density: at 20 [kg/m3], λ = 0,0581 W/m^{0}C; at 30 [kg/m3], λ = 0,0541 W/m^{0}C and at 40 [kg/m3], λ = 0,0496 W/m^{0}C. This is explained by the decrease of the quantity of air and increase stability in the sample, with increasing density.

Thermal conductivity of the consolidated layer with a thickness of 0.068 m is greater than the thickness of the sample as 0.034 m. While thermal resistance is great for the layer with thermal conductivity is lower so for thicker layer. The layer formed by the consolidation, the air pockets are uniform and due to layer structure they have the air more compact.

Textile materials which have been tested, the layer obtained from regeneration fibers in the form of flock and the consolidated fiber layer used in the insulation thermic, may be a basic resource as the raw material which comes in large part from recycled textile and have thermal conductivity more little than 0,06 [W/mK].

5. REFERENCES

[1]. Jiří Z., Martin S. & Jitka H., (2013), *Development of building elements with thermal insulation filler based on secondary raw materials*, Advanced Materials Research Vol. 649 (2013) pp 147-150.

[2]. Theodore L., Adrienne S., David P. , Frank P., Incropera, (2002) , *Introduction to Heat Transfer*, Editura Hardcover, pp. 34.

[3]. Kreith, F.; Boehm, R.F.; et. al., (1999), *Heat and Mass Transfer*, Mechanical Engineering Handbook, Ed. Frank Kreith, Boca Raton: CRC Press LLC, pp. 57-58

[4]. Hossu I., Horga G., Grosu M.C., Avram D., Breabăn F., Defer D., Antczak E., (2012), *Thermal Transfer Through Wool Layers*, 14th Romanian Textiles and Leather Sinaia Romania ”Conference CORTEP 2012” pp. 211-217.

[5]. Aristide D., Butnaru R., Vasileanu E., (2002), *Manualul inginerului textilist*, Vol II, Partea B, Editura AGIR Bucuresti, pp. 525.

[6]. Preda C., Leon L., Harpa R., (2004), *Textile neconvenționale cu conținut de fibre recuperate din materiale refolosibile*, Editura Performantica Iaşi, pp. 47.

ACKNOWLEDGEMENT

This paper was realised with the financial support of the project POSDRU CUANTUMDOC “DOCTORAL STUDIES FOR EUROPEAN PERFORMANCES IN RESEARCH AND INNOVATION” ID79407, project financed by the European Social Fund and the Romania Government.

THE QUANTITATIVE AND QUALITATIVE ANALYSIS OF WOVEN FABRICS TYPE WOOL SURFACE CHARACTERISTIC USING ANOVA MODEL

Liliana Hristian[1], Demetra Lăcrămioara Bordeianu[2], Iuliana Gabriela Lupu[3]

[1, 2, 3]Technical University "Gh. Asachi", Jassy, Romania

Corresponding author: Liliana Hristian, E-mail: hristian@tex.tuiasi.ro

Abstract: Three different woven fabrics made from yarns type wool have been studied regarding pilling resistenace. Impact of number of abrasion cycles and pressure force on surface characteristic was studied. The experiemental data were analyzed by multifactorial analysis of variance (ANOVA).
Pilling is a typical manifestation of plane textiles, which consists in formation on textiles surface, of some fiber agglomerations as result of friction forces action.
The experimental work was carried out in lab condition, on samples designed by specimen device and subjected to homogeneous friction on one side. Differentiation of woven fabrics depending of surface characteristic, respective handle (soft, rough, cold) was established by determining the number of agglomeration formed and detached/unit area or unit mass. So, it has been made a quantitative and qualitative analysis of those three groups of woven fabrics.
Mathematical modeling is an investigation method of technological processes based on experimental data collection and processing, processing used in computer simulation of these processes.
It was established, after mathematical modeling, that exists significant differences between the mean values of fiber agglomerations number of woven fabrics analyzed and having soft, rough or cold handle. These models, in relation with the factors that influenced the taking of the decision, permits the optimal conditions finding of action in a shorter time and less material expenses then on lab researches way, obtaining quality products with minimal costs.

Key words: woven fabrics, pilling, handle, statistical analysis, ANOVA, friction.

1. INTRODUCTION

Technological complexity of modern industry requires research on mathematical models without excluding experimental research. Through mathematical model can be analyze the effects of two or more independent variables on dependent variable.

Mathematical models reproduce the phenomenon investigated using some functional relations. These models, in relation to factors which influence the decision- making and enables optimal conditions finding in a short time and less material expenses. Mathematical modeling is a research method of technological processes based on experimental data collecting and processing, processing used in computer simulation of these processes.

The statistical processing following of two directions:

- description of a population by highlight a characteristic or multiple characteristics:
- the comparation of populations between them.

Research on a single characteristic is designated by the concept of univariate analysis. ANOVA model illustrates the homogeneous character of a population by separating and testing of the effects caused by the considered factors. If the test data obtained from trials on the elements of sample drawn from a homogeneous population are divided into distinct groups, the mean values of groups does not differ significant between them. In a non-parametric population, the individual value deviations from values compare to mean value are not random, and a division into distinct groups of the test data the mean values differ between them significantly due to systematic causes actions ANOVA (Analysis of Variance) is a statistical measure that can compare the mean values of a variable where are there are at least three indepedend samples. Before the real testing are checked three hypothesis: of independence, normality and equality of variance[1], [2].

The purpose of this investigation was to perform a quantitative and qualitative analzsis of resistance to pilling of wovens fabrics made from zarns type wool. Using the mathematical model ANOVA allowed to verify the hypothesis that there are significant differences between three groups of woven fabrics regarding the handle (soft, rough, cold) [3], [4], [5].

2. EXPERIMENTAL PART

2.1. Materials and methods

The woven fabrics analyzed in terms of surface characteristic, namely the number of fiber agglomerations formed and detached/unit area, were divide into three gropus as follows: Group 1- woven fabrics from 100% wool; Group 2 – woven fabrics from 45% wool + 55% PES and Group 3 – wovens fabrics from 44% wool + 53% PES + 5% Dorlastan [6].

The experimental work was carried out in lab condition on Rubtester Metrimpex FF 25 machine based on STAS 7316-90, on samples designed by specimen devive and subjected to homogeneous friction on one side. Following friction wear operation occurs on the surface of tested fabric the pilling phenomenon.

The pilling is a typical manifestation of plane textiles, which are formed on the surface thereof, fiber agglomerations composed of three types of fiber: the outer ends (fiber with one end fixed in the basic structure), the outer loops (with both ends in basic structure) and marginal fiber (set very least, one end), as result of friction forces action affecting the appearance.The phenomena is more pronounced at the articles of synthetic chemical fibers or blends of synthetic fibers and natural fibers, open flexible textile structures like knitted fabrics owing to emergence and generated agglomerations persistence[4].

Quantitative analysis of the dynamic of pilling phenomenon is performed by measuring the specific number of fiber agglomeration effect and modeling pilling phenomenon.

Based on experimental data from testing the three groups of woven fabrics has been established a ANOVA regression model in which:

- dependent variable (Y) = number of agglomerations/ pilling effect;
- independent variable = handle woven material (soft, rough, cold) – two variables dummy.

2.2. Results an Discussion

The experimental data regarding the quantitative analysis of the three woven fabrics groups are shown in Figure 1, which graphically illustrates the differentiation of woven fabrics materials analyzed by variation of the number of formed fiber agglomerations/unit area and number of fiber agglomerations formed and detached /unit area and number of fiber agglomerations formed and detached/unit mass, depending on the number of abrasion cycles and pressure force (P=20 N).

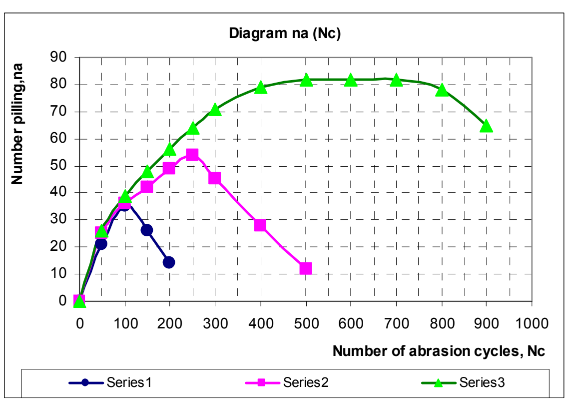


Figure 1: Variation graph of number of fiber agglomerations/unit area, n_a, and number of fiber agglomerations/unit mass, n_m, formed and detached

Series 1	Group 1	100%Wool
Series 2	Group 2	45%Wool+55%PES
Series 3	Group 3	44%Wool+53%PES+5%D

Resistance to pilling of woven fabrics differentiate both early and advanced stage of abrasion (see Figure 1).Woven fabrics in Group 3 (44%Wool+53%PES+5%D) characterized by a higher initial resistance can generate more persistent pilling up to 800 cycles, compared with woven fabrics in Group 1 (100% wool) the pilling effect formed and detached from a small number of cycles, respective 100 cycles.

The presence of polyester fibers and Dorlastan in the fabric strucure of the woven fabrics in Group 3 had prevented the formation and detaching of fiber agglomerations to a small number of cycles as a result of uniform length of these these compared to the length of wool fibers.

Due to the high elasticity of D fibers, woven fabrics in Group 3 have allowed detaching of the fiber agglomerations to a higher number of cycles than in the case of fabrics in Group 2.

Differentiation of woven fabrics analyzed in terms of characteristic surface, respective handle, have been established depending on number of fiber agglomerations to a certain number of cycles and fiber composition, such as: soft, rough and cold handle fabrics. Woven fabrics of Group 1 (100% wool) with the lowest number o fiber agglomerations to a certain number of cycles (see Figure 1) shows a soft handle.

In Group 2 are included the assortment of woven fabrics with rough handle due to presence of synthetic fibers and a smaller number of fiber agglomerations formed and detached compared with woven fabrics in Group 2 having cool handle in which detaching of fiber agglomerations made to a higher number of cycles (presence of D fibers).

2.3. Applying mathematical model ANOVA

Statistical analysis was performed using experimental SPSS19 program and mathematical model ANOVA [1, 2, 3] .

Hypothesis formulation

Ho: between the number means of fiber agglomerations of woven fabrics materials having soft, rough or cold handle no significant differences;

H1: between the number means of fiber agglomerations means woven fabrics having soft, rough or cold handle exists significant differences (Ho is reject).

Establishing of the regression model

The ANOVA model with two variables dummy is defined by the relation (1):

$$Y = \alpha o + \alpha_1 D_1 + \alpha_2 D_2 + \varepsilon \qquad (1)$$

Regression, as a conditioned mean, has the form:

$$\begin{aligned} M(Y/D) &= \alpha_o, & D_1 = 0, D_2 = 0 \\ M(Y/D) &= \alpha_o + \alpha_1, & D_1 = 1, D_2 = 0 \\ M(Y/D) &= \alpha_o + \alpha_2, & D_1 = 0, D_2 = 1 \end{aligned} \qquad (2)$$

For this model is noted with:

- μ_1 the mean of fiber agglomerations of woven fabrics with soft handle;
- μ_2 the mean of fiber agglomerations of woven fabrics with rough handle;
- μ_3 the mean of fiber agglomerations for woven fabrics with cold handle.

Regression has the following form:

$$\begin{aligned} M(Y/D) &= \alpha_o = \mu_1, & D_1 = 0, D_2 = 0 \\ M(Y/D) &= \alpha_o + \alpha_1 = \mu_2, & D_1 = 1, D_2 = 0 \\ M(Y/D) &= \alpha_o + \alpha_2 = \mu_3 & D_1 = 0, D_2 = 1 \end{aligned} \qquad (3)$$

To etablishe the model parameters estimators as follow:

$\acute{\alpha}_o = \mu_1$
$\alpha_o + \alpha_1 = \mu_2$
$\alpha_1 = \mu_2 - \mu_1$ **(4)**
$\alpha_o + \alpha_2 = \mu_3$
$\alpha_2 = \mu_3 - \mu_1$

Estimations of the model parameters are:

$a_o = \ddot{y}1 = (1/n1) \sum yi$
$a_o + a1 = \ddot{y}2 = (1/n2) \sum yi$
$a_o + a2 = \ddot{y}3 = (1/n3) \sum yi$ **(5)**
$a_1 = y_2 - y_1$
$a_2 = y_3 - y_1$

The dummy variables are defined in table 1.

Table 1: Definition of dummy variables

Group	D1	D2	Handle
1	1	0	cold
2	0	1	rough
3	0	0	soft

The modeling was performed using SPSS ((Statistical Package for the Social Sciences). For the established model has been calculated the coefficients defined in table 2:

Table 2 : ANOVA model – the coefficients

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
Model		B	Std. Error	Beta		
1	(Constant)	44,674	,668		62,542	,000
	D1	-19,258	1,342	-,416	-15,553	,000
	D2	-29,412	,941	-1,003	-31,318	,000

a: Dependent Variable: nraglfb

ANOVA estimated model has the following expression:

$y = 44{,}678 - 19{,}258\ D_1 - 29{,}412\ D_2$ **(6)**

where the estimations are:

$a_o = 44{,}678$
$a_1 = -19{,}258$ **(7)**
$a_2 = -29{,}412$

Model interpretation

The model interpretation is the following:

a) a_o = **44,678** is mean of fiber agglomerations of woven fabrics with soft handle:

b) $a_o + a_1 = 44{,}678 - 19{,}258 =$ **25,42** is mean of fiber agglomerations of woven fabrics with rough handle.

c) $a_o + a_2 = 44{,}678 - 29{,}412 =$ **15,266** is mean of fiber agglomerations of woven fabrics with cold handle.

Based on the results (see Table 2) shows that sig< 0,05, so the hypothesis Ho is rejeted and is accepted the hypothesis H1. Therefore, between the mean of fiber agglomerations for woven fabrics type wool with soft, rough or cold handle there are significant differences.

The hypothesis testing on errors:
M(ε) = 0 (errors mean is nule)
Hypothesis:
H_o: M (ε) = 0
H_1: M (ε) ≠ 0 **(8)**

It was applied Student test t for errors (Unstandardized Residual) as is indicated in Table 3.

Table 3: Student test for the errors mean testing

	Test Value = 0					
	t	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Unstandardized Residual	,000	99	1,000	-2,345E-15	-,930	,930

(Sig.=1 > 0,05), so hypothesis Ho is accepted. Errors mean is nule.
V (εi) = σ^2 (hypothesis homoscedasticitate)
Apply a non-parametric correlation test between estimated errors and dependent variable (D1, D2) being calculated the correlation coefficient Spearman and Student test for this coefficient. The results are indicated in table 4.
Hypothesis:
Ho: correlation coefficient is not significantly different from zero (is accepted the hypothesis nule of Student test);
H1: the correlation coefficient is significantly different from zero (is rejected the hypothesis nule of Student test).

Table 4: Spearman test for the veryfing of hypothesis homoscedasticitate

			D1	D2	Unstandardized Residual
Spearman's rho	D1	Correlation Coefficient	1,000	-,367**	,003
		Sig. (2-tailed)	,	,000	,988
		N	100	100	100
	D2	Correlation Coefficient	-,367**	1,000	,077
		Sig. (2-tailed)	,000	,	,526
		N	100	100	100
	Unstandardized Residual	Correlation Coefficient	,003	,077	1,000
		Sig. (2-tailed)	,988	,526	,
		N	100	100	100

** Correlation is significant at the .01 level (2-tailed).

Values of sig. for correlations D1 – estimated errors *(0,000)* and D2 – estimated errors *(0,000)* are equal and constant. In table 4 is calculated the Spearman correlation coefficient *(r = -0,367)* and also is carried out the Student tes t for this Spearman coefficient. Significance of Student test *(Sig t= 0,000)* leads to the decision to reject the null hypothesis of Student test (hypothesis that the correlation coefficient is not significantly different by zero).

In conclusion is rejected the hypothesis **homoscedasticitate** regression model of variable *number of fiber agglomerations* and variable *handle* with a probability of 0,95.

εi ~ N (0, σ^2) – normality hypothesis
The testing of errors repartition normality is done with non-parametric Kolmogorov – Smirnov test (see Table 5).

Tabel 5.One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual
N		100
Normal Parameters	Mean	3,401873E-07
	Std. Deviation	4,2427
Most Extreme Differences	Absolute	,090
	Positive	,090
	Negative	-,059
Kolmogorov-Smirnov Z		,789
Asymp. Sig. (2-tailed)		,435

a Test distribution is Normal.b Calculated from data.
(Sig = 0,789 >0,05), therefore the normality hypothesis is accepted.
cov (εi, εi) – errors autocorrelation testing
Hypothesis:
Ho: $\rho = 0$ (the errors are not autocorrelated)
H1: $\rho \neq 0$ (the errors are autocorrelated)
The veryfing is done with Durbin Watson and the results are indicated in Table 6.

Table 6: Durbin Watson test for errors autocorrelated testing

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0,421	0,135	0,134	11,56	0,034

The value of 0,034 is compared with the calculated value of test (dl,du). It has been observed that the obtained value is in the range (0, dl), which leads to the decision to reject the null hypothesis, that is considered positive autocorrelation errors recorded [1], [2], [3], [5].

3. CONCLUSIONS

- Quantitative analysis of surface characteristic, expressed as the number of fiber agglomerations formed and detached/unit area or unit mass, allowed the differentiation of woven fabrics. For an established number of cycles, on surface of the woven fabrics of 100% wool were observed a high number of fiber agglomerations formed and detached in a time interval lower compared with woven fabrics which are composed of synthetic fibers.
- Woven fabrics that contain Dorlastan fiber formed a higher number of fiber agglomeration formed and detached within a longer time interval due to the elasticity of Dorlastan fiber.
- Differentiation of woven fabrics assortment in terms of surface characteristic, expressed by handle, was established depending on number of fiber agglomerations to a set number of cycles and Mathematical modeling using ANOVA model was performed using SPSS to determine the existance of significant differences between woven fabrics with soft, rough and cold handle.
- Based on ANOVA model have been established that exists significant differences between the mean values of fiber agglomerations number of woven fabrics analyzed with soft, rough or cold handle.

4. REFERENCES

[1]. Jemna, D., *Econometrie*, (2009), Ed. Sedcom Libris, Iaşi.
[2]. Jaba, E., Jemna, D., *Econometrie*, (2006), Ed. SEDCOM Libris, Iaşi.
[3]. Jaba, E., *Statistică*, (2002), Ed Economică, Bucuresti.
[4]. Hristian, L.,„ *Fundamentarea si elaborarea unei noi metodologii de analiză a caracteristicilor de suprafată ale tesăturilor cu mijloace clasice de analiză - teză de doctorat, Universitatea Tehnica "Gheorghe Asachi",* Iaşi, 2008.
[5]. www. *Analysis of Variance*.
[6]. Neculăiasa, S. M., (2004), *Metrologie Textilă*, Editura Performantica, Iași.

COAL REINFORCED COMPOSITE POLYAMIDE NANOFIBERS

R. Keskin[1], I. Gocek[2], U. K. Sahin[2], O. B. Berkalp[2], N. Acarkan[3], S. Ozkan[2], C. D. Dikmen[4], E. Daskaya[2], H. Saglam[2]

[1] Pamukkale University, Dept. of Textile Engineering, Denizli, TURKEY
[2] Istanbul Technical University, Dept. of Textile Engineering, Istanbul, TURKEY
[3] Istanbul Technical University, Dept. of Mineral Processing Engineering, Istanbul, TURKEY
[4] Istanbul Technical University, Dept. of Food Engineering, Istanbul, TURKEY

Corresponding author: Ikilem Gocek, E-mail: goceki@itu.edu.tr

Abstract: Polymer nanocomposites are novel classes of composite materials derived from nanoparticles with at least one dimension in the nanometric range. Nanofibers that are produced by electrospinning process have a wide range of use in different textile applications including medical textiles, filtration textiles, protective clothing, as well as coatings for various purposes [1-4]. The aim of this study is to design and develop nanosized coal reinforced composite polyamide (PA) nanofibers by electrospinning process that have homogeneous morphological structure providing the same characteristics throughout the resulting nanocomposite product. In order to accomplish this goal, high molecular weight PA66 and coal nanoparticles were used as materials to obtain the nanocomposite structured nanofibers. Different weight percent coal nanoparticles such as 0, 0.5, 1, 1.5 and 2 were used in the PA polymer matrix in order to compare the effect of coal amount on dispersibility of the filler in the polymeric matrix used to produce nanofibers. 5 wt.%, 10 wt.%, 15 wt.% and 20 wt.% solutions of PA66 were prepared in formic acid in order to find out the optimum concentration for the polymer that is needed to produce nanoscaled, well-defined and well-structured nanofibers without defects such as beads and fractures in their structure. Nanofiber web structures were produced in order to evaluate the processability of the nanosized coal reinforced PA nanocomposite in the electrospinning process. Morphological analyses were performed on the nanofibers produced in order to assess the dispersibility of the nanosized coal particles in nanocomposite structured nanofibers.

Key words: Coal, nanocomposite, nanofiber, polyamide, nanoparticle reinforced polymeric matrix, coal reinforced nanofibers.

1. INTRODUCTION

With the availability of handling materials in nano scale, scientists have found out that materials at that scale had unique features, and that brought increase in number of studies in that disciple commonly referred to as nanotechnology. This discipline has found itself great fields of applications including those in polymer science, material science, and electronics as well as in textile engineering. The unique features offered bring possibilities in reaching novel materials with unparalleled versatility of applications.

Electrospinning is an electrostatic fiber formation technique with the use of electrical forces to offer natural or synthetic polymer fibers with diameters from microns to as low as 2 nm. A decrease in fiber diameter causes an increase in surface areas of the fibers with smaller pores when compared to those of regular fibers, and that brings novel end-use opportunities in filtration, protective clothing biomedical applications as well as in optical electronics, photonic crystals and flexible photocells [1-9].

Polyamide (PA) is a commercial polymer widely utilized in electrospinning process to obtain functional nanofibrous webs for different applications. One of the application areas it is mostly used as electrospun web is filtering applications. There are diverse studies in the scientific literature regarding electrospinning of polyamide polymer. In one of the studies, by using electrospinning process with a rotational collector aligned nanofiber webs having Nylon 6 and surface-modified multiwalled carbon nanotubes (MWNT) were produced. Rotational collector drum with high speed was utilized for collecting aligned surface-modified MWNTs in the polyamide matrix. Different characterization techniques such as scanning electron microscopy (SEM), differential scanning calorimetry (DSC), X-ray diffraction (XRD), transmission electron microscopy (TEM) and dynamic mechanical analysis (DMA) were used to analyse the morphology and characteristics of the nanofibrous webs. The presence of MWNTs was verified by DSC and XRD, and MWNTs and their molecular orientations were characterized by TEM and WAXD. Carbon nanotube content in the structure of the nanocomposite leaded to improvements in both structure and mechanical properties [10]. In another study, nanofibrous nonwoven webs were fabricated via electrospinning of Nylon 6 in order to investigate its performance as a filtering media. The effects of electrospinning parameters such as solution concentration, tip-to-collector distance, and the feed rate on fiber size distribution were observed. Nanofibers in the range of 50 to 150 nm diameters were fabricated. It was observed experimentally that with the solution concentration of 10 and 12wt% fibers possessing around 85 nm diameter and with 15wt% fibers possessing around 121 nm diameter were obtained. To obtain finer fibers slower feed rate and longer tip-to-collector distance were used. Nanofibrous webs produced with different experimental parameters were analysed to assess their filtration efficiency and pressure drop by exploring their applicability in filtration. Filtering performance of nanofibrous webs were compared with the conventional melt-blown nonwoven surfaces. It was found that nanofibrous webs produced had potential in application as HEPA and ULPA grade filter media. With the results of this study it was displayed that electrospinning was a versatile technique for fabricating filtering media that could capture particles smaller than 50 nm [11]. Another study covers the usage of nanofibrous nylon 6 webs coated on conventional air filter media with changing coverage levels by the use of multi-nozzle electrospinning process to investigate the filtration performance of the produced hybrid filter media. Nylon 6 nanofibers having diameters of 120 to 700 nm were shown to be fabricated by electrospinning process from nylon 6 solutions in 88% formic acid in this study. According to the results of the study as the coverage level increases and thickness of the nylon 6 fibers decreases, the initial filtration efficiency of the air filter media enhances. The effects of average diameter and mass coverage level of nylon 6 fibers on the initial filtration efficiency, pressure drop and durability of air filter media was studied [12]. Processability of nylon 6 and polyethylene oxide (PEO) in electrospinning process was investigated in this study. Hybrid nanofibrous nonwoven web was obtained by electrospinning solutions of these polymers onto a rotational collector. It was shown in this study that two different polymer solutions of two dissimilar materials could be processed and blended together homogeneously utilizing two single syringes in electrospinning process. Since these polymers are dissimilar in structure, different electrospinning parameters such as electrospinning voltage, feed rate, needle size and needle-to-collector distance were preferred for each polymer. Mixture and distribution of the fibers were found to be homogeneous through the depth of the fabric and porosity and distribution of pore size were determined in the nonwoven webs before and after washing. Since PEO was a water soluable polymer and nylon 6 was not, PEO content was removed from the electrospun webs at the end of the washing treatment by increasing pore size in the electrospun nonwoven fabric. Therefore, by this technique how to control pore size distribution independently from fiber formation step was displayed [13]. In this study antibacterial characteristic was tried to be obtained with three structurally different N-halamine additives, chlorinated 5,5-dimethylhydantoin (CDMH), chlorinated 2,2,5,5-tetramethyl-imidozalidin-4-one (CTMIO) and chlorinated 3-dodecyl-5,5-dimethylhydantoin (CDDMH) in the electrospinning process of nylon 6. Investigation of the effects of N-halamine addition on the characteristics of nanofibrous webs was conducted. Different characterization techniques such as nuclear magnetic resonance (NMR) and attenuated total reflectance mode Fourier transform infrared spectroscopy (ATR–FTIR) were utilized for analyzing the synthesized N-halamine structures. The uniform distribution of N-halamines on the nanofibrous web surface was verified by energy dispersive X-ray (EDX) mapping patterns. Differential scanning calorimetry (DSC) and wide angle X-ray diffraction (XRD) were utilized to analyze the crystal structure of the nanofibrous web. It was observed in this study that a total reduction of both Escherichia coli (gram-negative bacteria) (E. coli) and Staphylococcus aureus (gram-positive bacteria) (S. aureus) was achieved after a short contact period of 5–40 min depending on the type of N-halamine and the active chlorine contents. The mechanical properties of the nylon 6 nanofibrous webs were found to be not affected significantly in a negative way by the addition of N-halamines

[14]. In this study nylon 6 without any treatment was electrospun to fabricate nanofibrous nonwoven mats having fiber diameters between 30-110 nm in order to apply it as a pre-filter media for water purification since nylon 6 provides excellent chemical and thermal resistance as well as wettability to the nanofibrous webs. These webs were proven to separate particles in the range of 1-10µm as well as separate submicron particles. The electrospun webs were characterized and evaluated in terms of separation capability in order to obtain a relation ship between its their structural characteristics and separation performance [15]. In another study adhesion of different electrospun nanofibrous webs onto the surface of polypropylene (PP) nonwoven substrate was investigated. For the enhacement of the adhesion of the nanofibrous mats to the surface of the PP nonwoven low temperature oxygen plasma treatment was utilized. PEO and PA6 were consumed to cover a PP nonwoven surface with nanofibrous mats by using electrospinning process. Single-jet solution electrospinning was done both on the plasma modified and unmodified PP substrate surfaces. While determining the electrospinning process parameters the aim in this study was to obtain almost defect-free nanofibrous mats coated on the nonwoven substrate. Since PA6 nanofibers were obtained finer than PEO nanofibers with the determined process parameters, smaller pores were achieved with PA6. Therefore, air permeability of the filter media composed of nonwoven and nanofibrous web combination was lowered in the condition of PA6 usage when compared to PEO usage. When adhesion of the nanofibrous mats to the PP supporting fabric was considered, adhesion was found to be increased by the oxygen plasma treatment after the results of customized 180° peeling test were obtained. Although before the plasma modification adhesion of PEO and PA6 nanofibers were similar to the surface of PP nonwoven, after the plasma treatment it was observed that adhesion of PEO nanofibers were better than PA6 nanofibers. After plasma treatment the substrate was found to be more wettable and permanently sticky. Plasma treatment improved the adhesion between the nonwoven and the nanofibers by enhancing bonding, however, it had no effect on nanofiber diameters, coated areas and air permeability of the multilayered material fabricated [16].

2. EXPERIMENTAL

2.1 Materials

Coal was supplied in nanometer size, and used as supplied. High molecular weight PA (PA66) was supplied by EPSAN Plastics Incorporation (Turkey) and used as received. Formic acid was supplied by Merck.

2.2 Preparation of Nanoparticle Reinforced Polymer Solutions

Selected concentrations of polymer were separately dissolved in formic acid by vigorously stirring at room temperature for at least one hour, depending on the concentration. After observation of total dissolution, pre-determined amount of coal was added portionwise into the solution while stirring at room temperature. In order to increase dispertion of coal throughout the solution, ultrasonication was applied for 15 minutes at selected levels of agitation.

Table 1: Concentrations of PA66 and coal in solutions

Sample ID	PA66 (wt%)	Coal (wt%)
1	5	0
2	5	0.5
3	5	1.0
4	5	1.5
5	5	2.0
6	10	0
7	10	0.5
8	10	1.0
9	10	1.5
10	10	2.0
11	15	0
12	15	0.5
13	15	1.0
14	15	1.5

15	15	2.0
16	20	0
17	20	0.5
18	20	1.0
19	20	1.5
20	20	2.0

2.3 Electrospinning of PA Mats

Electrospinning uses an electric field to draw a polymer melt or polymer solution from the tip of a capillary to a collector. A voltage is applied to the polymer, which causes a jet of the solution to be drawn toward a grounded collector. The fine jets dry to form polymeric fibers, which can be collected on a web. In this study, 18kV of voltage, 8 cm of distance between the syringe and the collector, and 0.1mL/hr polymer flow rate were applied.

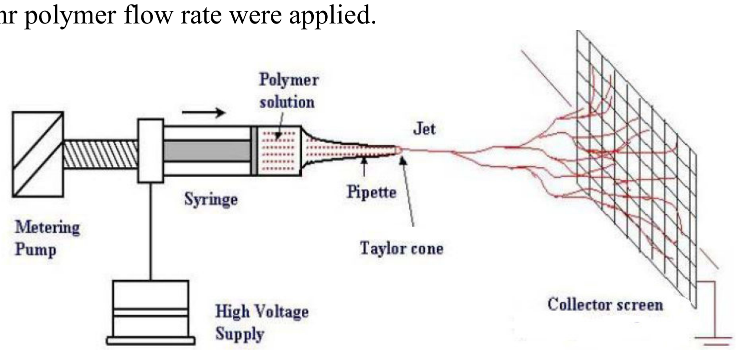
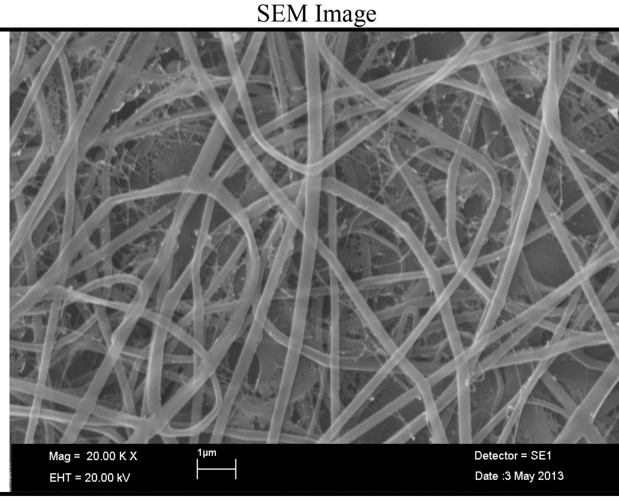


Figure 1: Schematic view of the electrospinning set-up used [2].

2.4 Characterization

Since the main focus of this study was to obtain nanocomposite nanofibrous PA mats that have homogenous morphological structure with well-dispersed coal particles, all of the samples produced were thoroughly investigated under SEM to analyse the distribution of coal particles in PA66 matrix, and images were taken where a clear general representation of distribution was observed. Also for the verification of coal incorporation to the structure of nanofibrous mats, other characterization techniques were utilised.

Table 2: SEM images to represent distribution of coal

Sample ID	SEM Image	Coal (wt%)
16		0

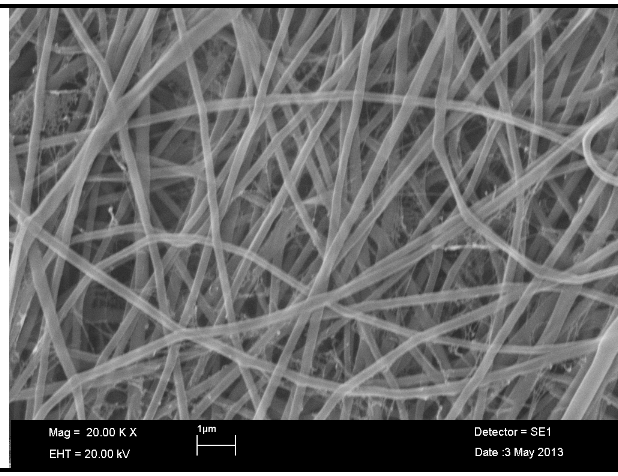
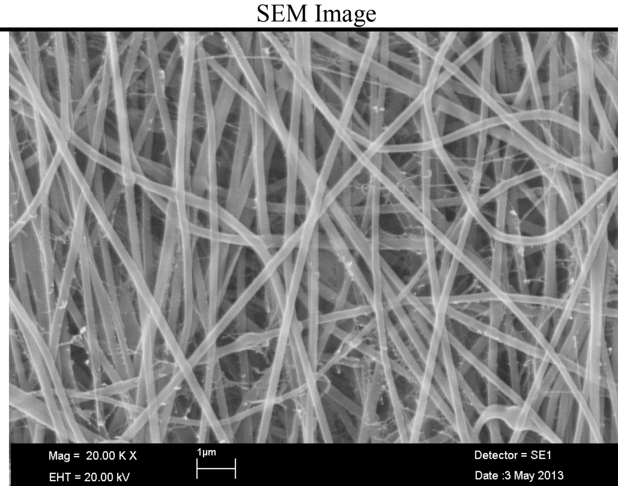
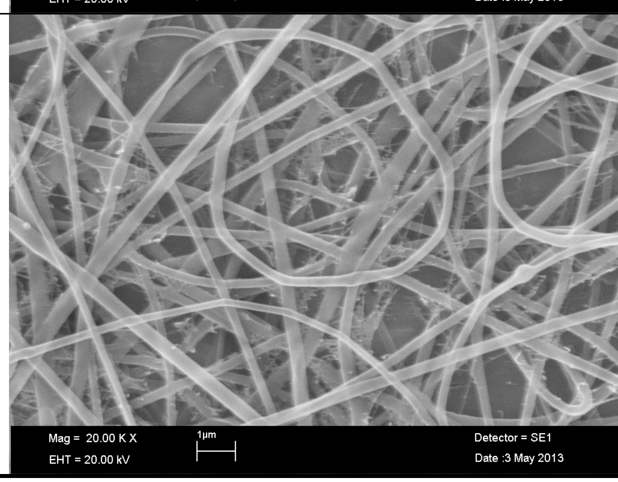
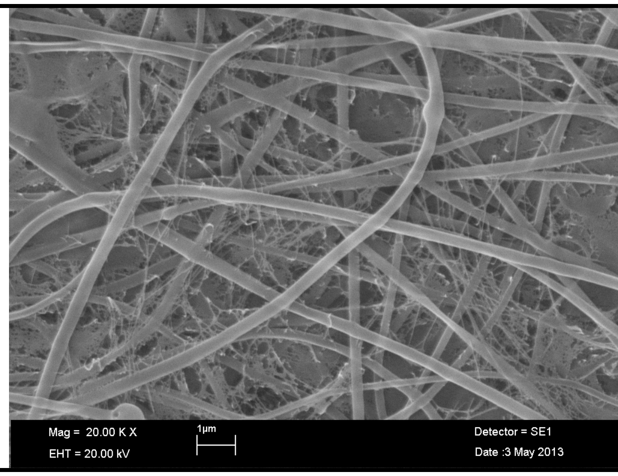
17		0.5

Table 2: SEM images to represent distribution of coal (continued)

Sample ID	SEM Image	Coal (wt%)
18		1.0
19		1.5

20		2.0

3. RESULTS AND DISCUSSION

Some of the images out of those taken from different samples were selected in order to represent the distribution of coal among PA66, which are given in Table 2 above. It is apparent from the images that a very good distribution was achieved throughout the experimental levels applied, i.e. from 0.5 to 2.0 % of coal concentration in PA66. Moreover, it appears that coal particles are covered well with the polymer resulting in a continuous matrix almost without causing any increase in the thickness of the nanofibers.

4. CONCLUSIONS

PA nanofibrous mats were fabricated by electrospinning process. Electrospinning process parameters were chosen as constants. Polymer and coal concentrations were varied and their effects were investigated in this study. SEM images showed that a very good distribution was achieved throughout the experimental levels applied. Moreover, it appears that coal particles are covered well with the polymer resulting in a continuous matrix without increasing the thickness of the nanofibers.

5. REFERENCES

[1]. Subbiah, T., Bhat, G. S., Tock, R. W., Parameswaran, S. & Ramkumar, S. S. (2005). Electrospinning of Nanofibers, *Journal of Applied Polymer Science,* 96, 557–569.
[2]. Grafe, T. & Graham, K. (2002). Polymeric Nanofibers and Nanofiber Webs:A New Class of Nonwovens, *Proceedings of INTC 2002: International Nonwovens Technical Conference (Joint INDA – TAPPI Conference)*, Atlanta, Georgia.
[3]. Bhardwaj, N. & Kundu, S.C. (2010). Electrospinning: A fascinating fiber fabrication technique, *Biotechnology Advances,* 28, 325–347.
[4]. Hellmann, C., Belardi, J., Dersch, R., Greiner, A., Wendorff, J.H. & Bahnmueller, S. (2009). High Precision Deposition Electrospinning of nanofibers and nanofiber Nonwovens, *Polymer,* 50 (2009) 1197–1205.
[5]. Subbiah, T. (2004). *Development of Nanofiber Protective Substrates,* M.Sc. Thesis, Graduate Faculty of Texas Tech University.
[6]. Huang, Z.M., Zhang, Y.Z.,Kotaki, M. & Ramakrishna, S. (2003). A review on polymer nanofibers by electrospinning and their applications in nanocomposites, *Composites Science and Technology*, 63, 2223–2253.
[7]. Essalhi, M. & Khayet, M. (2013). Self-sustained webs of polyvinylidenefluoride electrospun nanofibers at different electrospinning times: 1.Desalination by direct contact membrane distillation, *Journal of Membrane Science,* 433, 167–179.
[8]. Soukup, K., Hejtmánek, V., Petrá˘s, D. & Solcová, O. (2012). Determination of texture and transport characteristics of electrospun nanofibrous mats, *Colloids and Surfaces A: Physicochem. Eng. Aspects,*

[9]. Desai, K., Kit, K., Li, J., Davidson, P.M., Zivanovic, S., Meyer, H. (2009). Nanofibrous chitosan non-wovens for filtration applications, *Polymer,* 50, 3661–3669.
[10]. Jose, M.V., Steinert, B.W., Thomas, V., Dean, D.R., Abdalla, M.A., Price, G., Janowski, G.M. (2007). Morphology and mechanical properties of Nylon 6/MWNT nanofibers, *Polymer,* 48, 1096-1104.
[11]. Zhang, S., Shim, W.S. & Kim, j. (2009). Design of ultra-fine nonwovens via electrospinning of Nylon 6: Spinning parameters and filtration efficiency, *Materials and Design,* 30, 3659–3666.
[12]. Li, L., Frey, M.W. & Green, T.H. (2006). Modification Of Air Filter Media With Nylon-6 Nanofibers, *Journal of Engineered Fibers and Fabrics,*1, 1.
[13]. Frey, M.W. & Li, L. (2007). Electrospinning and Porosity Measurements of Nylon-6/Poly(ethylene oxide) Blended Nonwovens, *Journal of Engineered Fibers and Fabrics,2, 1,* 31-37.
[14]. Tan, K. & Obendorf, S.K. (2007). Fabrication and evaluation of electrospun nanofibrous antimicrobial nylon 6 membranes, *Journal of Membrane Science,* 305, 287–298.
[15]. Aussawasathien, D., Teerawattananon, C. & Vongachariya A. (2008). Separation of micron to sub-micron particles from water: Electrospun nylon-6 nanofibrous membranes as pre-filters, *Journal of Membrane Science,* 315, 11–19.
[16]. Rombaldoni, F., Mahmood, K., Varesano, A., Songia, M.B., Aluigi, A., Vineis, C. & Mazzuchetti, G. (2013). Adhesion enhancement of electrospun nanofiber mats to polypropylene nonwoven fabric by low-temperature oxygen plasma treatment, *Surface & Coatings Technology,* 216, 178–184.

ACKNOWLEDGMENT

The authors would like to sincerely express their highest appreciations and gratitudes to Dr.Filiz Altay for her support during the conduction of this study.

NEW METHOD TO DETERMINE WOOLS AND HAIRS DEGRADATION

Feliu Marsal [1]

[1] *CTF Innovation Center of the Technical University of Catalonia, Terrassa, Spain*

Corresponding author: Feliu Marsal, E-mail: marsal@etp.upc.edu

Abstract: A new method is proposed, validated in the industrial practice, to determine possible bacterial and microbial degradation in textile wools and hairs.
It is applied to wools of variable fineness between 18 and 34 microns and to alpaca fibers between 20 and 36 microns. It is based on a dynamometer test to determine tribocharge excision the slivers combed.
The rheological behavior of degraded fiber slivers is quite different in the spinning process in addition to the major problems that appear in dyeing textiles made thereof. We propose two new indices to determine the extent of degradation that are well correlated to the results of the test the pH of the aqueous extract.
The proposed new method for determining microbial and bacterial degradation is very sensitive for this type of degradation and keep a very good relationship with the results obtained by measuring the pH of the aqueous extract.The variation of the slope of the ascending curve of the excision tribocharge-elongation is a good indicator of degradation.
The conventional parameters are complemented with isocharging elongation of the tape in addition to indicate the degree of degradation of the fibers, orients the spinner to the behavior of these materials in successive stretched degraded in the process of spinning machines.
The results of industrial application of the new method in industry environment conditions, have been very successful in the full range of wool and alpaca fibers studied.

Key words: Bacterial and microbial degradation, Wool, Alpaca, Tribocharging excision, Isocharging elongation.

1. INTRODUCTION

As is well known, the work of wools and animal hairs degraded along the textile process is very problematic. Increases in a significant waste in spinning and weaving, due to the loss of tensile strength and tensile adhesion in spinning machines.

The problems in dyeing and/or finishing are also important because of its high affinity for the dye, in the initial phase, and a desorption at the end of the dyeing process. The colorations that acquire these wools and hairs are difficult to remove in subsequent treatments and represent a change in the final color of the textile product. In some cases, degradation occurs in the use of the garment, owing to problems of colour fastness of the dyes and/or excessive pilling on textile normal use.

The sheep and camelids, throughout his life, can be attacked by pests and diseases, among which the tapeworm, lice, scabies, "sheep fly", the drowsiness, the weevil , moth, foot and mouth disease, smallpox and pneumo-enteritis, among the most important. The greater the degradation rate microorganisms originate "Microsporum gypseum" and "Microsporum canis" oxidizing the cystine, amino acid chemical structure that integrates the animal fiber, forming a fluorescent pigment (pteridine) which is visible under UV light. When the pH is acid, rare in the process of wool and fine hairs, the action of microorganisms is greatly reduced.

During the growth of the fiber on the animal is a yellowing of the most exposed to the weather and urine, true photochemical degradation, light acting as a catalyst. This degradation of wools and hairs, known as dichroism, can be positive or negative. We define positive dichroism, which most frequently occurs when the ends of the fibers are more reactive to chemical agents than the rest of the wool and hairs. Hence the great importance of a good mix as the first operation of the spinning process.

Throughout history, people have developed many methods to estimate the degradation of animal fibers, especially wools and fine hairs, such as alpaca, vicuna, llama and mohair. The most reported method is the determination of the pH of the aqueous extract. This method can be used on wools and hairs at any stage of presentation of the material, provided that you can have a sample to transfer the acidity or alkalinity of the matter to the distilled water used in preparing the extract. From an industrial standpoint, particularly in spinning, this method is complex to implement. We prepare extracts triplicate maintain mechanical stirring for one hour, working with distilled water with a pH very controlled and measured with a pHmeter accuracy.

Given this complexity, we understand that it is much faster to go to an indirect method, simple and fast: on a dynamometer assess the traction force necessary to excise the combed sliver composed of fibers which is to assess its possible degradation.

A fibrous vein (one roving or combed sliver) when subjected to a traction effort, it does not break but excises. The force required to excise the probe excision tribocharge the call (from the greek "tribos", friction). The unit of measurement in the International System of Units is the centinewton (cN).

There are on the market since many years, various measuring equipment designed for stretching forces to the base by working deflection transducers [Smith, Grosberg and Scardino [1], [2], [3] and [Audivert [4]]. More recently tuned measuring techniques based on a pair of draw rolls mounted on a signal transducer element. Several studies relate to relation between the drafting force and the mass irregularity slivers, rovings and yarns made [Postle, Wegener, Kedia, Belin and Plonsker and Tarrin [5], [6], [7], [8], [9], [10], [11], [12]] showed, in a comprehensive study, the good correlation between the static tests, from an installation of dynamometry, and dynamic tests performed on modern instruments used to interfibrillar cohesion of the slivers and rovings.

For many years, our research group has preferably dedicated to the study of the rheological phenomena in spinning [Marsal [13], [14], [15], [16], [17], [18] and [19]. The proposed method is one of the results of our investigations.

2. EXPERIMENTAL

In the first phase of our work, to the tune of the new method, we have studied the behavior in industrial conditions, variables fineness of wools between 18 and 34 microns, with different degrees of pigmentation, with and without vacuoles and alpaca slivers of varying fineness between 20-36 microns, including major commercial varieties of Baby Alpaca, Suri, Huacaya and Huarizo, different colors and with continuous and discontinuous central medulla.

In the case of wools, is taken as a representative example of a wool Uruguay, about 25 microns in average fineness considered and physicochemical characteristics representing the global group wools sensitive to bacterial and microbial degradation. We selected as representative of the group of alpacas, a type of 24 microns Suri.

It started from a worsted slivers of 10 ktex (grams/meter), from a gill preparation in fine, with a pH of aqueous extract of alkaline character, of 9.3. This sliver was subjected to an aggressive environment of 75% relative humidity and 28°C temperature, for a complex cause bacterial and microbial degradation controlled. These climatic conditions usually occur in many spinning hairs and wools processing.

The test specimens are prepared by cutting a 300 mm of combed sliver to place a separate tapes 200 mm. Adhesive tape is placed on the top and one at the bottom to form the nip between clamps of the dynamometer. In this way greater compactness is achieved in the two attachment zones. The test speed is decisive in the results. Preliminary tests show that the optimum test speed is 50 mm/minute.

Test has been applied to the slivers without degrading and degraded after 20 and 30 days of storage in aggressive environment. The pH of the aqueous extract decreased from 9.3 to 6, 2 to 20 days, decreasing to 5.8 after 30 days of initiation of degradation. Table 1 indicates the values found for excision tribocharge three references, values are expressed graphically in figure 1.

The study of the values in Table 1 and Figure 1 shows a substantial reduction in the cleavage tribocharge, a maximum displacement of the family of curves to higher elongations and a significant variation in the descending section of the curve. Self degradated wools lubricates itself, therefore reduces the coefficient of friction interfibrillary and therefore the tribocharge (force) needed to cleave wools slivers.

The degree of degradation of wools, in the new proposed method is assessed by the change in slope of the ascending part of the curve and the maximum displacement at higher elongations. In different tests with different wools no significant differences in the slope of the descending portion between 20 and 30 days of degradation. As the decline is more gradual, indicating that increase the chances of a greater draft of the sliver in a next step of gill, roving frame or spinning frame, without being "cut". Industry practice confirms that degraded wool can stretch more, although the degradation carry other problems, especially dyeing, intractable.

The rising section of the curve has, in all cases studied, a linear character so the variation of the angle between the curve and the abscissa is an excellent indicator of the presence of degradation. This slope coincides with the initial modulus or Young's modulus.

Table 1: Excision tribocharges worsted sliver 25 microns, depending on the degradation of the fibers

Tribocharge (cN) as the days of degradation			
Elongation (%)	**Original**	**20 days**	**30 days**
2,5	50	50	50
5,0	110	95	85
7,5	170	140	125
10,0	235	170	160
12,5	290	210	185
15,0	285	220	200
17,5	255	200	205
20,0	220	190	195
22,5	185	180	185
25,0	160	170	170

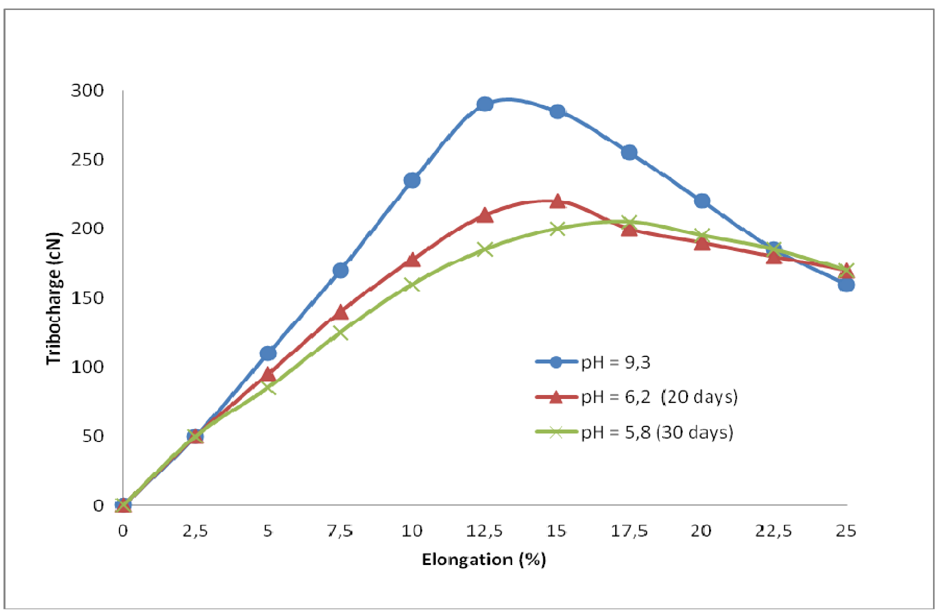


Figure 1: Influence of microbial and bacterial degradation of worsted sliver 25 microns, on excision tribocharge

This slope should be complemented by a new parameter we have called isocharging elongation (elongation at the same load). The isocharging elongation described and applied by the authors in previous work [13], [14], [15], [16], [17], [18] and [19], in contrast to industrial production system, its good fit with the rheological behavior of the combed sliver drawing in subsequent steps in the spinning process. We understand that this same parameter indicator can serve to quantify the degree of degradation. Its value is obtained by determining, on the scale of the graph excision tribocharge-elongation, elongation value corresponding to half the maximum load. Plotting performed on this family of curves of Figure 1, we see that the isocharging elongation passes from a value of 19.5% for worsted slivers original values, in the example selected, exceed the scale of measure, highlighting the effectiveness of the new method.

Due to the importance and bacterial microbial degradation has on alpaca fiber we performed tests of applying the new method to slivers of fineness alpaca variables between 20 and 36 microns, commercial varieties of Baby Alpaca, Suri, Huacaya and Huarizo, of different colors, with and without continuous medulla inside the fibers. In all cases studied we have chosen, considering the collective good representative of alpacas, a combed sliver 20 grams/meter, variety Suri, and comprising fibers 24 microns. Table 2 and Figure 2 give the values obtained for tribocharges excise without degrading the original sliver and the sliver itself subject to the same aggressive environment described above, after 20 and 30 days, respectively.

Table 2: Excision tribocharges Suri alpaca tape of 24 microns, with a grammage of 20 g/m depending on the degradation of the fibers

Tribocharge (cN) as the days of degradation			
Elongation (%)	**Original**	**20 days**	**30 days**
5,0	124	88	80
10,0	330	195	170
15,0	338	243	224
20,0	270	212	205
25,0	193	180	180
30,0	131	150	150
35,0	40	122	122

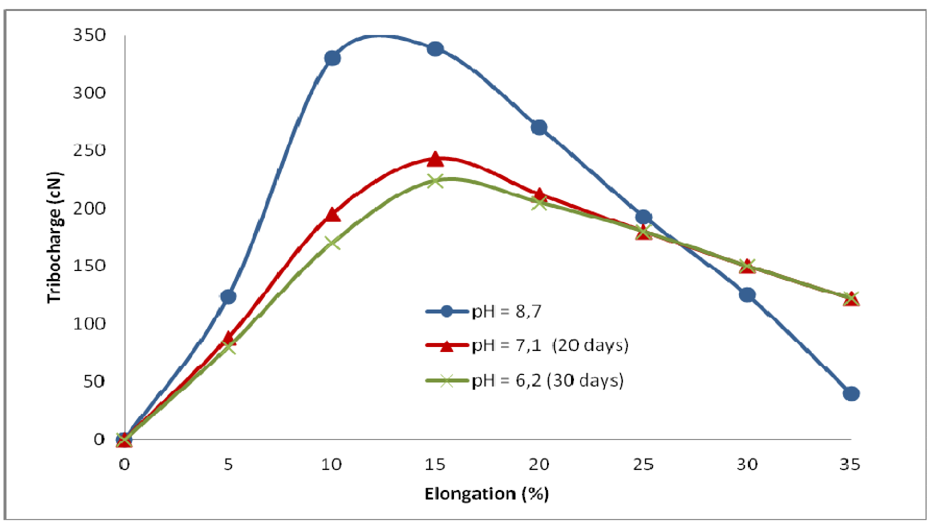


Figure 2: Influence of microbial and bacterial degradation of Suri alpaca sliver of 24 microns, with a weight of 20 g/m on the excision tribocharges

Analyzing the family of curves obtained shows the goodness of the proposed method. The pH of the aqueous extract of alpaca sliver of 8.7 was not degraded, passing to 7.1 after 20 days of degradation and 6.2 after 30 days of being subjected to degrading environment. Isocharging elongation of the tape was 20.6% degraded passing values much higher for degradation at 20 and 30 days (29 and 31%, respectively).

This is a very fast and accurate method. The determination of the pH of the aqueous extract is, undoubtedly, the universal method to determine this type of degradation, but in complex industrial application by the time required in the routine testing of process control. The method of measuring the variation of the excision tribocharge of the sliver simple and fast can provide an idea of the degree of degradation quantified by a matter which can be supplemented, if necessary, with the method the pHs of the aqueous extract usually figure in contracts of sale in global transactions. It is proposed to replace the conventional method by this new method for quickly and be more complete, since at the same time gives information to spinner drafting possibilities degraded tape in successive drawing steps of the spinning process.

This method is also applicable to mixtures of wools and hairs fibers, although its sensitivity is reduced.

3. CONCLUSIONS

- The proposed new method for determining microbial and bacterial degradation of combed wools slivers of varying fineness between 18 and 34 microns, with different degrees of pigmentation, with and without vacuoles and tapes alpaca fiber fineness variables 20-36 microns commercial varieties Baby Alpaca, Suri, Huacaya and Huarizo, is very sensitive this type of degradation and keep a very good relationship with the results obtained by measuring the pH of the aqueous extract.
- The variation of the slope of the ascending curve of the excision tribocharge-elongation is a good indicator of degradation, since the variation corresponds to the initial or Young' modulus.
- The above parameter is complemented with isocharging elongation of the tape in addition to indicate the degree of degradation of the fibers, orients the spinner to the behavior of these materials in successive stretched degraded in the process of spinning machines.
- The results of industrial application of the new method in industry environment conditions have been very successful in the full range of wool and alpaca fibers studied.

4. REFERENCES

[1]. Smith, P.A., Journal Textile Institute, 53, T511-T518 (1962).
[2]. Grosberg, Smith y Yoshikawa, Journal Textile Institute, 53, T533-T536 (1962).
[3]. Scardino, Rebenfeld y Lyons, ASME,66,Tex,3 (1966).
[4]. Audivert, R.,USDA, Grand FG, Sp100 (1965).
[5]. Postle, L., Doctoral Thesis, University of Leeds, (1955).
[6]. Wegener, W., Textil Praxis, 15, 1223-1228 (1960).
[7]. Wegener, y Bechlenberg., Reyon Zellwolle, 5, 14-19; 78-83: 142-155 (1955).
[8]. Wegener, y Bechlenberg., Textil Praxis, 15, 693-697 (1960).
[9]. Kedia, y Smith., Department of Textile Industries of Bela University of Leeds, (unpublished), (1964).
[10]. Belin, R.,III Cirtel, vol IV, 57-69 (1965).
[11]. Plonsker, y Backer., Textile Research Journal, 37, 673-687 (1967) y 39, 9, 823-829 (1969).
[12]. Tarrin, J., Doctoral Thesis, University of Rouen, (1973).
[13]. Marsal, F. y López Amo, F., Revista de la Industria Textil, 9, (1978).
[14]. Marsal, F. y López-Amo, F., Ingeniería Textil, 10-12 (1979).
[15]. Marsal, F. y López-Amo, F., Bull. Scient, ITF, Vol 8, 32 (1979).
[16]. Marsal, F. y López-Amo, F., Textil Veredlung, 9 (1980).
[17]. Marsal, F. y López-Amo, F., Melliand Textilberichte, 11 (1984).
[18]. Marsal, F. y otros., Revista de la Industria Textil, 249 (1987).
[19]. Marsal, F., Documents unpublished CTF Innovation Center of the Technic University of Catalonia, Spain (2000 to 2012).

ACKNOWLEDGEMENTS

Our gratitude to all companies that have collaborated in the experimental phase verifying the reliability of the new method proposed and to Ms. Montserrat Guerrero and Ms. Isabel Castro for their assistance in the laboratory tests required for setting up the new method

ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

RESEARCH ON SOME QUALITATIVE PARAMETERS ANALYSIS OF COTTON KNITTING, TO ENSURE THE FUNCTIONALITY AND QUALITY ON ITEMS GROUPS

Dorina Oana[1], Ioan Pavel Oana[2], Olimpia Marcela Iuhas[3], Liliana Doble[4]

[1,2,3,4] *University of Oradea, Romania*

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

Abstract: It is needed to approach the research resulted from the diversification of textile raw materials base and the global trend of reducing specific mass of choice for clothing.
This situation increased issues along the technological process and product quality assurance problems in usual limits, in accordance with the requirements of the current stage of development of the standard of living and fashion and the requirements of external partners.
In these circumstances, it was necessary to set limit values for certain characteristics determined of the articles, providing useful products for usage value, corresponding to the requirements of the consumer in relation to the purpose and usage method.
Considering the diversity of cotton type products within their large and their usage, it was considered necessary to split into groups of items according to destination, regardless of feedstock and processing module.
In this sense, we have chosen the following groups: Articles for shirts - blouses, Goods for dresses, Goods for outerwear, Goods for bedding articles.
Within each group were selected products from natural raw materials and chemicals, as those obtained from mixtures (tercot, terocel). We selected also within each articles group painted with yarn and in pieces.
When choosing the features that can be considered crucial in assessing the quality of textile products, should be considered primarily on the application.

Key words: slip resistance, laceration, recovery from wrinkling, piling.

1. INTRODUCTION

If the original consumer demands priority heading toward lasting durable goods, particularly durables, in recent decades there has been a fundamental change being requested items with a high fence functionality and aesthetic requirements imposed by fashion.[1]

Values were determined for some quality parameters of cotton knitting group items. In choosing features that can be considered crucial in assessing the quality of textile products, should be considered primarily the area of application. It has been considered being given those characteristics that influence consumer and lead to a subjective assessment of quality. To limit values it was considered appropriate while taking five different batches for each article, the volume selection formed in this way is sufficient to characterize the quality of the community.[2]

2. FIGURES ACHIEVEMENT

Considering the diversity of cotton type products within their large and their usage, it was considered necessary to split into groups of items according to destination, regardless of feedstock and processing module.

In this sense, we have chosen the following groups [3].

A. Articles for shirts - blouses,
B. Goods for dresses,
C. Goods for outerwear,
D. Goods for bedding articles.

They are restored limit values for groups of articles (Tables 1, 2, 3 and 4). It is noted that the groups A and B practically have the same values; this shall be explained by the fact that the practice has shown that a number of articles, according to the pattern and color can be used either to a destination or to the next. [4], [5].

Table 1. Group of shirts

		tercot 67/33 Subgroup PES/cotton	tercot 80/20 Subgroup PES/bumbac	Terocel Subgroup	Cotton	Cotton/m.t.r.
Slip resistance, minimum Kgf	U	25	25	25	22	22
	B	20	20	20	20	20
Tearing resistance, minimum Kgf	U	1,5	1,5	1,5	1,2	1,5
	B	1,5	1,5	1,5	1,2	1,5
Accelerator mass loss,% maximum	U	3	3	5	6	6
	B	7	7	9	10	10
Recovery angle, minimum degrees	U	110	110	105	-	-
	B	115	115	110	-	-
Returning from wrinkling. minimum	Immediately	2	2	2	-	-
	After 24h	4	4	4	-	-
Piling, minimum		4	4	4	-	-

Table 2. Group of dresses

		Tercot	Terocel	Celofiber 100%	Cotton 100%	Cotton/ m.t.r.
Slip resistance, minimum Kgf	U	25	25	20	25	18
	B	20	20	18	20	18
Tearing resistance, minimum Kgf	U	1,5	1,5	1,5	1,2	1,5
	B	1,5	1,5	1,5	1,2	1,5
Accelerator mass loss,% maximum	U	3	3	5	6	6
	B	7	7	9	10	10
Recovery angle, minimum degrees	U	110	110	105	95	-
	B	115	115	110	100	-
Returning from wrinkling. minimum	Immediately	2	2	2	2	-
	After 24h	4	4	4	4	-
Piling, minimum		4	4	-	-	-

Table 3. Outerwear

		Tercot mass of 150g/m^2	Tercot mass of 150g/m^2
Slip resistance, minimum Kgf	U	-	-
	B	-	-
Tearing resistance, minimum Kgf	U	2,2	1,5
	B	1,5	1,5

Accelerator mass loss,% maximum 1' 3'	5 12	7 15
Recovery angle, minimum degrees U B	115 120	115 120
Returning from wrinkling. minimum Immediately After 24h	- -	- -
Piling ,minimum	5	5

For Group C was not considered necessary to follow the slip resistance of yarns because this is not a specific deficient parameter for the analyzed structures.

Table 4. Bedclothes

	100% cotton or mixed with celofiber	Cotton or celofiber mixed with PES
Slip resistance, minimum Kgf U B	20 20	25 22
Tearing resistance, minimum Kgf U B	1,2 1,2	1,2 1,2
Accelerator mass loss,% maximum 1' 3'	6 12	4 10
Recovery angle, minimum degrees U B	- -	- -
Returning from wrinkling. minimum Immediately After 24h	- -	- -
Piling ,minimum	-	-

3. CONCLUSIONS

The limiting values for the considered features can be heavily influenced by the variability of the production process, that for limit values mostly close to reality at some point, it is necessary to compare the current limits to the values obtained in successive measurements. In the current situation, the creation assortment of cotton type items essential changes are known for maintaining quality is recommended to include indicators in the internal rules which are given above and find technology solutions that ensure compliance with the limit values.

4. REFERENCES

[1]. Cioara L..(2001) *Structura țesăturilor*, Ed. Performantică Iaşi
[2]. Chinciu D.. (1990). *Structura şi proiectarea țesăturilor*, Ed. Rotaprint Iaşi
[3]. Cojocaru M. (1986). *Metode statistice aplicate în industria textilă*, Ed. Tehnică Bucureşti
[4]. Preda C.(1996). *Metode şi aparate pentru controlul calității materialelor textile destinate confecționării produselor de îmbrăcăminte*, Ed. BIT Iaşi
[5]. Preda C. (1983). *Controlul calității produselor*, Ed. Rotaprint Iaşi
[6]. Chinciu D. Oana D. (2005). *Structura şi proiectarea țesăturilor cu dungi longitudinale,* Ed. Universității din Oradea

ANALYSIS OF THE HEATING NEEDLE MACHINE, IN SEWING PROCESS AT HIGH SPEEDS

Ioan Pavel Oana[1], Dorina Oana[2], Liliana Doble[3]

[1, 2, 3] *University of Oradea, Romania*

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

Abstract: Needle heating due to friction with the material and sewing, has negative effects on sewing process. Relatively low thermal conductivity of fabrics will cause thermal degradative effects concentrating on a limited area, placed around the needle holes. Thermal degradation leads to a decrease sewing thread strength, after which follows the melting and his rupture.
The main factors that influence needle warming can be grouped as follows:
Factors that depend on the material, they are: fiber content, thickness and number of layers, the physical density, structure, finishing treatment, thermophysical properties, etc.
Factors that depend sewing: fiber content, fineness, structure and type of wire, twisting, finishing, all the dependence of the material being sewn.
Factors that depend on the sewing machine: speed drive needle stitching structure, step size, depth of penetration of the needle into the fabric, yarn tension force, pressure foot on materials, the hole in the needle plate.
Factors that depend on the needle: the geometry of the needle diameter and the length of the lower rod, the length and cross-sectional dimensions of the grooves, the hole shape, the length and shape of the tip and ends of their, the manner of finishing of the surface of the needle through use of the various special plating processes.
Working conditions: The length of time sewing and stops, standard microclimate conditions; existence needle cooling systems, provided they do not affect the user.

Key words: needle, material thickness, fiber composition, heating the needle.

1. INTRODUCTION

Sewing needle is the main organ that contributes to the stitching. [1] The sewing machines are of several forms: some are straight and on special machines may be curved. Straight needles are used in machines for sewing the spool (Figure 1) has the following main parts: - the upper rod 1, - valve stem, 2, - opening through which the needle thread, 3, - the needle which can be of different form, 4 (figure 3).

The cross-sectional shape determining the sign left from the material and the arrangement of the steps in the seam, as in the example of Figure 2. The end of peak can have varying degrees of rounding, such as shown in Figure 3. The peak end is rounded, the lower surface of the piercing needle thread so that the sewing of knitted fabrics and woven fabrics of fine susceptible to puncture, to adopt a rounded peak needles (from spherical), which penetrate the lateral displacement of the wire [2], in order to avoid damage to connections knitted or woven fabric.

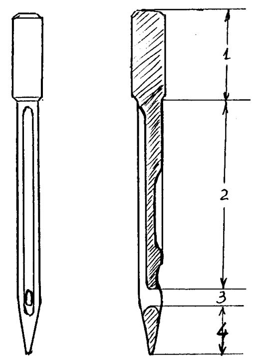


Figure 1. Sewing needle

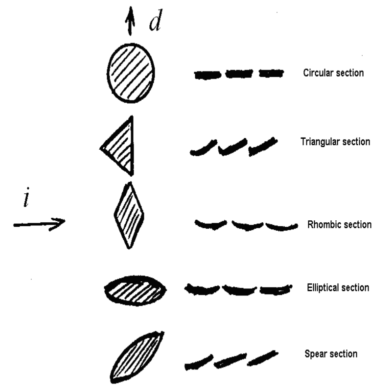


Figure 2. The needle peak under various sections

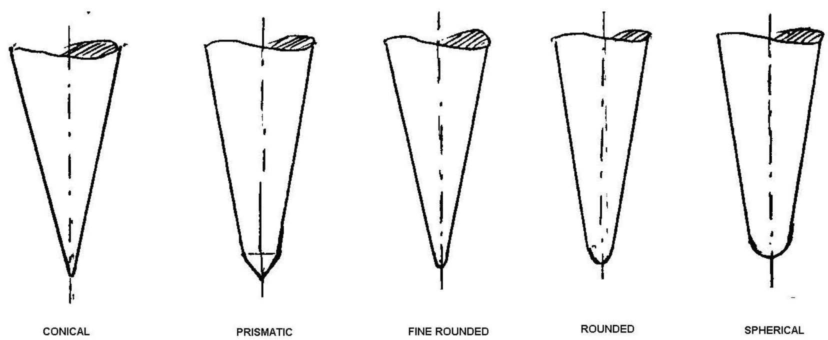


Figure 3. the needle peak in various forms.

Needles used on sewing machine must meet the following requirements: do not damage the fabric or sewing, to provide high resistance to friction, buckling, heat, tearing can be mounted in the drive. Warming needle sewing machine can be considered undesirable phenomenon where products manufacture synthetic fiber fabrics and knits [3, 4, 5]. For the manufacture of clothing products the high speeds of up to 5000 împ-/min sewing. Being pierced by the needle material of the friction forces occur between the surface of the needle material, the needle plate hole, the size of them is influenced by a number of factors including: the thickness of the fabric structure, the size of the contact surface, the geometry of the needle (Figure 3) sharpening angle of the needle, presser foot pressure. Pressing forces lead to heating needle up to 300-400^{o}C, especially when sewing clothing products are made from synthetic materials, the sewing machine works with 4000-5000 Imp-min, generating quality defects in assembly.

Figure 4 shows graphically the correlation between the needle and the temperature rise speed of rotation of the main shaft, materials of different thicknesses. Figure 5 shows the relationship between the number of layers of material and temperature rise function, shown in Figure 6. The correlation between the length of the stitch and the needle heater is shown in Figure 7. Correlation between the diameter of the needle and the needle heater, and Figure 8 shows the correlation between the pressure feet according to heating the needle [1].

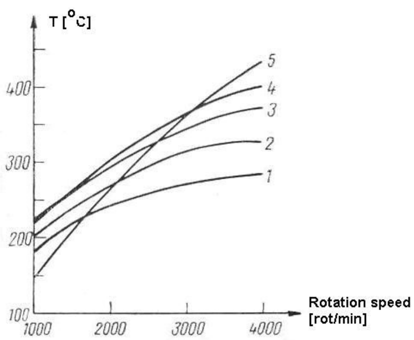


Figure 4. The correlation between the heating temperature of the needle and the rotation speed

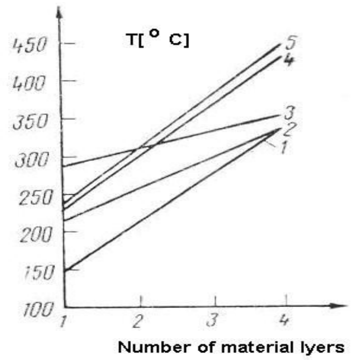


Figure 5. The correlation between the number of material layers and the temperature rise function

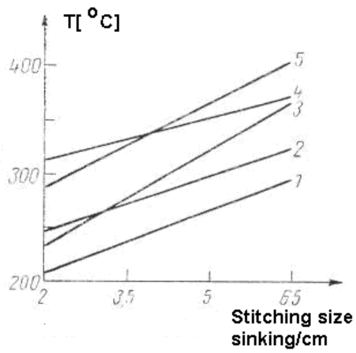


Figure 6. Correlation between stitch length and needle heater

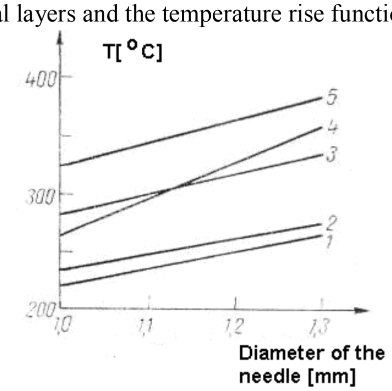


Figure 7. The correlation between the diameter of the needle and the needle heater

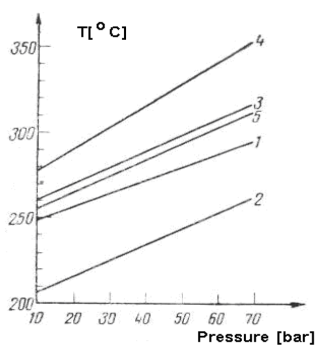


Figure 8. The correlation between the pressure foot according to the needle heater

Heating the needle is influenced also by and sewing used thread. The sewing thread of cotton and silk can work normally, so the needle is heated to a temperature of 400 ° C, while the sewing thread of synthetic fibers behave more difficult at higher temperatures, as shown in Table 1 . The sewing thread is chosen in all cases based on the basic raw material which are assembled by searching the composition is similar to the thread of the fabric in order to prevent any quality defects in the assembly, resulting in different contraction for non-assimilation composition.

Table 1. Correspondence between material, sewing thread and needle heating temperatures

Material	**Thread**		**The heating temperature at different speeds of the machine**			
	composition	**finesse**	**1000**	**2000**	**3000**	**4000**
Pure Wool Fabrics	cotton 1	30/6	143	195	244	286
	cotton 2	40/6	145	208	287	348
	natural	50/6	157	215	295	337
	silk	18	176	253	337	408
	relon	64/3	177	225	breakage	

Fabrics -	cotton 1	30/6	170	201	332	379
25%	cotton 2	40/6	137	255	366	412
viscose	natural	50/6	160	168	305	395
	silk	18	174	266	350	404
	relon	64/3	218	287	breakage	
Relon	cotton 1	30/6	200	262	321	385
woven	cotton 2	50/6	248	316		482
fabrics +	natural	18	273	353	411	
50% wool	silk					
	relon	64/3	322	358	breakage	

The synthetic fiber thread breaks at temperature of 250 ...280^{o}C, so it is necessary to use the sewing machine with lower speeds than natural fiber threads can handle. The lowest thermostability it has the polypropylene fiber sewing thread which melts at a temperature of 162^{0}C, after this the relon at 248 ...277^{o}C, cotton with PNA at 299^{0}C. The strong needle heated during operation, have a negative effect over thread, material on destroying their structure. Thermostability defines the critical temperature of the heating value, which fibrelepolipropilenice of melt seam points. To secure bonding moment fused fiber needle, you can use a strobe that illuminates the needle moving.

If the frequency is set at the value of the lamp frequency motion, is obtained when the stillness can be seen on the surface of molten fibers needle. The data in Table 2 shows that the critical temperatures depend on the composition of the fiber, thickness, and stiffness and material structure. In Figure 7 that the values of Table 2 corresponds to the working speed of 2000-2500 rev / min.

Table 2. The correlation of the material, the critical temperature and temperature.

Material	Critical temperature	The standard deviation	Coefficient of variation	The error	Temperature
Relon - wool	272	7,90	2,9	2,1	272
Knit-polyurethane	330	5,52	6,8	4,4	230
Buret velvet	238	8	4,8	2,1	233
	4	0,015	0,035	0,048	0,065

Wear of the needle comes out of the destruction of the material under the influence of factors that contribute to the deterioration of their properties [6]. The most important factor is the friction wear.

When sewing different materials it occur neddle wear which manifests itself in removing microparticles of material especially in the region of peak leading to the so-called attrition. The wear of those depends on the compactness of the structure, material thickness the speed of rotation of the main shaft, the density of steps and the time of use. The most worn needle encounters a greater resistance than the new material and is heated to a higher temperature, thus directly influencing the wear needle heating. The wear of the needle according to time is shown in Table 3.

Table 3. Needle wear according to the working time

Material	Mm needle peak wear after working x hours						
Woven fabrics of cotton	0,25	12	3	4	10	16	18
	0,015	0,021	0,021	0,050	0,120	0,25	0,390

2. CONCLUSIONS

Manufacturers of these recently proposed a number of technical solutions to improve the quality and reliability of those in order to reduce heat and wear the needle by making special steel or special processing of those areas side by chrome plating to reduce friction. In this sense we can intervene by changing the needle geometry such as reducing needle section, conducting special channels, additional holes that prevent needle warming.These procedures allow increased speed of 16 - 30%, but also contribute to reducing resistance in the needle in the plate needle in the hole. In addition to these methods may be used cooling means of air or liquid, which enables reduction of 25 is a good heat cooling can be achieved by aerosol or by a method combined with compressed air and wetting. These cooling methods have some disadvantages such as the worker's hands cooling, additional noise, complex system, further development of a product price.

To reduce heating and therefore the needle thread to the sewing material can be actuated primarily by:

- the use of these modified geometry: lower tapered rods, which lead to the reduction of friction with the material, air circulating tubular rods, rods with holes or grooves through which involves additional air streams;

- using these special finishes with discontinuous skins that reduce surface contact and surface drives air through micropores, with continuous coating, very smooth to reduce friction and particle accession melting metals or alloys with anti-friction properties.

3. REFERENCES

[1]Potoran .I, Predoiu, C., (1985) – *Procese şi maşini în confecţii* – Editura Tehnică Bucur

[2] Loghin .C, (2003) – *Tehnologii şi utilaje în confecţii*, Ed. Performantica, Bucureşti

[3] Stan.M, Mitu, M – (1998) – *Bazele tehnologiei confecţiilor textile* –volI, Ed.Gh Asachi Iaşi

[4].Papaghiuc, V., (2000) – *Procese şi maşini pentru pregătirea tehnică a fabricaţiei şi croirea materialelor textile*, Ed.Gh. asachi Iaşi

[5]. Suteu, M., Indrie, L., Ganea, M.**, "***Determination of optimum performance regime for SunStar buttonhole machine by vibrations measuring technique. Processing the data measured with Data Explorer Software",* Annals of the University of Oradea, Fascicle of Textiles-Leatherwork, Oradea, vol XII, nr. 1, 2011 pp. 146-157.

[6] Papaghiuc, V., (2003) – *Procese şi maşini pentru coaserea materialelor textile*, Ed Performantica, Iaşi

[7]*** *Manualul inginerului textilist* – 2005 volumul II

THE CAUSES OF UNDESIRABLE FABRIC CURLING ON THE ASSEMBLY LINE

Viorica Porav[1]

[1] *University of Oradea, Department of engineering and Industrial Management in Textiles and Leatherwork.*

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

Abstract: Over the decades, having been production activity director in a company producing textile garments, I faced many times the effect of shrinkage of the material on the assembly line. This paper will present some of the causes that can produce this effect. If the causes are known, the effects can be prevented and even eliminated. In this sense, a description was made of the phenomenon of shrinkage and wrinkling of the material in the direction of assembly lines or parallel to it. It described the appearance of wrinkling, depending on the direction of the presser assembly line, or immediately in the vicinity of the entire length of the stitch, or in part, on one side or on both sides of the assembled materials. There are presented different methods to prevent and eliminate this drawback which affects the appearance and at the same time significantly reduces the amount of product presentation value.

Troubleshooting curl when it has already occurred, involves conducting additional costs to remedy. Total or partial remediation depends heavily on the types of basic raw materials, secondary and ancillary product model but sometimes it is not feasible. From the variants presented, a conclusion about a specific set of factors that influence curl has been made.

Key words: line assembly wrinkle, sewing machines vibrations, compatibility thread/fabric, effects after wash cloth, compatibility thread/needle/fabric structure, sewing thread tension.

1. INTRODUCTION

The phenomenon of shrinkage of textiles on the assembly line can be reduced or even eliminated, if we analyze the possibility of its` causes and if the process strictly adheres to conditions imposed by the analysis of factors that may have a direct influence on curling of the stitching. Curl is defined as the differential shrinkage that occurs on a seam line on the fabric. This is caused by the difference in tension in the stitching thread or yarn material or due to differential movement between the two layers of material. A number of factors contribute to this such as: [1, 2].

The condition and type of sewing machine control:

- Incorrect thread tension
- Improper adjustment of the conveyor
- Incorrect needle plate whole diameter, improper characteristics couple between the material and the needle
- Excessive speed of the machine
- Improper pressure on the presser foot
- Improper conveyor adjustment
- Improper choice of stitch step
- Improper devices attached to the machine
  - Style and length of needle
  - The number of stitches / cm.
  - Sewing direction
  - Adjustment of thread tension wires
  - Pushing or straining in the sewing material
  - Construction and finishing materials

- Contraction / elongation of the thread and / or material
- Incompatibility between the thread and material

Curling can highlight:

- The difference in elongation of the material
- Elongation of threads
- Tightness of the material.

2. DESCRIPTION OF FACTORS

2.1 Sewing machine

The mechanical condition of the sewing machine has a major role. A poorly maintained sewing machine (uncalibrated, ungreased etc) is disturbed during operation due to vibration and may cause as a result of these disturbances, the effect of the folded seam. Global measurements of vibration provide a quick and useful indication of the approved vibration level, useful if you want to obtain information on the general condition of a dynamic machine or vibration isolation effectiveness.

Vibrations represent a mechanical agent that is harmful to machines and wastes energy. In practice vibrations can not be avoided, they are a result of machinery operation, the environmental action on mechanical structures of the machines. Relatively low level vibrations can propagate along the elastic structure of the equipment, triggering other parts of the structure to resonate with the vibration and this can become a significant source of noise and vibration that is harmful for equipment operation. [3]

Equally, incorrect needle choice uncorrelated with thread fineness, can lead to stitch curling, step skipping, holes in the material, or the breaking of the thread above or below. There are over 30 different systems of numbering that indicate needle fineness. It is generally recommended to choose a thread with diameter equal to 40% of the diameter of the needle. To ensure safety, these limits are recommended:[4]

$$\Phi \text{ needle} = 14\sqrt{Tex} \text{ for cotton yarn} \quad \textbf{(1)}$$

$$\Phi \text{ needle} = 16\sqrt{Tex} \text{ for synthetic yarn} \quad \textbf{(2)}$$

Inserting the bobbin incorrectly can cause wrinkles, breaking of the needle, present danger to the material or even a component of the mechanism of transport of material stitching, or at best become a cause for thread breakage. An abrasive machine table will cause a braked movement of the material layer in contact with it, compared to the upper layer due to a higher coefficient of friction than the material of the upper layer.

Depending on the type of machine used, under the conditions set, wrinkles can be more or less pronounced. Generally chain stitch type 401, produces less pronounced curl than 301 lockstitch seam. This is due to the fact that the upper and lower thread is woven into the layers of material. If there is no looping chain stitch there will be a smaller internal volume for each stitching step. [5] (Fig. 1.).

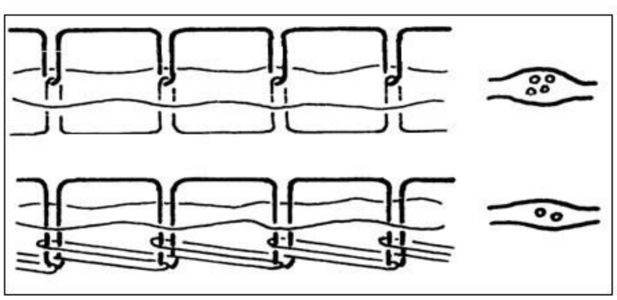


Figure 1. Dependence of stitch type: lockstitch / 301 and chain stitch / 401

2.2. Structure and finishing the material

Curl stitching is often caused by a structural blockage. It occurs when the material is woven tightly and simply inserting another thread distorts or moves the stitch adjacent to it, causing the emergence of tensions inherent in the thread crimp. If a few stitches of a seam crimping are cut and remove, it is noted that the creases disappear on both sides. (Fig. 2).

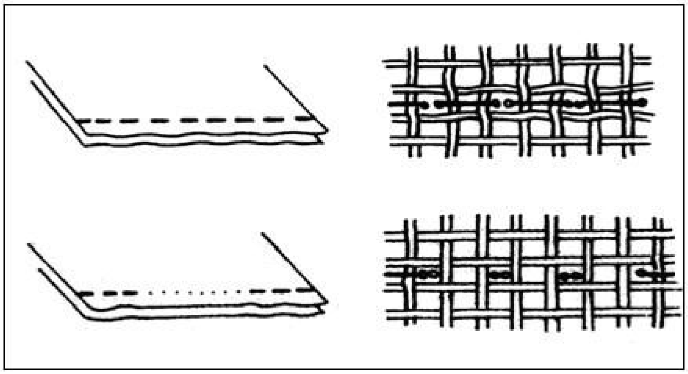


Figure 2. Structural jumming. stitches removed

Sewing direction influences the degree of distortion of the material, contributing to curling. A stitch parallel to the weft has a lower degree of shrinkage, than the seam parallel to the warp yarns as weft yarns can move easily across the warp yarns. A stitch made on the bias(diagonal) will seldom curl because each step distorts a different set of yarn material, avoiding the accumulation of tension. (Fig. 3).

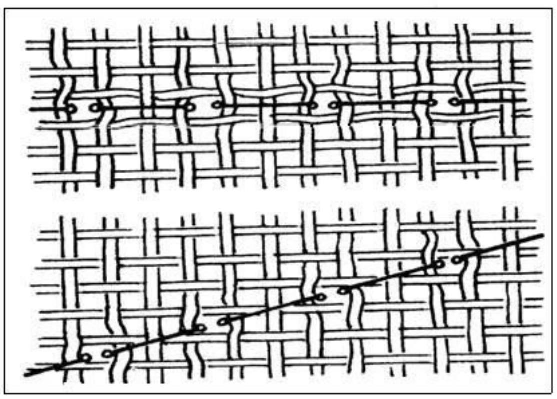


Figure 3. Lockstitch parallel to the weft and lockstitch on bias angle

Another cause of wrinkling phenomenon is the high tension of sewing threads and faulty handling by the technician. This is demonstrated if the wrinkling disappears when a few stitches are cut and the ends are left in the material. [5] (Fig. 4)

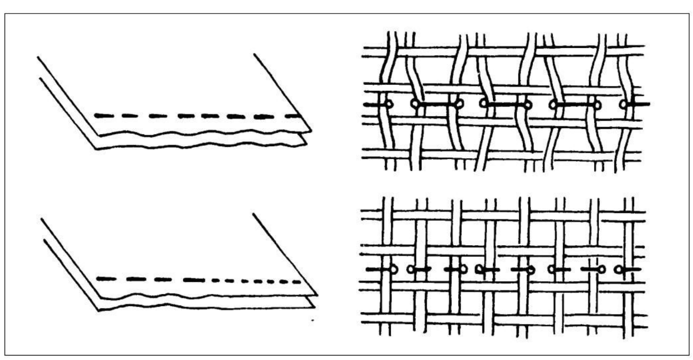


Figure 4. Thread loops severed but retained in fabric

2.3. The elasticity and differential contraction of the material and the thread

Failure to comply with strict rules of stitch can lead to subsequent wrinkling of the materials along the seam line due to the fact that the synthetic fibers resume their shape after a period of time, and the cotton fibers retain their length. The stitch thread fixes the fibers in a new position by dragging. The dragging of fiber material increases with the number of stitches per inch. Fibers tend to resume their original length due to the elasticity, but sewing them causes wrinkling.

The choice of sewing thread depends on the nature of the material, and maintenance actions may have negative effects on product quality.

When sewing synthetic materials with cotton, during washing or cleaning, wrinkling may occur because of different behavior in water of the material versus the thread, which is not observed in the synthetic thread. [6]

3.CONCLUSIONS

We recommend using sewing thread of the same kind as the materials processed because wrinkling is due to the effects of sewing thread tension and also because of the stresses that appear in the material during and after processing.

Particular attention should be paid to the correct relationship between the needle, thread smoothness and structure of the material, avoiding the application of low tension sewing and proper handling of the material in the needle area and the use of appropriate technology equipment.

4. REFERENCES

[1]. Mitu, S., Mitu, M., (2005). Vol. I. *Bazele tehnologiei confecțiilor textile*, Editura "Gh. Asachi ", page number 315 - 316, University Publicher, ISBN 973-730-025-4; 973-730-026-2 Iaşi, România.

[2]. Dodu A & colaboratorii (2003) Vol. II . Partea B. Secțiunea VII. Confecții textile *Manualul inginerului textilist,* Editura AGIR, page number 1507 – 1508, ISBN 973-8466-10-5; 973-8466-96-2 Bucureşti, România.

[3]. Şuteu, M., Indrie, L., Ganea, M., (2012 *), Determination of optimum performance regime for sunstar buttonhole machine by vibrations measuring technique processing the data measured with Data Explorer Software module.* Annals of the University of Oradea – Fascicle of Textiles - Leatherwork, Proceedings of Internatoinal Scientific Conference ' Innovative Solutions for Sustainable Development of Textiles Industry ", University Publicher, page number 146, CD-ROM ISSN 2068 – 1070, ISSN 1843 – 813X, Oradea, România.

[4]. Mitu, S., Mitu, M., (2005). Vol. I. *Bazele tehnologiei confecțiilor textile*, Editura " Gh. Asachi " , page number 303 - 404, University Publicher, ISBN973-730-025-4; 973-730-026-2 Iaşi, România.

[5]. Mitu, S., Mitu, M., (2005), VOL. I. *Bazele tehnologiei confecțiilor textile*, Editura " Gh. Asachi " , page number 318 - 319, University Publicher, ISBN 973-730-025-4; 973-730-026-2 Iaşi, România.

[6]. Mitu, S., Mitu, M., (2005), Vol. I. *Bazele tehnologiei confecțiilor textile*, Editura "Gh. Asachi ", page number 314 - 315, University Publicher, ISBN 973-730-025-4; 973-730-026-2 Iaşi, România.

THE INFLUENCE OF HUMIDITY ON THE TENSILE STRENGTH AND BREAKING ELONGATION OF YARNS FOR KNITTING SOCKS

Dorin Vlad[1], Alina Mihaela Coldea[2]

[1, 2] *Faculty of Engineering, Sibiu, ROMÂNIA*

Corresponding author: Dorin VLAD, E-mail: dorin.vlad@ulbsibiu.ro

Abstract: Tensile property of textile yarn is a prime important parameter in establish the suitability for any particular application. Breaking strength, elongation, elastic modulus, abrasion resistence etc. are some important factors which will represent the performance of the yarn. It is therefore of utmost importance to determine this characteristic accurately. Raw material characteristics influence properties of the knitted products. The yarns are subjected to mechanical stress during knitting and while wearing the products.
The most common types of force applied to knitted fabrics is traction, which usually does not exceed 25 to 30% of breaking strength. In some cases the tensile forces are higher and are producing remanent deformation and damages. On getting dressed, the product is stretched out with a force bigger than during the wearing.
Because socks are subjected to tensile forces both in the dry and wet state, we have studied the tensile strength and the breaking elongation for different types of yarn used in knitting these products. Tests were made in dry and wet state using SR EN ISO 2062:2000 Textiles - Yarns from packages- Determination of single-end breaking force and breaking elongation, using Titan2 device. The testing results for tensile strength and breaking elongation are presented in graphics and analysed.

Key words: yarns, sock, tensile strength, breaking elongation, humidity

1. INTRODUCTION

Phisical and mechaninal caracteritics of yarns are influencing the behaviour of knited products. The properties of the fibers, including textile fibers are influenced by humidity. According the molecular and morphological structure of each type of fiber, textile fibers have the capacity to absorb or to release water vapours from the environment. Moisture and humidity affects the strenght of the fibers. [1]

Humidity leads to the expansion of textile fibers. Because the structure of the fibers it's aligned along the textile fiber, the water molecules are pushing outwards the polimers chains therefore the diametre will increase with a much higher percentage than their lenght. [1]

Generaly speaking, the presence of the water molecules in the fiber's structure reduces the cohesion forces wich mantains together the polymer chains, thus diminishing the resistance of the fibers and of the yarns. An exception from this rule includes the vegetable fibers, e. g. cotton, where the presence of the water increases in fact strength. [2]

In figure 1 is shown how the properties of raw materials influence fabric characteristics. [3]

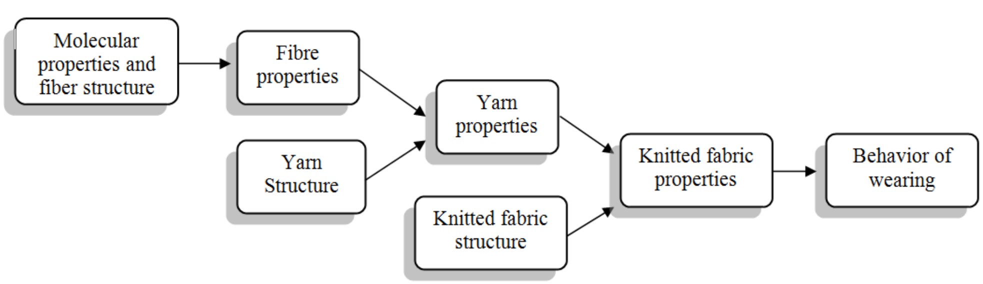


Figure 1. Influence of raw material properties on the characteristics of products [3]

Because some products are applied while wearing both the dry and wet, in the present study we determined the breaking strength and breaking elongation dry and wet for several types of yarn used in knitting socks. [4]

2. TESTING METHOD AND EQUIPMENT

In order to analyze the breaking strength and breaking elongation, samples were tested on Titan[2] dynamometer, applying the breaking force according to standard SR EN ISO 2062:2000 Textiles -Yarns from packages - Determination of single-end breaking force and breaking elongation using constant rate of extension (CRE) tester.

Before testing the dry yarns, these were conditioned in the standard atmosphere for 24 hours at a temperature of 20^{o}C and 65% relative humidity. The wet yarns were obtained according to standard SR EN ISO 2062:2000.

10 tests were carried out for each type of yarn, applying a tensioning force of 0,500cN/tex. Jaw separation was 250 mm and rate of extension 250 mm / min. [5], [6].

The tests were performed with the Titan[2] – Universal Strength Tester, Model 710. The device draws in real-time stress-elongation chart for each sample. For each yarn, the averaged values are calculated and shown in table 1. [5], [6]

4. RESULTS AND GRAPHS

Table 1. Results

Sample	Raw material	Yarn Fineness [Nm]	Breaking strength [cN]		Elongation [%]	
			dry	wet	dry	wet
1	Cotton 100%	34 / 1	393	448	6.38	10.14
2	Cotton 100%	40 / 1	275	326	5.14	10.30
3	Cotton 100%	50 / 1	241	355	4.20	8.59
4	Organic cotton 100%	34 / 1	350	574	5.24	11.99
5	Cotton + soybean (50% + 50%)	34 / 1	446	519	9.88	16.53
6	Polyester + viscose (52% + 48%)	34 / 1	700	615	12.76	13.62
7	Tencel	34 / 1	755	667	9.50	16.91
8	Bamboo + viscose (50% + 50%)	34 / 1	588	310	16.86	20.26
9	Viscose + silk (90% + 10%)	34 / 1	551	281	15.57	19.92
10	Polyester 100% Recycled	34 / 1	784	748	14.70	15.72

In the figures 2-11 are shown the diagrams of the tested yarns and in the figure 12 and 13 are shown the tests results for breaking strength and elongation at break, for yarns in dry and wet de state.

DRY **WET**

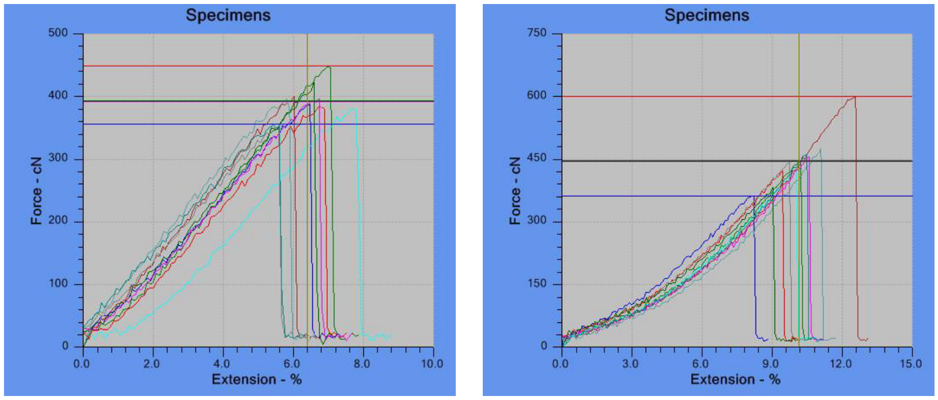


Figure 2. Sample **1** - Cotton 100%, 34/1 Nm

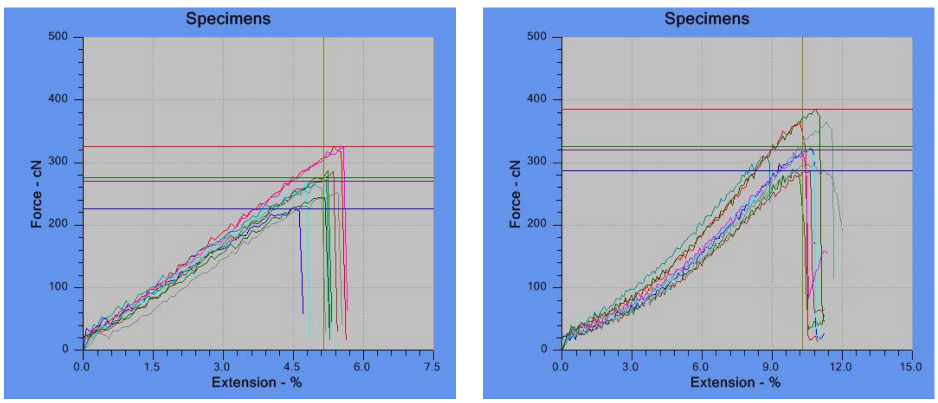


Figure 3. Sample **2** - Cotton 100%, 40/1 Nm

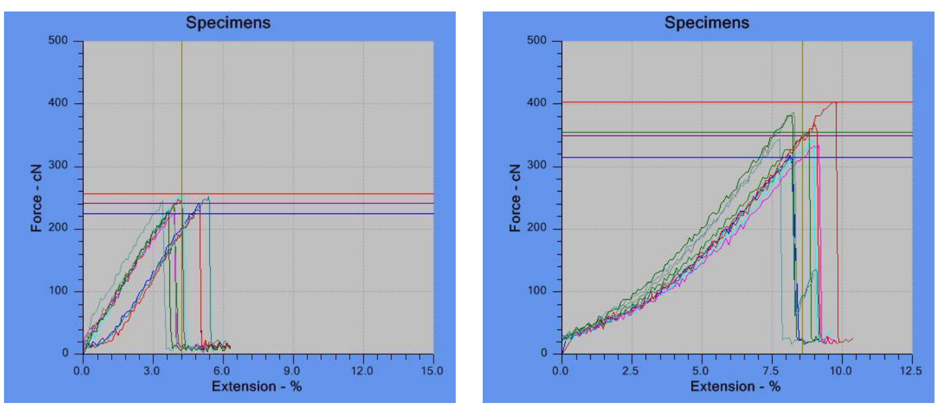


Figure 4. Sample **3** - Cotton 100%, 50/1 Nm

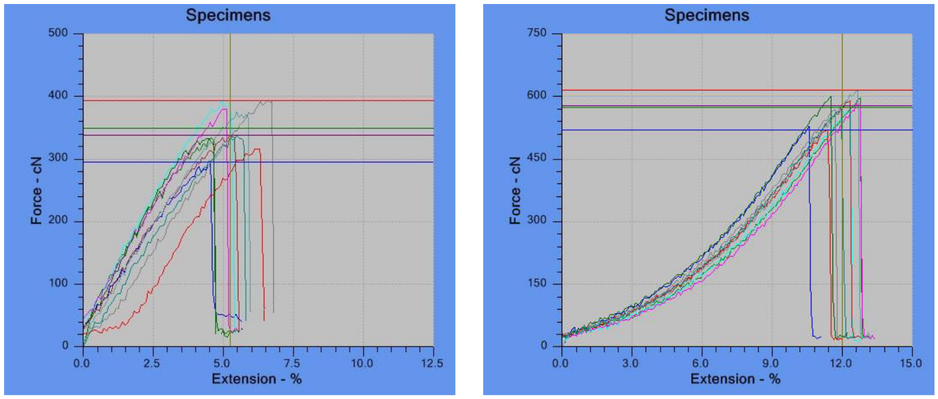


Figure 5. Sample **4** - Organic cotton 100%, 34/1 Nm

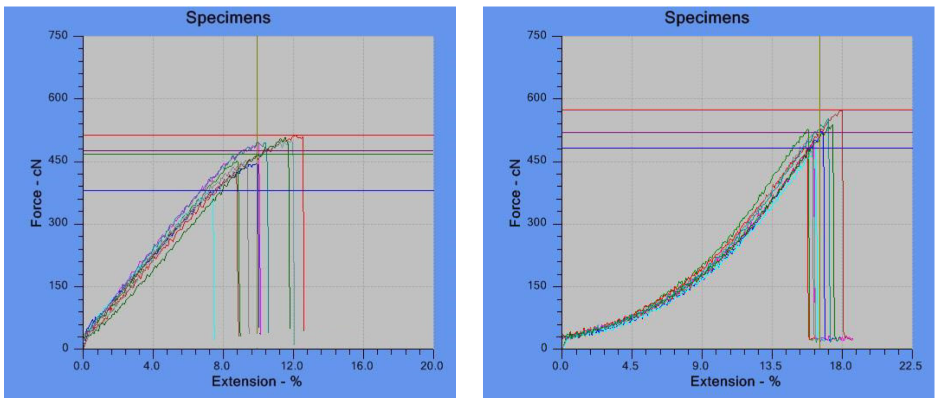


Figure 6. Sample **5** - Cotton + soybean (50% + 50%), 34/1 Nm

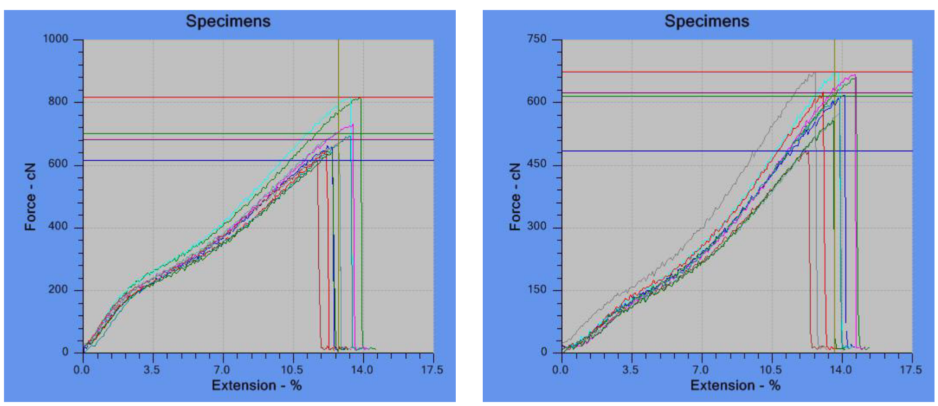


Figure 7. Sample **6** - Polyester + viscose (52% + 48%), 34/1 Nm

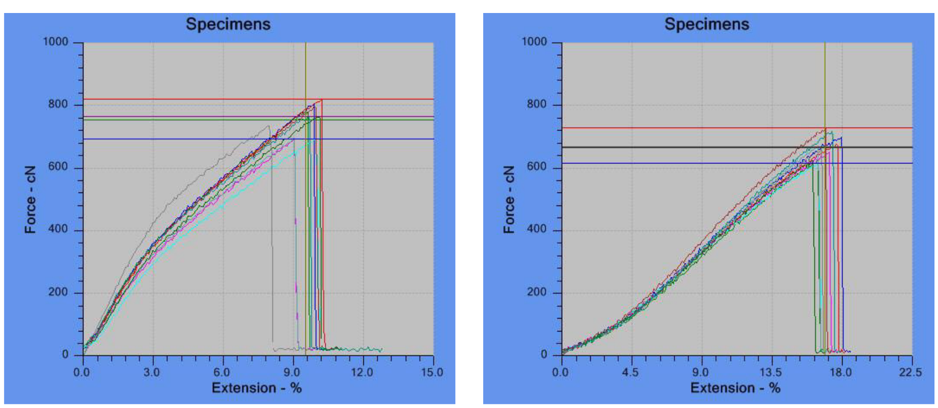


Figure 8. Sample **7** - Tencel, 34/1 Nm, 34/1 Nm

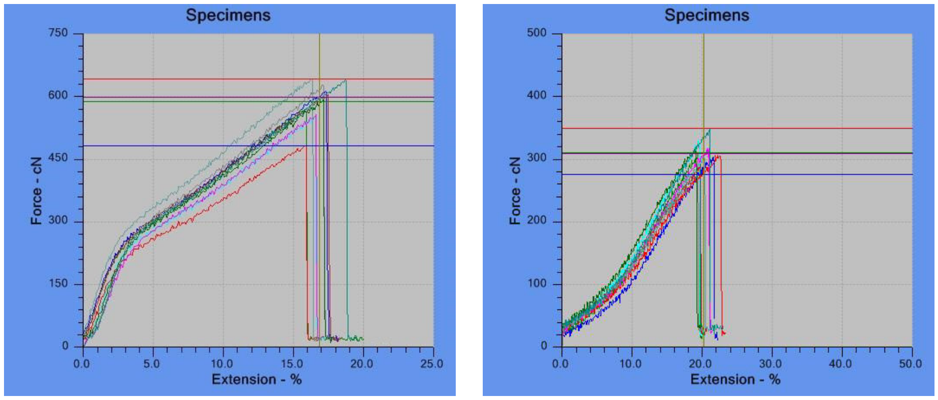


Figure 9. Sample **8** - Bamboo + viscose (50% + 50%), 34/1 Nm

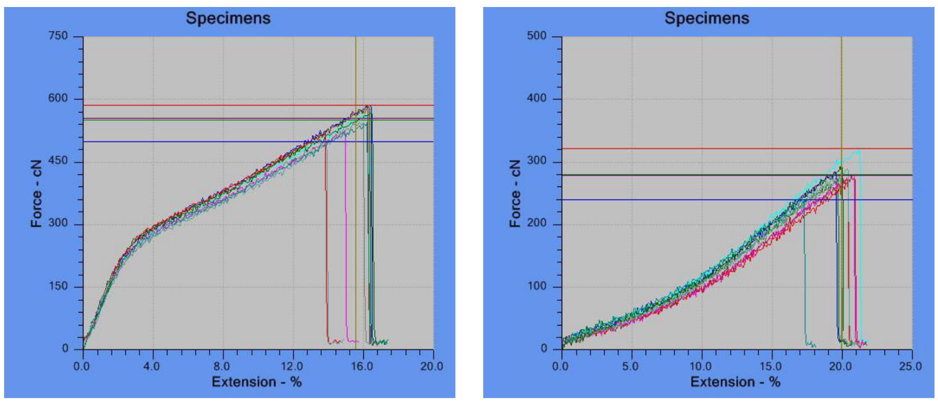


Figure 10. Sample **9** - Viscose + silk (90% + 10%), 34/1 Nm

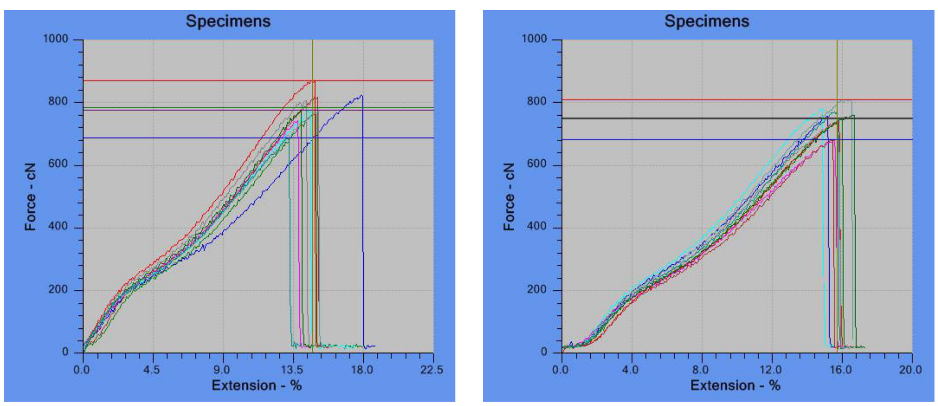


Figure 11. Sample **10** - Polyester 100% Recycled, 34/1 Nm

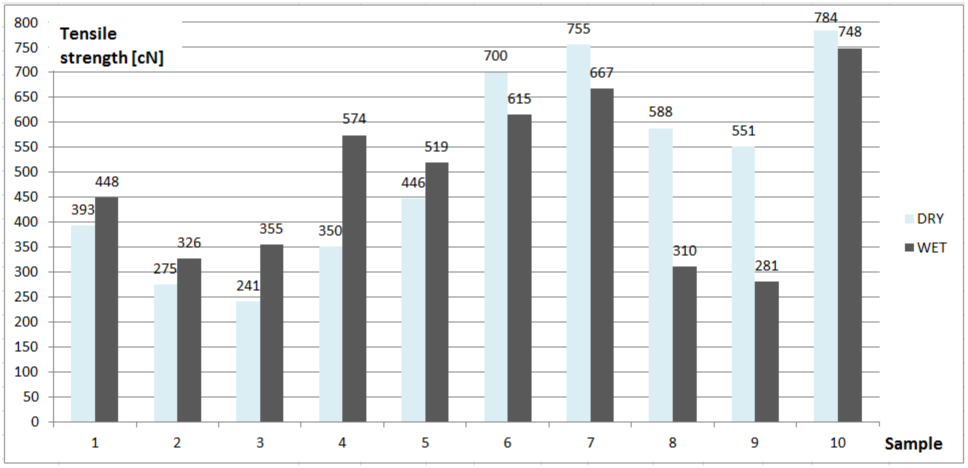


Figure 12. Graph for breaking strength – dry and wet samples

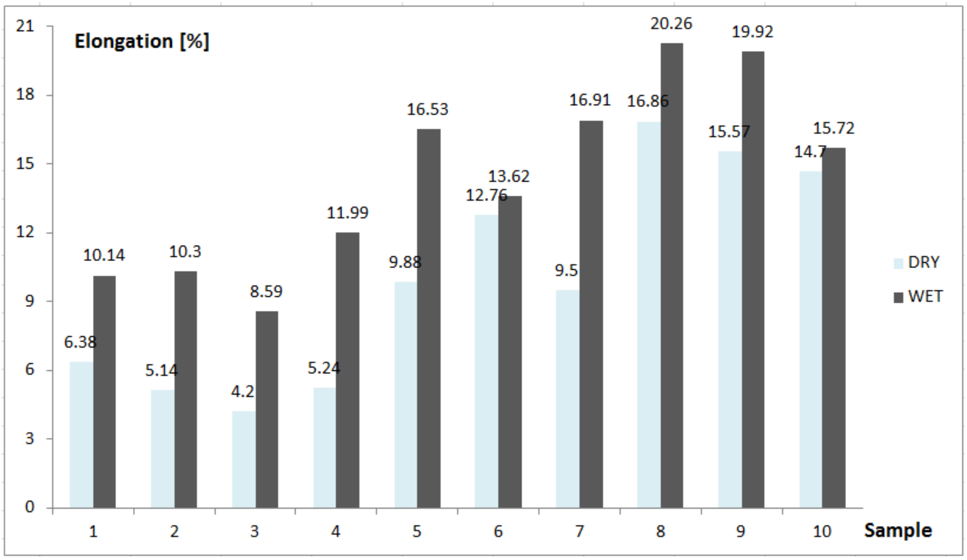


Figure 13. Graph for elongation – dry and wet samples

For 100% cotton yarn tested in dry state, if we change yarn fineness from 34/1 Nm to 40/1Nm, and from 40/1Nm to 50/1 Nm then tensile strength decreases with 43% and 14%.

For samples 1, 2, and 3 tested in wet state, if we change yarn fineness from 34/1 Nm to 40/1Nm, and from 40/1Nm to 50/1 Nm then breaking strength decreases with 37.4% and 9%.

In the case of samples 1 (100% cotton) and 4 (100% organic cotton) tested in dry state and for the same fineness of the yarn (34/1Nm), the breaking strength increased with 12.3% in the case of sample 1, while for the same samples tested in wet state, breaking strength increases with 28% for sample 4.

Analyzing the samples 1 (100% cotton) and 5 (50% cotton +50% soybean), 34/1 Nm, it is observed that the soy fiber increases breaking strength in dry state with 13.5% and with 15.8% in wet state.

For yarns made from mixtures of fibers, 6 (Polyester Viscose + 52% + 48%) and 10 (100% Polyester recicled) 34/1 Nm, it is observed that the presence of viscose fibers decreases the breaking strength in the dry state with 12% and with 21.6% in wet state.

The 100% Recycled Polyester yarn has the highest breaking strength in dry and wet state, 30/1 Nm.

If one compare the results obtained for dry 100% cotton yarn (samples 1, 2 and 3), when yarn fineness decrease with 17, 6% (samples 1 and 2) and 25% (samples 2 and 3), the breaking elongation decreases with 24% and 22, 4 %.

For samples 1, 2, and 3 tested in wet state, when yarn fineness decrease with 17, 6% (samples 1 and 2) and 25% (samples 2 and 3), the breaking elongation decreases with 1, 6 % and 19,7%.

In the case of samples 1 (100% cotton) and 4 (100% organic cotton) tested in dry state and for the same fineness of the yarn (34/1Nm), the breaking elongation increased with 21,8% in the case of sample 1, while for the same samples tested in wet state, the breaking elongation increased with 18,2% for sample 4.

Analyzing the samples 1 (100% cotton) and 5 (50% cotton +50% soybean), 34/1 Nm, it is observed that the soy fiber increases the breaking elongation in dry state with 54, 8% and with 63% in wet state.

For yarns made from mixtures of fibers, 6 (Polyester Viscose + 52% + 48%) and 10 (100% Polyester recicled) 34/1 Nm, it is observed that the presence of viscose fibers decreases the breaking elongation in dry state with 15, 2 % and with 15, 4% in wet state.

5. CONCLUSIONS

Breaking strength on wet samples is greater than dry state for the yarns of natural cellulose fibers and smaller for the yarns made from artificial or chemical fibers 100%

For all samples, the breaking elongation is higher in wet state.

The presence of soy fiber in mixture of fiber increases the yarns breaking elongation in dry and wet state

The presence of viscose fibers decreases the breaking elongation and the breaking strength for yarns made from mixtures of fibers, in both states: dry and wet.

6. REFERENCES

[1]. DODU, Aristide (coord.). Manualul inginerului textilist: *Tratat de inginerie textila. Vol.III: Tricotaje. Textile neconventionale si alte textile. Confectii textile. Tehnologie chimica textila. Partea A* (2004)

[2]. Preda, C., Preda, C..*Metode si aparate pentru controlul calității materialelor textile destinate confecționării produselor de îmbrăcăminte*, Editura Bit, Iași, 1995.

[3]. Floca, A.M. Thesis. *Contribuții privind proiectarea calității produselor tricotate pe maşini circulare cu diametru mic, Iași, 2005*

[4]. Vlad, D.; Floca, A. M., Dinu, M., Study on Strength and Breaking Elongation for Yarns and Knitted Fabrics Used to Make Socks, *Annals of DAAAM for 2010 & Proceedings of the 21st International DAAAM Symposium*, pp 0268, ISBN 978-3-901509-73-5, ISSN 1726-9679, Editor B. Katalinic, Published by DAAAM International, 2010, Vienna.

[5]. Technical book of Titan^2 – Universal Strength Tester

[6]. SR EN ISO 2062:2000 Textiles -- *Yarns from packages -- Determination of single-end breaking force and breaking elongation using constant rate of extension (CRE) tester.*

MAKING THE FOOTWEAR PARTS USING DELCAM CRISPIN ENGINEER

Mariana Drişcu[1]

[1] *Faculty of Textile, Leather and Industrial Management,"Gh.Asachi" Technical University of Iasi*

Corresponding author: Drişcu Mariana, E-mail: 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 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. 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, CAD (Computer Assisted Design).
This paper presents how the **CRISPIN Dynamics Engineer** can be used in designing of footwear products. This is a part of application **CRISPIN Dynamics CAD Suite**. It is a range of quality software products to give you the shoemaker a major advantage in shoemaking. With **CRISPIN Dynamics** you can visualise a range of designs on-screen, work out the costs of a new style and even cut out sample shoe components. Reliance on manual skills are largely eliminated, so your staff can work creatively, but with increased accuracy and productivity. You can even send designs to a distant office or manufacturing centre in a matter of minutes.
The **Engineer** program is broken into a series of 'tasks'. Each 'task' has a 'tool tray' that contains a number of separate functions to achieve the task. This are:
- **Drawing** Menu is used for digitise the flattened half shell and develop into a full shell
- **Grade** Menu is used for gradin main shell
- **Assess** Menu is used to develop various template placement and estimate resources consumption.

Key words: digitise, function for makig modell, pattern of the shell, grade for creating other shell

1. INTRODUCTION

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 lot of the producer's time [1],[2],[3]. Moreover, the results of this classical methodology may contain many inaccuracies with the most unpleasant consequences for the footwear producer. 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, CAD (Computer Assisted Design)

This paper presents the basic function for footwear designing using the system **CRISPIN *Dynamics* CAD Suite Engineer.** This is 2D application of the **CRISPIN Dynamics CAD Suite**. The **Engineer** program is broken into a series of 'tasks'. Each 'task' has a 'tool tray' that contains a number of separate functions to achieve the task [4], [5], [6]. This are:

- **Drawing**
- **Grade**
- **Assess**

When the Engineering program first starts the Draw task is active and the tool tray is displayed, as shown in the above partial image.

2. THE LAYOUT OF CRISPIN DYNAMICS ENGINEER

The layout of **CRISPIN Dynamics Engineer** follows a pattern established by many PC programs using the 'single document' model as the basis of operation (see figure nr. 1). This means that a single instance of **Engineer** can only have one pattern file open at a time [2],[3],[5].
Engineer consists of these main areas:

- A title bar, that shows the program title with the name of the pattern currently loaded.
- A menu bar, at the top, following normal Windows convention.
- A main toolbar, underneath the menu bar (default location).
- A small 3 option task bar, underneath main tool bar.
- A tool tray at the left of the screen, the Draw, tool tray is automatically active at startup (see fig. 1).
- The Parts and layers manager will 'slide out' from the right side of the screen when the mouse pointer 'hits' the side. There is an alternative 'icon brwser' view of the parts not shown below.
- A status bar at the base of the screen displays prompts and other information while the program is being used.
- Last but not least is the main workspace area. When a pattern is first loaded the program is in 'selection mode' waiting for a line type or function to be selected.

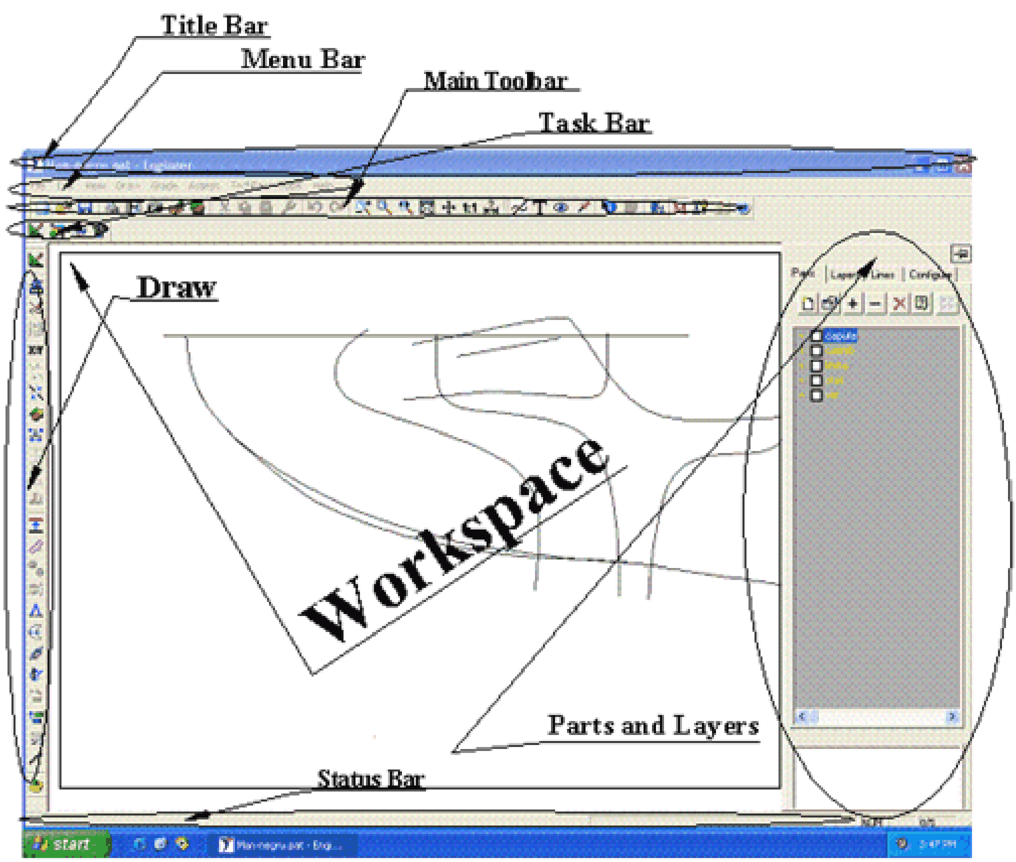
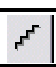


Figure 1: Workspace of the Engineer

3. THE BASIC FUNCTIONS FOR DRAWING

The following table presents the main functions of Crispin system that are used to create a footwear product, a detailed template or to scale the designed or digital model [4],[5].

ICON	Name of function	Function
	**Digitise** (a pattern)	The function digitise base lines
	**Draw** (base line)	The function freehand draw wits the mouse
	**Split**	Split a single base line, at any point, to creat two more new base lines
	**Join**	A function to 2 or more base lines together, to create one new base line
	**Shape**	A function to draw regular geometric base lines shapes
	**Construct a base line**	A function to draw single straight (two point) base line starting in 'free space', from one base line or two intersecting base lines.
	**Mean** (Average of two base lines)	Create an average base line of two approxi-mately parallel lines
	**Partial Mean** (Average of two base lines)	Create an average base line of a portion of two approximately parallel lines
	**Spring**	Use this function to change existing or create new base lines by moving and rotating selected lines to a new position
	**Margins**	A function to create or modify dependant margins
	**Markers** (Stitch Markers/Slots)	A function to create or modify dependant markers
	**Stabs**	A function to create or modify dependant stabs (perforations)
	**Mirror**	A function to create dependant mirrored lines
	**Boundary**	A Boundary line is just a dependant closed line connecting one or more lines to define the shape of a pattern part
	**Chain**	A Chain line is connecting two or more lines
	**Rotate**	A function to create or modify dependant rotated lines
	**Translate**	A function to create or modify dependant translated lines
	**Offset**	A function to create or modify dependant offset lines
	**Decorative** (Feature)	A function to create or modify Decorative features
	**Gimp Plus**	A function to create or modify Gimp lines
	**Duplicate**	The function duplicate one or more base line
	**Create by X/YCoordinates**	Draw lines by entering X, Y coordinates

4. RESULTS. THE FOOTWEAR DESIGNING SESSION

4.1. Digitise the flattened half shell or standard

The first step in the footwear designing session is to save in the computer's memory the digitized form of '"half shell', or standard [2], [3],[5]. The speps for digitizing are as folows:

- Prepare the flattened half shell or standard for digitising by lightly marking where the key points to record are on the edges and internal lines.
- Align the shell on the digitiser, fix in place with a little low tack tape and digitise all the lines.
- Launch the digitizing by clicking on the tool: 

The processes for digitized to input base line data from a 2D digitising tablet . You can use any 2D digitiser supported by the 'Wintab' standard and as only 3 buttons (and delete) are needed it is easy to learn, quick and accurate.

To begin we will assume that the digitising tablet has been correctly configured and calibrated if necessary. So the first step is to click on the digitise icon, shown above. There is a variation in the process if there is already data on the sceen but for the moment let us assume this a new pattern.
Align the shell on the digitiser, fix in place with a little low tack tape and digitise all the lines.
For that prepare and mark the shell with a pencil, the points to digitise along the lines . In the process keep the number of data points to a minimum. In picture 2 is one examples of digitse pattern.

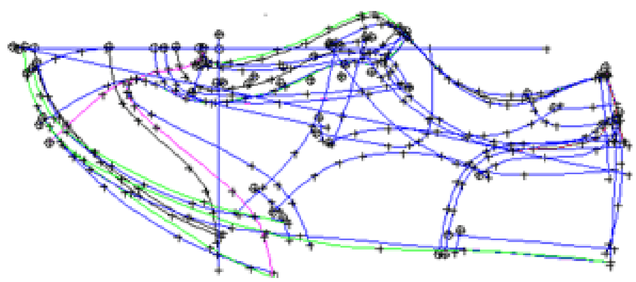


Figure 2: Digitise the flattened half shell

4.2 Develop into a full shell

For define the shape of a pattern part we develop into a full shell using various dependant line types, like margins and boundaries [4],[5], [6].
The system **CRISPIN *Dynamics* CAD Suite Engineer** offer many function for draw the footwear pattern. Using the CRISPIN function we develop into a full shell and create sundries effect for the fotwear patterns. In picture 3 is one examples of develop pattern.

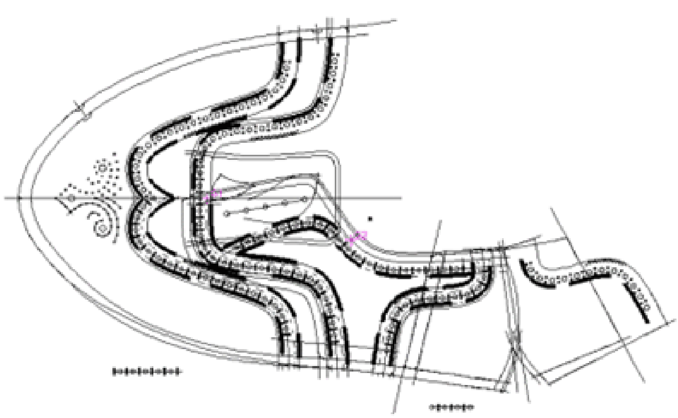


Figure 3: Develop into a full shell

4.3 Create the individual parts

Templates can be made in Crispin with the Boundary and Chaine tools; the Mirror function is subsequently applied, to make the template whole. The template database can be made using the Part Manager function.

The individual parts (see picture 4) will created using the menu **Parts Manager** [2],[3],[6]. The selection, creation and management of parts is on the first tab of the dialog that 'slides out' from the right side of the workspace, when the mouse cursor comes within 5 pixels of the edge.
In practice you simply 'bump' the mouse pointer to the edge of the screen and the dialog is displayed. This is easier when the program is 'maximised' as the pointer literally 'hits' the edge of the screen.
This does not happen in all circumstances, for example when 'dragging' an area with a mouse button held down. Also to minimise the accidental selection of this dialog there is a 500 millisecond delay before it activates. This delay can be changed by editing the registry [5].
The dialog can also be 'pinned' in the 'out' condition. In this mode the dialog will stay visible until a function is started at which point it will be hidden, when the function is complete the dialog will re-appear (see picture 1).

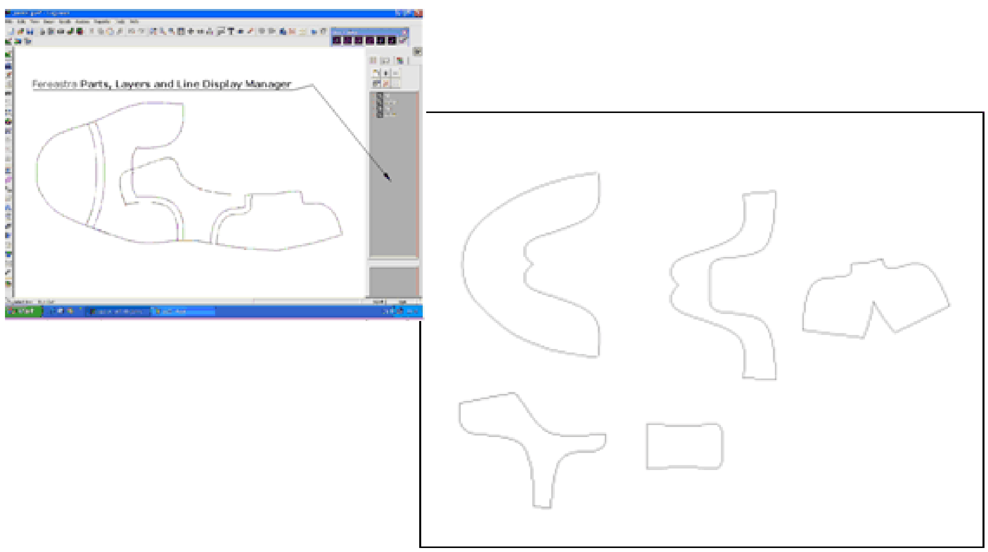


Figure 4: Window of the function Parts Layers and the parts of the shell

4.4 Grading

The grading a pattern and/or parts can to make using the **Grade Task Tool Tray [4],[6]**. This task is many fuctions wich launches the dialogs providing all the facilities to set up a size range and grading parameters. In picture 6 is one examples of grade pattern.

The major fuctions for the grade are:

– Choice of **Arithmetic** or **Geometric grade** and whether or not width fittings apply.

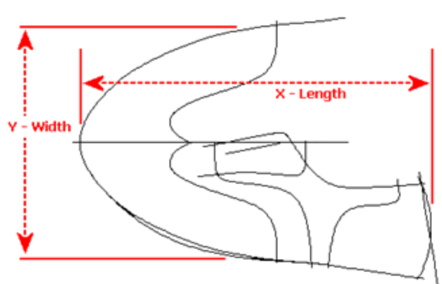


Figure 5. Dimension the base pattern

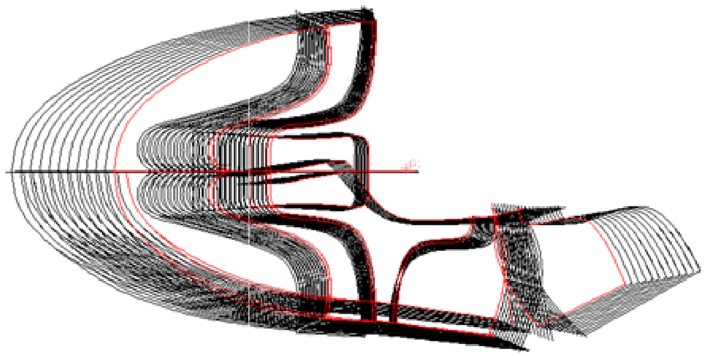


Figure 6: Grade the pattern

Note:

Using Arithmetic grading basically means that you simply add the size increment value to the previous graded size. If you were to plot the size change on a graph you would find that the resulting line is straight. Geometric grade, where the increment values are applied as a percentage, will produce a curved line.

Using geometric grading basically means that you apply the size increment value as a percentage of the previous graded size. If you were to plot the size change on a graph you would find that the resulting line is curved.

– The definition of the model size, its length and width measurements. The button at the left will start a special measure function. (see picture 5). The values measured are actually stored within the pattern documentation.

– Create and place **Grade Centres** to control the grading process.

5. CONCLUSION

With **CRISPIN Dynamics** you can visualise a range of designs on-screen, work out the costs of a new style and even cut out sample shoe components. Reliance on manual skills are largely eliminated, so your staff can work creatively, but with increased accuracy and productivity. You can even send designs to a distant office or manufacturing centre in a matter of minutes.

6. REFERENCES

[1] Costea M., Drişcu M (2011), *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] Drişcu M. (2010), *Reconstruction and flattening of the surface shoe last*, Proceedings of The 14th Internaţional Conference, Iaşi&Chişinău ModTech2010, May, 2010, Romania, ISSN:2006-391

[3] Mihai Aura, Costea M 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] Drişcu Mariana, *Modelarea formelor plane şi spaţiale ale încălţămintei,* Ed Pim, Iaşi, 2008

[5]***http://www.google.ro/search?q=shoe+size&hl=ro&prmd=imvns&tbm=isch&tbo=u&source=univ&sa=X&ei=KlpTT4DwNaik4ATx7rGzDQ&sqi=2&ved=0CEkQsAQ&biw=1024&bih=515, Acessed on 08.04.2013

[6] *** http://www.footwear-cadcam.com/languages/fr/general/cadsuite.asp, Acessed on 08.04.2013

FOOTBALL PLAYERS' LEGS BIOMECHANICS DURING THE GAME AND THE REQUIREMENTS FOR FOOTBALL SHOES

Cornelia Ionescu Luca[1], Cristina Secan[2]

[1] *"Gheorghe Asachi" Technical University of Iaşi, ROMÂNIA*
[2] *University of Oradea, ROMANIA*

Corresponding author: Cornelia Ionescu Luca, E-mail:cionescu@tex.tuiasi.ro

Abstract: Football players, during the game, find themselves in both static and dynamic positions. Movement may be accomplished through walking, marching, running and jumping. While walking, the step may be simple, if referred to a single leg or double when talking about both legs. The simple steps have different phases for the bare-foot, the impact phase, supported foot and oscillating shank-bone and propulsion. Football shoes for walking make contact with the support surface through cleats. The back cleats have the same role as the heel, causing on impact the foot to swivel in the tibia-astragalian joint, which makes the shank bone translate by sliding. The load that is placed on the heel begins to be progressively be trickled down to the front of the leg. During the football game, shoes are involved in all the specific technical procedures, with both positive and negative effects, depending on their characteristics. The general requirements are: provide a high degree of mobility; avoiding good impulse on the ball when kicked. This paper, we will summarize the results of study about the requirements that football shoes have to meet as a result of the stress that football players' legs are subjected to during the game in both static and dynamic positions.

Key words: athletics, running biomechanics, track and field shoes

1. INTRODUCTION

Football players, during the game, find themselves in both static and dynamic positions. This paper will go through the results of a study regarding the biomechanics of football players' legs. Also, we will analyze the characteristics that football shoes have to have in order to properly adjust to the wear and tear during the game, both in static and dynamic positions.

2. STATIC POSITIONS

Fig. 1 shows different balance situation of the human body [1], with support base changes:

A. bipedal balance, position that increases the lateral stability at the same time with spreading the legs and the support base is trapeze shaped.

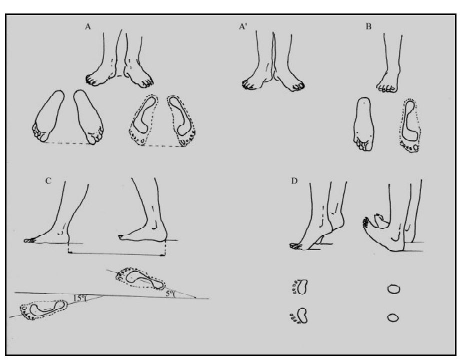


Figure 1: Static football player legs positions

B. single leg balance, when the support base is reduced transversally, but it is increased on the longitudinal direction, and the support base in triangle shaped.

C. step position, the support base is increased on the sagittal plane, with the center of mass free to oscillate.

D. tip-toes support, position that reduces the longitudinal support base, but a very good lateral support is made possible, even in one leg, because of the metatarsals freedom of movement I-V.

E. heel support, position that is very unbalanced.

Fig.2 shows the mechanism for the arch support showing the 3 different sole arch positions [1, 2]:

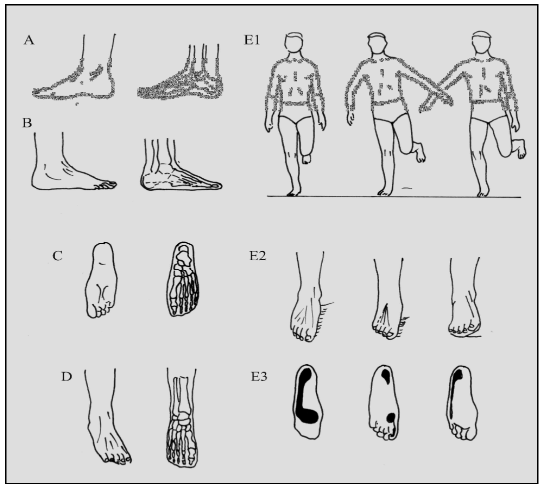


Figure 2: The arch support mechanism with the three arches

A. The internal longitudinal equilibrium sole arch which is very mobile and very accentuated. It is supported by the plantar aponeurosis, the thigh posterior muscle, the calf posterior retromalleolar muscle and the dorsal anterior calf muscle. By contracting these muscles makes the head of the metatarsal I get close to the sole and shifts the weight on the external support arch depending on the balance requirement.

B. the support arch, is less accentuated and is supported by the plantar aponeurosis and the external long fibular muscle.

C. Is an arch position where one can notice the flexors supporting the two longitudinal arches and the long fibular muscle goes across the plantar surface from the outside to the inside, helping to support the internal arch.

D. Is a view that shows the anterior calf, the dorsal support of the arch, the extensor and the long anterior fibular muscle.

E1. Different options to balance the subject that is in single leg balance by spreading his arms.

E2. The muscles for sideways balance, during the endurance test.

E3. The fingerprints during the balance game, while contracting the internal and external muscles. The single leg support duration is diminished a lot for a flat foot case or for inflammations that hurt.

The booted foot comes in direct contact with the shoe insole. The insole with its shape must provide a uniform distribution of the pressures against the plantar surface of the foot. Therefore, the insole has two curves in two directions[3,4]: the posterior-anterior one and very many transversal directions. Curving the insole in so many directions insures the heel can be easily raised; in the case of normal shoes, it's the heel that provides this feature. For football shoes, the heel is replaced by cleats. Beyond the metatarsal phalanges joints, towards the tip, the plane being slanted in the opposite direction provides the foot contact with the insole in orthostatic position by diminishing the load on the rest of the insole contact region.

2. DYNAMIC POSITIONS WITHOUT THE BALL

Movement may be accomplished through walking, marching, running and jumping[5]. While walking, the step may be simple, if referred to a single leg or double when talking about both legs [6]. The simple steps have different phases as seen in [1] Fig.3, for the bare-foot, the impact phase, supported foot and oscillating shank-bone and propulsion.

Football shoes for walking make contact with the support surface through cleats. The back cleats have the same role as the heel, causing on impact the foot to swivel in the tibia-astragalian joint, which makes the shank bone translate by sliding, like [1] in Fig. 4.

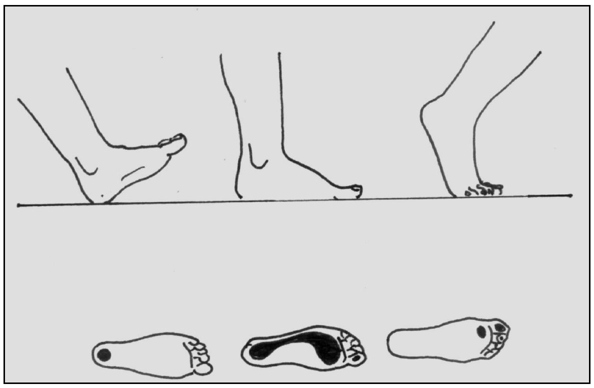


Figure 3: Simple step phases

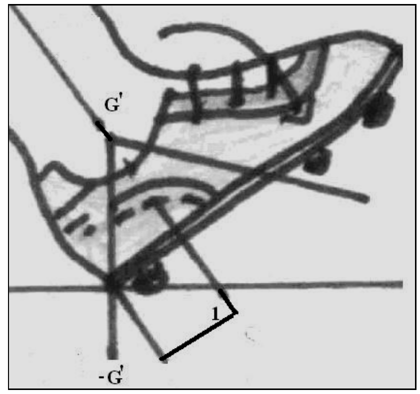


Figure 4: The impact between the support plane and cleats

A couple is formed and its moment is the product between force G that is applied by one leg and the distance l, measured from the posterior edge of the cleat and the tibia direction extension. One can assume that l=0 if the edge of the cleats is on a line that goes through the center of the heel and perpendicular on the plantar axis. At the same time, the load that is placed on the heel begins to be progressively be trickled down to the front of the leg. This way of putting stress on the posterior part of the shoe needs a rigid assembly, which currently, is comprised of the sole and the inner sole, both rigid, and the buttress which wraps around the posterior tars like a glove. To prevent injury on the ankle bones, the height of the back of the shoe is made of sponge like materials which avoid local pressure buildup. Load distribution from impact to propulsion is depicted [1,3] in Fig. 5.

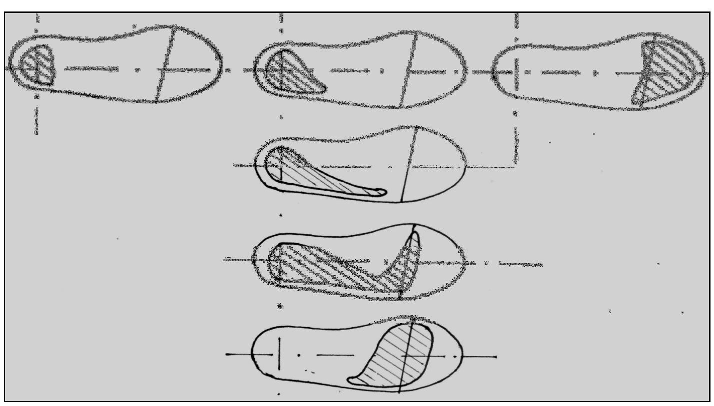


Figure 5: Load distribution from impact to propulsion

Moving the load from the anterior part of the leg is made possible by swiveling the shank bone in the tibia-astragalian joint and pulling up the heel using the Achilles' tendon. During this translation, the tarsal and metatarsal bones are being kept from moving by the fixating effect of the insole and the buttress and the anterior part of the back of the shoe which locks the foot with the lace.

Making the shoe rigid finishes with the metatarsal phalanges joints, which by design, is a portion in between the two groups of cleats. The cleats must be positioned so the leg may be easily flexed without using too much work.

The front part of the lower parts, made of the insole-sole assembly, follows the opposite inclination plane. This allows for the foot to come into contact with the insole, immediately after the impact, which takes some of the load. As the tibia swivels in the tibia-astragalian joint, then the load on the toes increases reaching its max in the propulsion phase.

Propulsion makes the foot swivel by lifting the back of the shoe to height H, which in normal conditions, corresponds to the angle φ_f between the posterior plane and the horizontal like [3, 4] in Fig. 6.

For football shoes, the angle that corresponds to height H is realized by rolling the sole on the plane until the tip almost touches the plane and flexing the entire sole-insole assembly around the metatarsal-phalanges joints. Flexing the foot with minimal effort requires a work that can be expressed as:

$$L_f = H_f \times P, \quad \textbf{(Nm)} \qquad \textbf{(1)}$$

Where: Hf – increasing the back height as a result of the bending expressed in m; P- bending force on the corresponding part of the φ_f angle and it is expressed in N.

This model is influenced by the way the rigidity of the ground allows for the cleats to puncture it.

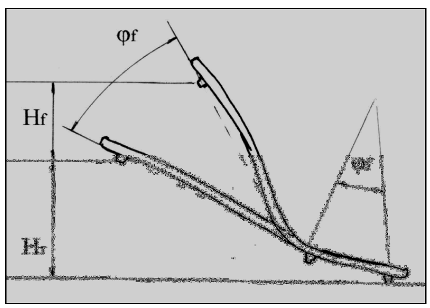


Figure 6. The booted foot during propulsion

Running makes the entire body accelerate in the coccyx-femur joint, the knee joint and the tibia-astragalian joint. Overall, the body is in instable balance, which makes the foot plant in the support surface. This is mainly done using cleats which through their shape, position, dimensions and mechanical characteristics make the foot anchor in the ground, thus avoiding the foot slipping. The running foot coming in contact with the support plane differs from the walking foot. Very often, this is made through the front sole, which avoids slipping. It is possible, that some cases, the contact to be made through posterior cleats and also anterior ones. This phase has special features for each player, the player being able to properly react to game situation by practicing during training [5].

The situations that the foot is placed during the game are highly complex, that being the main reason, shoes shouldn't limit the possible movements of the flexion tibia-astragalian joints, extension, rotation that changes the foot sole plane with respect to the vertical tibia plane or suspiration, pronation and rotation around the shank bone. These movements are manifested in the most complex game associations, especially when dribbling. Equally important, shoes shouldn't allow the metatarsal -phalanges articulations to be injured, that's why the shoes are more rigid in that area. On the other hand, the position and distribution of the cleats, must insure the booted foot rolling in the direction of walk and also allow for the pronation and suspiration movements. The complexity of these movements requires for the boot to become one with the athlete and at the same time be able to respond to his complex movements.

One of the body movements that comes under a lot of influence from the shoe, is coming to a stop after moving. This is possible in different variations, including stopping after reducing speed and coming to a full stop while speeding. For both cases, stopping is the result of the cleats puncturing and entering the ground. If running, the inertia comes into play. It is to be expected that the tibia-astragalian joints be affected by the body inertia and the shoes being pinned in the ground. To avoid unwanted effects that might lead to unwanted pressure on some of the body parts, it is necessary for the metatarsals and the tarsals to come together with the rigid shoe in back part with the insole, the sole and the buttress and the top of the foot to be strapped in with the lace[6, 7].

If there was a play between the tars and the shoe, that could determine passing the load on to the tars which can affect the inner tars and joints. Designing the sole, the innersole and the buttress, wrapped tight as a muff, will eliminate this risk and the foot will act as one. Sponge like materials, cushions make the pressure get spread out on the entire foot surface and therefore reduce locally focused stress.

Jumping is a very demanding phase, in which the body is tossed in an arching movement that quickly changes the position of the center of mass, both on horizontal and vertical [8]. They usually happen when the body is moving fast, running but also walking, the jump amplitude in both directions, the length of the step while jumping, are the result of a complex movement of the planted foot which pushing against the ground pushes the entire body. Being a movement that is realized through running, a sudden stop of the support leg is necessary, planting the foot through the cleats on the ground and projects the center of mass in a different direction. The amplitude in both directions depends on the intensity of this initial propulsion. Jumping is the moment when a lot of stress is put on the support leg. It is this moment when the foot and the boot have to come together as one to avoid building local pressure with negative consequences on the leg integrity. It is also important that the shoe maintains its shape.

Jumping impulse, in the propulsion phase of the support leg, is possible by pushing the toes against the ground through the tip cleats after the sole is rolled on the plane and bending the metatarsals. Therefore, the sole in between the first row of cleats and the tip of the shoe needs to be rigid. This insures a good contact between the toes and the insole, pushing the foot inside the shoe and propelling the body forward. It's easy to understand that the shape of the insole in this part, and the arch tending to flatten at this point, add to the safety of the foot. In all movement phases, we underlined the importance of the lower part assembly of the shoe, the insole and the buttress, getting rigid in the back part close to the metatarsals phalanges joints. In the back part, all the way halfway up the leg, the rigid buttress makes sure the "muff" prevents dislodging any bones. Tying the shoe laces adds to that.

4. DYNAMIC POSITIONS WITH A BALL

Shoes come in contact with the ball in several different situations: stopping the moving ball, controlling the ball, kicking the ball while standing and kicking while moving [9].

Stopping the ball while moving is possible in the following situations: the ball is moving on the ground without bouncing or bouncing less that ½ of its diameter, the ball is bouncing more than its diameter, the ball is in the air, and it will come into contact with the plane close to the player or far away from him. All these cases ask for the player to stop the ball when the game conditions require it. Sometimes, depending on the case, the ball does not come to a stop, but it is kicked while the player is still moving. Stopping the ball is usually done by the leg oscillating. This is done with the lower sole, with the interior or the exterior of the foot and the top of the foot. Through training, the player learns how to stop the ball without much of a bounce, and this is possible by pulling the leg back from the previous oscillation. This way, the relative speed of the leg to the ball is reduced and eventually the ball is stopped. Te impact effort is not a problem for neither the shoe, nor the foot. When the ball comes into contact with the oscillating foot, deforming the foot is avoided by the overall rigidity of the booted foot.

Controlling the ball at ground level is realized using small impulses with any of the parts of the shoe, making the ball moving forward for a short distance, at the same pace with the player. Using any part of the foot, one needs to dribble also, when encountering a player from the opposite team. To do this, the player will tap into an arsenal of various, repeated ball direction changes, by utilizing both legs. A successful dribble is the result of various invisible connections between the ball and the player, by setting the adversary off balance. The small impulses must not be elastic, they have to dissipate the effort, in order to cancel the shock. This may be done with the extra cushioning on top of the shoe.

The movement kick may be executed in two distinct situations. The first case, the ball is moving the same direction as the player, which usually coincides with the direction he wants to kick the ball in. This requires, depending on the shape and direction of the movement of the ball, a kick with the top of the foot. For special spins on the ball, depending on the player's skills and experience, one might use the inside or outside of the foot. Kicking the ball with the tip of the foot, while it may make the ball go faster, also makes it more unpredictable. This raises the problem of designing a proper shape for the tip and making the ball go in the direction it has been kicked in. If the ball is moving straight at the player, it is recommended to first stop the ball and then kick it.

While in the middle of the game, sometimes, the ball cannot be stopped as desired. The force of the ball descending is big enough to bend the shoe at the metatarsals level and possibly causing breaking the leg.

Kicking from a standing position comes in two variations: the goalie kicking the ball after releasing it from his hand and free kicks. In the first case, the ball is kicked with the top of the foot. That is realized by oscillating the leg. The second case, the ball may be kicked in several different ways: the dorsal part, putting pressure mainly on the metatarsal-phalange joints, on one of the sides, external or internal, affecting the same are as before through the tip of the shoe. In the case of kicking the ball with the tip of the shoe, one can get different spins and effects and the ball following a straight trajectory or a curved one. No matter what the case is, the ball will get deformed elastically, which, when getting back to normal will cause the ball to bounce off. This deformation will be more accentuated if the tip is pointed.

5. CONCLUSIONS

- During the football game, shoes are involved in all the specific technical procedures, with both positive and negative effects, depending on their characteristics.
- The football shoe requirements are results of the stress the leg comes under both static and dynamic conditions.
- The general requirements are: provide a high degree of mobility; insuring the foot is protected and it’s not subjected to too much stress; avoiding injuries; the player only uses the necessary energy; good ball control; good impulse on the ball when kicked.
- The shoe requirements may be met by different measures: properties of materials they are made of parts; shape and dimension of different design characteristics; capacity to maintain their shape; shape, dimensions and the cleats distribution and the center of mass position.
- Some of the conditions have a contradictory character, because some of the requirements are different. As a result, the problem may only come to a compromise, by optimizing the result.

6. REFERENCES

[1]. Iliescu A.(1975). *Biomecanica exercitiilor fizice si sportului*, Editura Sport Turism.
[2]. Hamilton M,Luttgens K;Kinesiology. (2002). *Scietific basis of human motion*, Mc Graw-Hill,Boston.
[3] Mărcuş L. (2000).*Concepte ortopedice şi biomecanice în construcția încălțămintei pentru sport*, Conferința Națională de textile Pielărie Chişinău.
[4]. Budescu E, Iacob I. (2004). *Segment power analysis in gait biomechanics*, Rev Sport si Societate, nr 1 Iasi.
[5]. Chan CW,Rudins A. (1994). *Foot biomechanics during walking and running*, Mayo Clinic Proc, 69 (5).
[6]. Dugan SA,Bhat KP. (2005). *Biomechanics and analysis of running gait*, Phys Med Rehabil Clin N Amer,16 (3).
[7]. Shanthikeinnas S, Low Z, Falvey E. (2010).*The eefect of gait velocity on calcaneal balance at heelstrike;implications for orthotic prescription in injury prevention.* Gait Posture, 31 (1).
[8]. O’Riley P. Ollela Croce U. (2001).*Propulsive adaptation to changing gait speed.* Journal of Biomechanics, vol.34,nr.2.
[9]. Constantinescu D. (1995). *Fotbal curs de bază*, Editura Universitatea Alexandru Ioan Cuza Iaşi.

ASPECTS OF THE TECHNOLOGICAL PROCESS OF MANUFACTURING – SEWING A FOOTWEAR PRODUCT FOR WOMEN, TYPE SHOE

Cristina Secan[1], Florentina Harnagea[2]

[1]*University of Oradea, Romania*
[2] *Gheorghe Asachi" Technical University of Iaşi, ROMÂNIA*

Corresponding author: Secan Cristina, E-mail: cris_secan@yahoo.com

Abstract: This paper presents the technological process for manufacturing a low-cut footwear product (type shoe) for women, for casual use, in an IL system.
The paper begins with a general presentation of the technological process of manufacturing the product, and follows with a case study which details the characteristic operations, as well as the common ones, which take place during the process.
Depending on the structure of the model and the characteristics of the raw and auxiliary materials, the technological process used in the manufacture workshops will be laid-out.
Product manufacture begins with cutting the materials, in our case the parts being cut from full grain leather, and the lining from lining leather. After the pieces for the upper part of the shoe are cut according to the guides, they will be assembled using different methods such as: stitching, gluing or fastening.
The guides are processed in order to thin out the edges evenly or in a slant, or to decorate them by bending, burning or painting.
For stitching the parts a simple two-thread stitch is used, with one or two seams and back-stitches, and the gluing can be temporary or permanent.
In the process the time and production quotas are presented, which are influenced by the qualification level of the workers, as well as the performance of the machines used.

Key words: footwear, cutting, technological process, operation, flux.

1. INTRODUCTION

The footwear manufacturing process includes operations for acquiring the guides, manufacturing and assembly, and product finishing.

In the technological process, these operations are carried out through a large number of separate processes, performed in a particular order, determined by a series of factors such as [1]:

1. the nature of the raw materials used in the product;
2. the characteristics of the product's assembly process;
3. the manufacturing processes adapted to suit the technical possibilities of the machinery
4. the model and structure of the article
5. the type of footwear
6. the confection system
7. the characteristics of the raw materials
8. the type of machinery
9. the processing required for the parts

The technological process for manufacturing footwear develops in parallel, due to the fact that the product has both flexible parts, components of the upper, and rigid parts, which form the bottom part of the product. These parts are obtained by cutting flexible materials such as natural leather or substitutes, or rigid materials, respectively. The parts will then be processed in order to prepare them for assembly, to form the upper of the product [2].

The steps for obtaining the component parts for the shoe's upper are: preparing the batches of materials; cutting the parts from flexible materials (natural leathers, leather substitutes, fabrics); evening out the leather parts; quality controlling the cut parts; forming bundles. The parts obtained after cutting will be processed by painting, thinning, bending, burning, perforating.

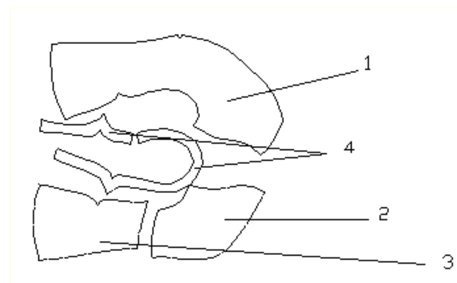
Temporary assembly of parts by gluing, fastening the lining on the sides, followed by sewing the lining on the sides, are operations which are executed in the manufacture-and-assembly workshop for flexible parts[3,4].

Sewing of the parts depends on the type of lining used, as these are loose. Thus all the upper parts as well as the lining will be assembled, and the two subassemblies obtained will be joined with a seam in the upper part of the product.

The product obtained is then finished by cleaning the glue traces, cutting loose threads and excess lining, after which quality control is performed, the product is bound in bundles and stored on carts.

2. CASE STUDY

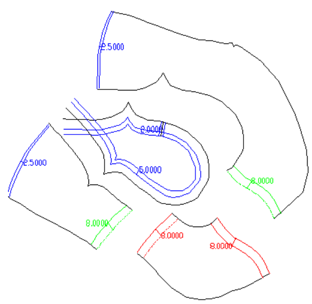
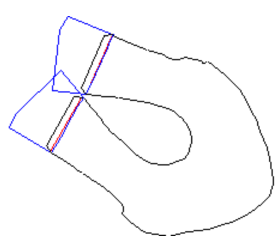
To exemplify the way in which the manufacturing-sewing process is organized in a continuous flux, here follows the technological process for a women's shoe in IL system, made from full grain leather, a natural-looking part combined with an altered part and sheepskin linings:

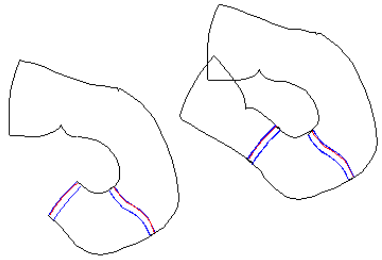
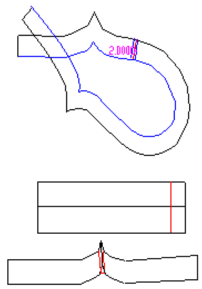
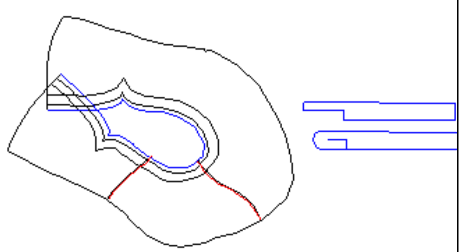
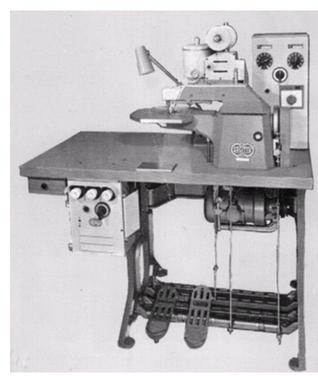
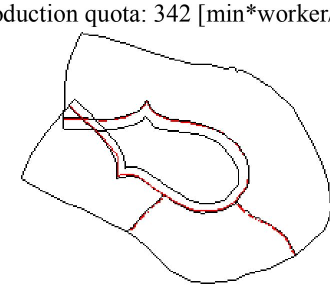
	
Figure 1: Women's shoe	**Figure 2:** Outer subassembly of the upper assembly: quarter + vamp, vamp, outer quarter, upper ornamental part

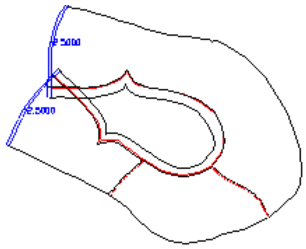
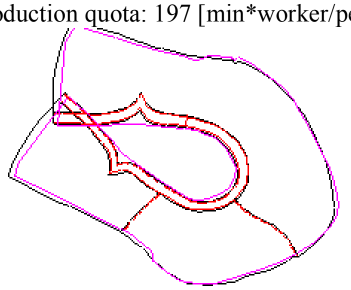
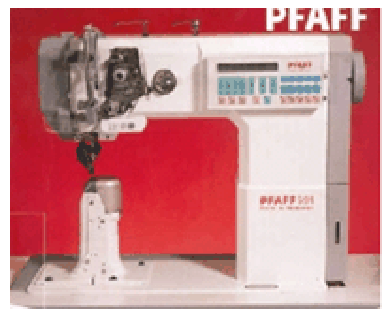
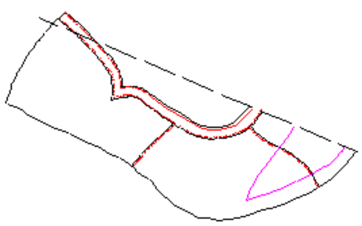
Shown below is the way in which the product is formed from the corresponding subassemblies and assemblies, following the flow of production consisting of operations that are carried out sequentially or in parallel, as well as the changes in state that the materials undergo during the process, also showing the type of equipment used for manufacturing the product [5].

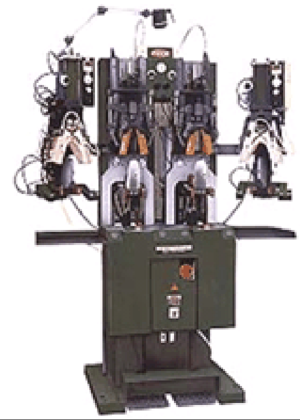
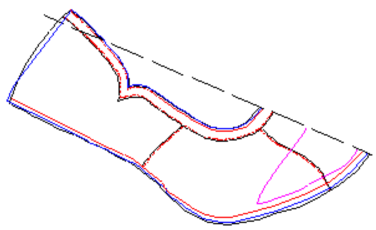
Table 1: The technological process

	Operation	Equipment type
1.	Cutting the parts: quarter + vamp, vamp, outer quarter, upper ornamental part and linings Operation mode: mechanical Time quota: 2.981[min*worker/per] Production quota: 161.01 [min*worker/per]	-punching machine with folding arm 

2.	Evening out the parts and lining Operation mode: mechanical Time quota: 0.8 [min*worker/per] Production quota: 600 [min*worker/per]	- equipment for evening out flexible parts 
3.	Thinning the edges of parts: slanted finished thinning, slanted gradual thinning and straight thinning Operation mode: mechanical Time quota: 1.5 [min*worker/per] Production quota: 320 [min*worker/per] 	- equipment for thinning 
4.	Sewing the lining for quarter + vamp with cu anti-slip Operation mode: mechanical Time qouta: 1.06 [min*worker/per] Production quota: 452 [min*worker/per] 	- flatbed sewing machine 
5.	Sewing the vamp on quarters Operation mode: mechanical Time quota: 1,1[min*worker/per] Production quota: 436 [min*worker/per]	- flatbed sewing machine 

		
6.	Sewing ornamental part 1 + ornamental part 2 Operation mode: mechanical Time quota: 0.96[min*worker/per] Production quota: 500 [min*worker/per] 	- flatbed sewing machine 
7.	Bending ornamental part Operating mode: mechanical Time quota: 0.66[min*worker/per] Production quota: 727 [min*worker/per] 	- bending machine 
8.	Sewing ornamental part on the upper edge of sides Operating mode: mechanical Time quota: 1.4 [min*worker/per] Production quota: 342 [min*worker/per] 	- column sewing machine 
9.	Fastening quarters at the back Operation mode: mechanical Time quota: 1.19 [min*worker/per] Production quota: 403 [min*worker/per]	- flatbed sewing machine

		
10.	Sewing lining on sides Operation mode: mechanical Time quota: 2.43 [min*worker/per] Production quota: 197 [min*worker/per] 	- single needle column sewing machine 
11.	Applying toe cap Operation mode: mechanical Time quota: 0.8 [min*worker/per] Production quota: 600[min*worker/per] 	- toe cap machine with thermal adhesive 
12.	Fitting heel counter, preform the half-finished product in the counter area Operation mode: mechanical Time quota: 1.5 [min*worker/per] Production quota: 320[min*worker/per]	- machine for preforming the counter

		
13.	Sewing sides on the area reserved for pulling Operation mode: mechanical Time quota: 1.4[min*worker/per] Production quota: 342[min*worker/per] 	-simple column sewing machine 
14.	Pulling out thread ends and cleaning the half-finished product Operation mode: manual Time quota: 1.57[min*worker/per] Production time: 305[min*worker/per]	-work table
15.	Control, transport bundles to the warehouse for grouping Operation mode: manual Time quota: 1.5[min*worker/per] Production quota: 320[min*worker/per]	-work table

3. CONCLUSIONS

The factors influencing the technological process of manufacturing, fitting and assembling are:

- Footwear article model
- Mode of processing part edges
- The type of fastening used for quarter – vamp parts
- Type of outer linings:
    - Loose with regard to the sides
- Type and structure of footwear

The parts are thinned in order to reduce thickness of the parts around the edges, to avoid excessive thickness in the overlap zone.

The parts are sewn with simple two-thread steams and 180º back-stitches for the quarters at the back.

Because the process consists mainly of operations carried out mechanically, it leads to an increase in production quota and implicitly to a decrease in the necessary workforce.

An important role in the manufacturing process is also played by the performance of the equipments used, and the way in which the work place and the process are organized.

4. REFERENCES

[1].Harnagea F.(2002). *Tehnologia articolelor de marochinărie*, Editura Performantica, Iaşi.
[2].Secan C, Dorsonszky L.(2011). *Lucrări practice şi de proiect la disciplina ''Procese de fabricație în pielărie''*, Editura Universității din Oradea, ISBN 978-606-10-0525-3.
[3]. Volocariu S. R.(1999). *Procese de fabricație în industria produselor din piele şi înlocuitori*, Editura Gh. Asachi, Iaşi.
[4]. Volocariu R. S., Mărcuş L.(2007). *Îndrumar de laborator pentru procese de fabricație în industria confecțiilor din piele*, Editura Pim, Iaşi.
[5].Croitoru D. F.(1987). *Utilaje şi automatizări pentru industria confecțiilor din piele şi înlocuitori*, Rotaprint , I.P.Iaşi.
[6]. *** www.atomSPA.it

ALTERNATIVE SOFTWARE USED FOR CARPETS' DRAWINGS DESIGN

Marin Florea[1], Cristian Matran[2]

[1, 2] *„Lucian Blaga" University, Sibiu, ROMANIA*

Corresponding author: Marin Florea, E-mail: floreasb@yahoo.com

Abstract: The Romanian carpet industry has followed the natural course of computerization processes in the carpets' manufacturing. The final textiles' consumer diversified their aesthetic taste for Western culture dominated by a functional and minimalist design that could be found in the everyday environment. There is a trend towards short series of industrial products, a trend which causes an acute diversification especially in the textile product styling. Usually, the CAD department is limited to 1-3 workstations thanks of high price of industrial software, operating systems and hardware. Increased production of drawings is limited by costs; the solution must be sought in the direction of licensed free/open software. This article proposes a solution that can be applied to industrial manufacturing with a minimum cost and high efficiency in styling and design, increasing the number of workstations of CAD department with minimal costs. Even the almost all software manufacturers use Microsoft6 Windows like operating system, we recommend Linux like a open source software. [1] [2] [3] By using Free / Open Source software for Linux, the designers can create industrial designs with low costs. [4] [5] The open source software named ArahPaint from Arahne d.o.o. (Slovenia) is a practical solution for the carpets' manufacturers. [6] In this paper are presented the steps for designing a repeating pattern carpet using the named software. Through the use of computers in the design drawings for carpets, discussions with potential customers can quickly materialize. Also, we assist to a rapid prototyping thanks to computerized aided design and thanks to electronic jacquard looms.

Key words: operating system, GNU/Linux, Arahpaint, CAD, carpets, design, drawings.

1. INTRODUCTION

The Romanian carpet industry has followed the natural course of computerization processes in carpets manufacturing. Mechanical jacquard looms were replaced by electronic jacquard weaving machines with computer controller. The electronic system offers major advantages in frequent changes of designs for carpets and textile floor coverings, promoting productivity and economic efficiency.

The final textiles' consumer diversified their aesthetic taste for Western culture dominated by a functional and minimalist design that is found in all around environment of the 21st century. Oriental carpets with traditional designs and modern furniture are matched tough and consumers require often abstract designs specific to European culture. These modern designs do not cover a large area of aesthetic tastes as if oriental carpets. There is a trend towards short series of industrial products, which causes an acute diversification especially in the textile product styling. Digital Design drawings for carpets is perfectly suited to market requirements of customers, the loom becomes a major consumer of digital drawings to be provided by designers.

2. INDUSTRIAL SOFTWARE FOR CARPETS' DESIGN

The leading manufacturers specialized in designing software are Nedgraphics carpet fitters, Booria, Sophis, CSS (Computer Software Service) and Arahne Apso. [1]

These companies have emerged with electronic jacquard of a single reason: providing IT and software components. Relationship between electronic jacquard manufacturers and manufacturers of specialized software became strongly consolidated in the last 20 years. When a customer buys an automatic loom it must buy the software as recommended by the manufacturer, too.

The common feature of these programs is very high cost price on the number of programs sold and use of operating system license. Also recommended for use in dedicated computer without another applications installed, excepting the operating system and antivirus software, in order to create best conditions to work without affecting the software operation.

These specific conditions lead to creative activity limitation in carpets, although there is potential to develop designs and color.

In many cases, the Design department was served about 20 developers that are achieving carpets' designs for mechanical jacquard looms. High price of industrial software, operating systems and hardware design drawings limited to 1-3 CAD workstations, although there personnel. The high speed digital design could effectively cover the work of all 20 designers. The market has much higher demands from industrial realities but the rise of drawings' production is limited by cost, the solution must be sought in line with license free/ open software.

The alternative of the proprietary software is to use the GNU operating system and open source software.

3. GNU / Linux OPEARTING SYSTEMS

The main role of an operating system is to harmonize the operation of the hardware configuration used by the user with a PC program that ensures operation. Normally, the user would be interested in only the operating system of the application itself.

Many software manufacturers create applications for Microsoft Windows OS because the only reason is the large number of users. We find that programs for Apple's computer systems are few even though it holds 40% of the U.S. market, and Linux applications are rare, too.

Linux operating system, initially developed by Linus Torvalds as an alternative to commercial operating systems Unix, and to avoid limitations Minix operating system were developed under the GNU General Public License (GPL). In fact, the discussion refers to the operating system kernel that were added libraries, various tools and a large amount of family UNIX programs with a free license, forming a package known as generic Linux. It is used specifically for network servers and it was long used as a programming environment and development but the latest versions could be used like a workstation OS. The most popular versions of Linux generated the distribution with a lot of various facilities. [2]

Downloading a distribution is legal and free, and most of them are running live CD / DVD, without installing on the hardware, just for system testing. Since 2007 many distributions have become reliable like personal desktop applications. The facilities offered by a free/open source software/operating system are the independence of the system from a developer, security and high reliability, diversity distributions for any claims, access to the source code of the operating system and programs, easy installation, ease of use, intuitive, the graphics and the console mode programs, reliability programs through continuous testing by developers, automatic device recognition sites of PC hardware and automatically install drivers, license free and legal for OS and all programs necessary for the user, the small number of computer viruses.

Continuing designers' principle to provide reliable, efficient and inexpensive solutions, Linux should be considered as an alternative to specific programs. In this case the costs would reduce to the hardware's cost and the operating system and programs are no cost but are legal, without infringing copyright as is the case of the proprietary operating systems and software. Obviously this solution does not drop anything quality of design drawings for carpets.

Since 2004 we have experienced more than 100 Linux distributions and versions (a list of tjem is available at http://distrowatch.com). [3]

Experiencing these operating systems and software was necessary as a viable alternative to the current situation. Thus we have seen major distributions RedHat availability of evolved and PC Linux OS and Fedora, Slax which splits from Slackware, SUSE, Open SUSE and Debian Linux distribution Ubuntu Mint major. Since 2009 we quit Windows in favor of Ubuntu OS, and then the distribution Linux Mint 9, 10, 11,12,13,14 that we use today (Fig. 1). [4] [5]

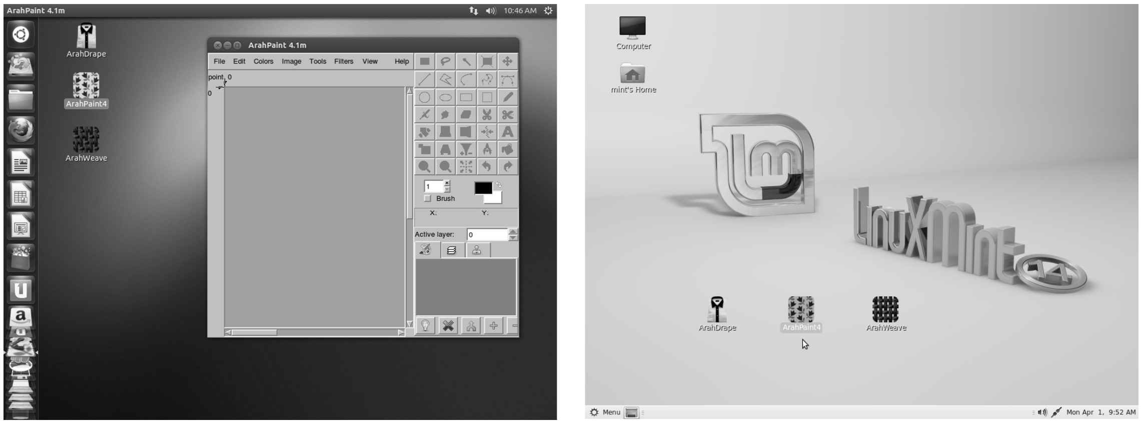


Figure 1: Linux Ubuntu v.12 vs. Linux Mint v.14.

Migrating from Windows to the Linux user is a consequence of the actual quality of the Linux operating system. High speed running without significant consumption of resources, reduced the number of computer viruses, a high security and a great system stability, and not least the legality license GNU / GPL, are key factors to use open/free software in manufacturing processes. The same applications running under Windows and Linux could be found just with changed names.

Where necessary the user can download, via Synaptic, needed applications or can also update/uninstall a particular application. Regarding were tested 42 vector and raster graphic applications that cover all the needs of the user (scanning, photo editing, advertising graphics).

These free programs are joined and industrial applications in the textile industry Open Source like ArahnePaint (http://www.arahne.si).

The need to search for a design consistent solution, efficient and low cost is motivated by the scarcity and high price of industrial CAD systems for the end user designer.

4. ARAHPAINT - CAD

ArahPaint 4 is the latest version of open-source industrial applications to achieve double-plush carpet designs on jacquard looms electronic mechanism. The manufacturer is widely known in Eastern Europe for integrated solutions offered to the textile industry. All software products are developed for Linux for the same reasons stated above.

For designing rugs, the manufacturers provide free Arahne ArahPaint4 application with source code that can be developed or modified by programmers. [6]

Given the low number of software producers, ArahPaint4 is a valuable solution for the manufacturers of textile floor covers.

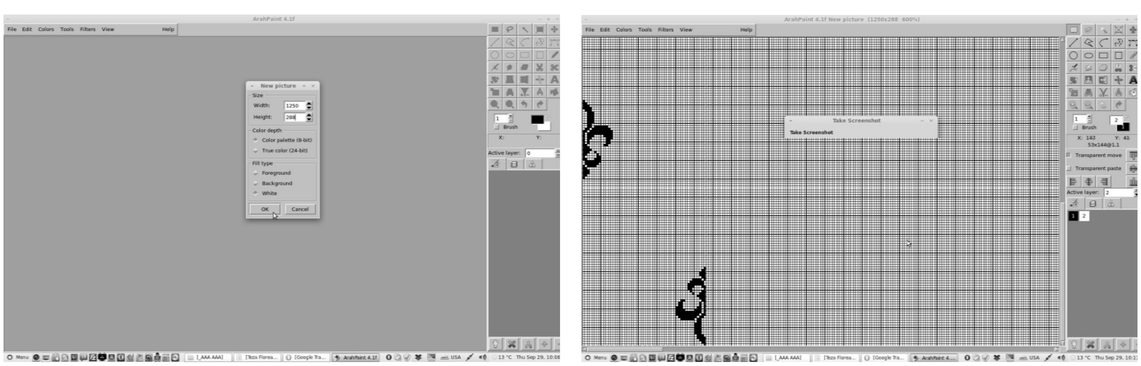


Figure 2: a. ArahPaint-values inserting. b. ArahPaint, plotting the ratio.

ArahPaint knowingly intended designers with certain specific textile arts. ArahPaint tools that provide them with the designer, not replace the skills and knowledge designer fabric. The title bar displays the program name, version and name of the drawing, the size in pixels and zoom level. The main window is the area where the picture is displayed for editing. Editing tools could be found in the Tools menu and below the line attributes, namely the thickness and color. The color palette displays the number of colors and shades.

To illustrate how ArahPain works, we create a drawing of a carpet for a hotel, where the architectural elements must be present in the grounds carpet. Decorative element is classic and represent French lily. For that reason we chose is unidirectional turning it to 180 degree on the next turn and displaced by ½ reports.

The first step is setting the data of composition paper (Fig. 2), then by copying and rotating multiply displacement ratio according to the project (fig. 2 b). Follow coverage of the field using the functions of repetition and drawing is almost done (Fig. 3a).

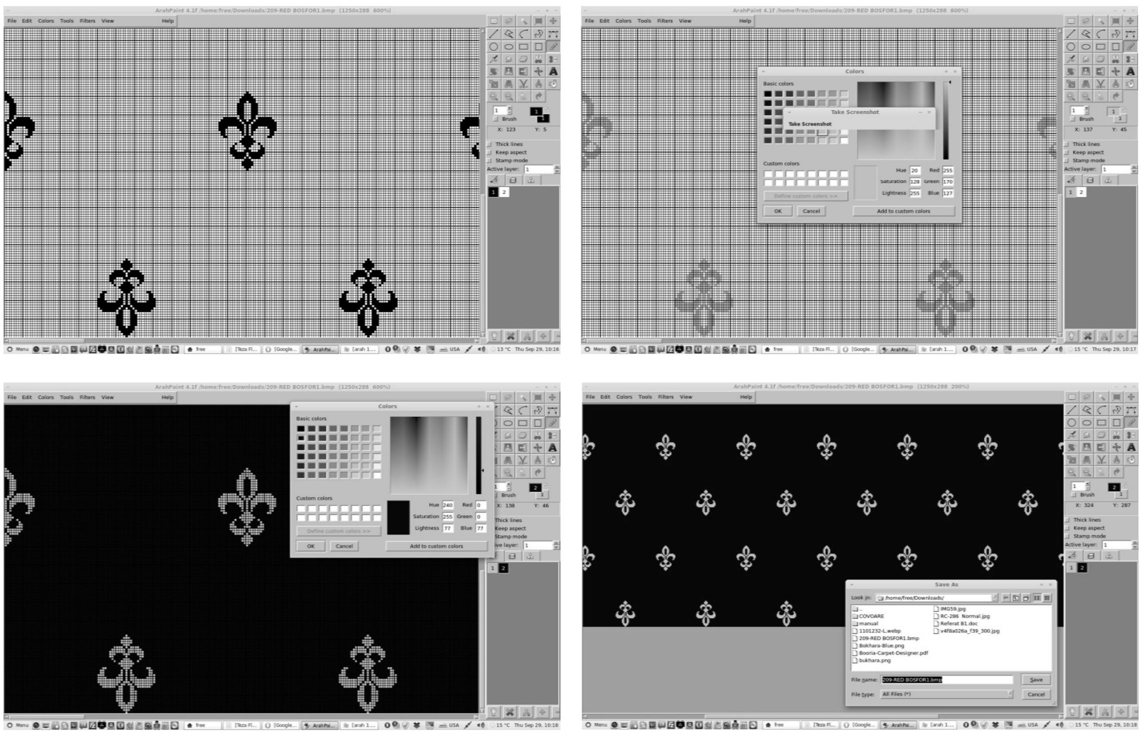


Figure 3: a. ArahPaint - field settings; b. Motifs' color changing; c. Background color changing; d. saving the works.

To change the color of motifs from black to golden lily could be obtained choosing the desired color and then the Menu Colors> Edit (Fig. 3b). The same steps permits to change the background from white to ultramarine blue (Fig. 3c). Design operation ends by saving the drawing with the name of the client or order name (Fig. 3d). At this point the design is ready to be loaded into the memory of the weaving machine.

6. CONCLUSIONS

1. The duration of training and the completion of the design were very short (about 10 minutes - for the case shown). We want to show that discussions with customers, in some cases can easily materialize in a short time.

2. The solution we adopted is relatively cheap because it involves new investments in addition to achieve new hardware.

3. This solution that combines a GNU free operating system with a program dedicated to industrial carpet is a free alternative that provides a powerful tool to independent designers for industrial integration and for carpet manufacturers provide the opportunity to develop creative departments at low costs.

4. These changes are necessary in the industry especially in areas where industrial product requires frequent change of design and color. For consumers is more important the appearance when buying a product and less important is the technical quality of the product.

5. Frequent changes in the design and color schemes carpet is a sales method of activation, which can be achieved at low cost in the carpet industry.

6. The alternative OS's like Linux would only reduce the cost of the PC. Operating system and programs are free but without violating the legal copyright.

7. Obviously this solution does not drop anything quality of design drawings for carpets.

7. REFERENCES

[1]. Carpet Software, (2013). *Available from: http://ng.nedsense.com, http://www.booria.com/default.htm, http://www.arahne.si, Accessed: 15/03/2013.*
[2]. Linux (2013). *Available from: https://en.wikipedia.org/wiki/Linux, Accessed: 15/03/2013.*
[3]. Distrowatch.com (2012). *Available from: http://distrowatch.com/, Accessed: 15/03/2013.*
[4]. Linux Ubuntu (2013). *Available from: http://www.ubuntu.com/, Accessed: 15/03/2013.*
[5]. Linux Mint (2013). *Available from: http://www.linuxmint.com/, Accessed: 15/03/2013.*
[6]. ArahPaint (2012). *Available from: http://www.arahne.si/download/software-demo.html, Accessed: 15/03/2013.*

(ARCHI)TEXTILES PARTITIONS: DESIGN SPECIFICATIONS FOR REUSE AFTER DECONSTRUCTION

M. Macieira[1], P. Mendonça[2]

[1] *Territory, Environment and Technology research Centre, University of Minho, Guimarães, PORTUGAL*
[2] *School of Architecture, University of Minho, Guimarães, PORTUGAL*

Corresponding author: Mónica Macieira, E-mail: mrfmacieira@gmail.com

Abstract: The use of membranes in the interior of buildings, particularly on their wide application possibilities as lightweight and innovative partitions systems, is not a major architectural concern. But membranes can contribute to different types of space partitioning in: housing, offices, hospitals, sports facilities, etc., in other words, in all occasions where spatial flexibility and reversibility are essential. This paper presents the result from a research project oriented to the concept and an adjustable partition system – which acronym is AdJustMembrane. This papper intends to communicate the result of the project AdJustMembrane. It presents the design and construction technology processes and potentials explored with architectural membranes in the conception and construction of non-load bearing partition walls. Some solutions available on the market were analysed from the design and building technology poit of view. Interior conventional partitions have significant cost and environmental impacts in a house and do not allow flexibility in the use of the space. Textile partitions promote modular, reversible (without use of permanent fixations or glue), and ease construction and deconstruction design specifications to achieve less environmental impacts and increase flexibility. The aim of this paper is to present some design specifications in the conception of textile partitions, to reuse after deconstruction.

Key words: Textiles, membranes, design, non load bearing partitions, interior space.

1. INTRODUCTION

The evolution of architecture involves, not only improvements in building construction techniques, methods, but also in materials research and development. The research of architectural textiles and membrane materials is extending its possibilities also to interior partitions in order to fulfil contemporary demands of comfort. The textile industry is undergoing a major reorientation toward technical applications, to areas where added value and sophistication emphasize their competitive advantages. Technical textiles, like membranes, account for about 40% of the production and consumption of textiles overall, and at a 4% annual growth rate, it is the fastest-growing sector of the global textile market [1]. Textiles for home furnishings are growing at about 1% per year. Architextiles [2] is a term given to textile products manufactured for their performance and functional properties, with applications in architecture/ building sector. Architextiles can include smart that sense and react to environmental conditions, such as electrochromic and thermochromic. Other new innovations involve nanotechnologies that have created new products such as textiles that detect chemicals and gases, generate mobile power, and incorporate sensing systems or light emmiting. Moreover, research is ongoing to develop textiles that can transport data and electric current, which could open a whole new area of product building applications, especially in interior spaces.

1.1. Textiles and polymer consumption in building construction

The technical textiles are produced in industrialized countries and this involves different sectors of industry and market segments. The use of textile in construction is becoming ever more common. According to Sabit Adanur [3], technical textiles, such as membranes, are replacing traditional textile materials, as well as metals, glass and other building materials. According to Englemasn et al [4], the building construction sector is the second higer of polymers, around 25%, just after the packaging industry The worldwide demand for textile fibers is increasing. It can be verified at Tabel 1, that the cotton and polyester fibers are the two types of fiber that dominated this growing market in 2005. Demand for polyester fibers has surpassed the cotton in the beginning of the 21st century. While the volume of production of natural fibers has remained relatively constant, the demand for cotton has increased in the last decades [5].

Tabel 1: Worldwide demand of fibers in 2005 [5].

	Worldwide demand of fibers (millions of tons)
Natural Fibers	
Raw cotton	24.40
Virgin wool	1.23
Virgin silk	0.13
Total	25.76
Processed fibers	
Cellulosic	2.53
Synthetic	2.63
Acrylic	3.92
Nylon	24.70
Polyester	31.25
Total of synthetic	33.78
Total demand of fibers	**59.54**

1.1.1. Textile interior partition walls

The natural fibers from plants and animals have been used since antiquity for clothing and shelter. Nowadays, fibers are more commonly used as insulating materials in interior partitions and pavements and in exterior walls and roofs, especially inorganic fibers. Fibers are also used to make textile fabrics for several types of interior uses in buildings, such as carpets, curtains, blinds, wall finishings, among others, Architectural membranes are generally used in the exterior of buildings. These are flexible, thin and tensile resistant composite materials, consisting of a base fabric (with a structural role) and a coating (with a protection role to extend its durability, even in exterior exposure conditions). Membranes are mainly: coated fabrics, meshes, sheets or films. The table below shows the fibers and polymers nowadays commonly used in interior partition walls, alone or mixed in composites or combined in sandwich panels or just juxtaposed layers.

Tabel: Relation between density and termal conductivity of fibers and polymers for termal insulation materials used in interior partitions (adapted from [6]).

Material	Density (kg/m^3)	Thermal conductivity (W/mK)
Aerogel	60-80	0,017 – 0,021
Cotton	20-60	0,040
Linen	20-80	0,040 – 0,050
Hemp	20-68	0,040 – 0,090
Aglomerated wood fibers	30-270	0,040 – 0,090
Wood wool	350-600	0,090
Coconut fiber	70-120	0,040 – 0,050
Cork	100-220	0,045 – 0,060
Melamine foam	8-11	0,035
Mineral wool	20-200	0,035 – 0,045
Polyester fibers	15-20	0,035 – 0,045
Polyethilene foam	50-110	0,033
Rigid polyurethane foam	30-100	0,024 – 0,030
Sheep wool	25-30	0,040 – 0,045
Straw	120-225	0,055 – 0,090
Insulation panel in vacuo	150-300	0,002 – 0,008
Cellulose fibers	30-80	0,040 – 0,045

Generally, the polyurethane (PU) coated fabric has coating on one side only. The PU coating tends to be thicker than the common coatings. In comparison with the PVC coatings, the PU coatings are more expensive. This may be influenced by the fact that it requires an accurately and thicker polymer layer. Normal use of PU coated fabric puts the coated side on the "inside" and leaves the tissue on the outside. This protects the PU coating from abrasion and humidity. The PU coating allows the slow diffusion of water vapor, what makes the membrane to be "breathable". The poliester (PES) membrane with PU coating is lightweight, it has high elasticity and provides a diversity of colors.

When used indoors, it is applied a layer of fire retardant on the fabric. The table 2, presented below, includes a number of membranes used in most architectural interior partition walls.

Tabel 2: Potentialities of membrane and its properties *[7].

Properties	Membranes			
	PES membrane and PVC coating	**FG membrane and PTFE coating**	**FG membrane and SI coating**	**PES membrane and PUcoating**
***Cost**	15 €/m^2	150 - 230 €/m^2	-	20 €/m^2
Weight ***Tensile resistance**	0,6 – 1,7 kg/m^2 2 – 10 N/5cm	0,4 – 1,6 kg/m^2 1 – 8 N/5cm	2,0 kg/m^2 1 – 8 N/5cm	2,5 kg/m^2 1 – 8 N/5cm
***Light transmission** **Light reflection** ***Colours**	0 – 25 % 50 – 70 % White and pigmented with all colors (these, reduce the durability).	4 – 22 % 65 – 75 % White and some metallized fabrics.	25-30% 70 – 85 % White and limited selection of other colors.	5 -20% 50 – 70 % White and other colors.
Union methods ***Durability** ***Self-cleaning property** ***Chemical resistance** **Handling** ***Recicling**	High frequency. Welding by impulse. 15/ 20 years. Good. Good. Easy to bend. Good.	Welding boost with intermediate film. + 25/ 30 years. Excellent Excellent. Criticizes. Neutral.	Vulcanization or sewing and gluing. + 25/30 years. Good. Good. Criticizes. Good.	Metallic or plastic profiles. 15/ 20 years. Good. - Easy to bend/stretch Good.
***Fire resistance**	B1	A2 (type I and II) B1 (type III and IV)	B1	B1
*** Thermal insulation (U value)**	2,6 W/m^{2}K for two membraneswith 200mm of air gap.	4,6 W/m^{2}K	-	-
Cracking sensibility	High resistance.	Without resistance.	Low resistance.	High resistance.

Abreviations: PES (polyester); PVC (polyvinyl chloride); FG (fiberglass); PTFE (polytetrafluoroethylene); SI(silicone) and PU (polyurethane).

2. USE OF MEMBRANES IN THE INTERIOR OF BUILDING SPACES

Architectural membrane partitions present several advantages in comparison to conventional rigid wall systems (such as plasterboard, metal or hollow brick) in an economy where being flexible is an important issue [8]. From the “classical” curtain, to sliding padded lamella structures, to spanned canvas elements: textile partitions allow different spatial situations to be created as required, so that individual areas can be used simultaneously for different functions [2, 8]. Partitions can usually be guided horizontally along ceiling tracks or can be vertically raised and lowered; their design incorporates storage room for folded textile when not in use. Various degrees of separation can be created, depending on the transparency and volume of the material – from lightweight solely visual separation to acoustically protected partition [8]. The figure below shows different textile applications that can be explored in the interior of buildings.

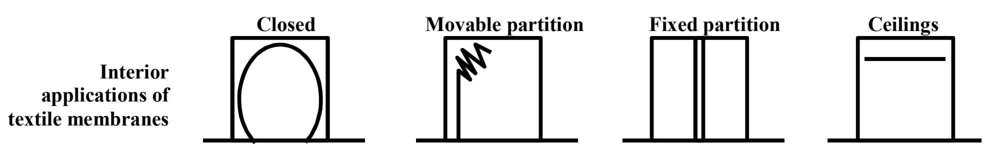


Figure 1: Classification of the different textile membranes applications in the interior of buildings.

3. PARTITIONS DESIGN TO REDUCE ENVIRONMENTAL IMPACT WITH TEXTILES MEMBRANES

A partition wall is a thin element built to divide the indoor space into rooms or other compartments. Additionally, it is used to enable more effective space organization and to improve comfort and safety [9]. Addis and Schouten [10] refer that partitions have emerged as building sub-systems, as result of several factors, including the development of frame construction where internal walls are no longer required to have a load-bearing function. In previous studies [9] it was concluded that textile partitios have a low environmental impact when compared with conventional partitions.

Textile interior partitions design has been developing significantly, since last decade [8]. The design of elements with architectural membranes combines the skills from several areas. In the process of designing with membranes, all project phases are interdependent: the area of materials (selection of membranes), the selection of the fixation method and the design of the structure so that, together, it influences the structural and functional performance of the element to design and build. Textiles partition walls can be: pneumatic (air-inflated), tensioned, multilayer sandwich panels (filled with fibers/polymer material), robotic, or composed with modular elements [8].

3.1. Design specifications to reuse after deconstruction

According to Lewis [11] and Addis & Schouten [10], it should be used fastening methods that allow the easy separation and recovery, such as: eliminating gluing and other systems which difficult and increase the number of steps taken to disassemble the partition, or turning this even impossible in part or in the whole. In an increasing rate, are appearing on the market innovative systems to integration of installations - pipework, cabling and interface mechanisms - which allow disassembly and deconstruction (inside or outside partitions walls) while maintaining the functional and aesthetic aspects. The following design specifications reveal the importance of textile partitions in the design to reuse after deconstruction.

3.1.1. Connections types

The construction process of membrane partition walls start with the idea of the designer and ends at the assembly. The first thing to explore is the form. The membrane is a lightweight material, for that reason it is designed to have minimal surfaces. The second step consists in selecting the connection solutions between the membrane and other components of the structure to allow reuse after deconstruction. The connection can be continue (figure 2a) or punctual (figure 2b). This decision has influence in the type and size selection of structural parts such as: profiles, straps, cables, ropes that can be used to transmit membrane efforts to the main parts of the structure.

Membrane partition wall solutions are characterized by lightweight materials and aggregation modules or profiles systems that allow tensioning of the membranes in the vertical plane. These solutions present the advantage of incorporating the finishing in themselves. Therefore, they do not require any further step in the assembly process, as it happens with the hollow brick partition solution or with plasterboard walls where is necessary to apply a finishing material to hide joints and offer a plain white or other coloured or textured surface.

The assemblies of some membrane partition solutions require professional teams with specialized training, such in the case of tensioned partitions (to give warranty on the workmanship and the safety of the installation). However, it exists membrane partitions with kit systems (thus only needed an instruction manual) with simple accessories and tools.

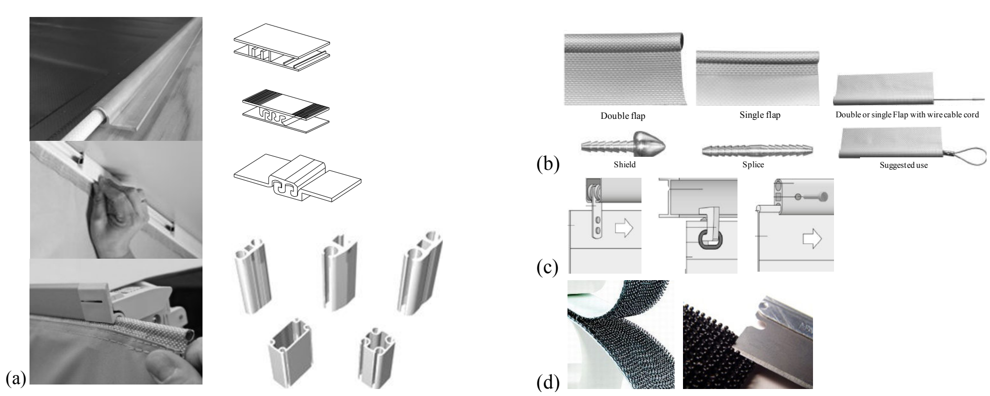


Figure 2: Connection types that permit reuse after deconstruction: (a) Cords and profiling solutions for hemming tensioned membranes; (b) Bead profile connections of polypropylene (PP) or polyethylene (PE); (c) connection types for membrane partitions of industrial spaces; (d) velcros with high strength, available on the market for joints/ trim membrane execution.

The coatings or overcoatings of thermostable membranes (PTFE or PVDF) make them difficult to fix. Before executing the joints or corners by gluing, the thermostable coating layer, in this zone, should be removed. This means intensive work with potential appearance of defects in the application. In industrial terms, this is obviously an unwanted process. There are fastening systems to overcome these difficulties. These include: fasteners with occluded and detachable bolts, that replace rigid fixation rulers; “velcro” seals; screws combined with other adhesives or permanent connections, such as improved seams or mechanically embedded buttons.

3.1.2. Dimensions

The architectural membranes available on the market for application into partition walls have widths ranging from 1.6 meters to 5 meters and lengths up to 50 meters. This allows to make wall panels with few joints or even a single wall because the heights of the ceiling of a room ranges from 2.40 meters to 2.70 meters tall. In the cases where the ceiling height is double, the advantage is greater.

3.2. Tensioned membrane indoor partitions

Tensioned membranes are often used indoors [8]. Conventional membranes, such as polyester with PVC coating, ETFE membrane or fiberglass with PTFE or silicone coating, need to have a specific geometry (hyperbolic) to assure tension (with cables, cords, etc). However, membranes used in interior partition walls need to be flat and therefore must have some elasticity to achieve tension between special profiles, as can be seen at figure 3. These can take various forms depending on the support and also the applied tension, so they are molded directly onto attachment points. The cotton, nylon and polyester fabric containing a percentage between 3% and 30% of polyurethane elastic fiber. ETFE is widely used today because of its mechanical stability, thermal and chemical qualities. The PTFE combined with fiberglass fibers, constitutes an interesting functional and economic alternative to ETFE membrane.

To assembly the tensioned PVC membrane partition, the procedure is as follows: 1 - the profiles are fastened to a rigid structure; 2 - the membrane is cut at the factory with almost 6% less than local measurements; 3 - on site, the material is heated to 40-46 °C and stretched using special tools - spatulas; 4 - in the final stage are cut and applied reinforcement rings to create openings for devices such as sockets, switches, etc. The installation is quick, clean and efficient. The needed tools to the installation are as follows: short, long and angle spatula; staples (4 or more) for propane forced air heater, a ladder, reinforcing rings (to create openings for outlets, switches, etc.) and glue (for installation of reinforcement rings). To assembly tensioned partitions of polyester membrane with polyurethane coating, the procedure is the same refered before but the heating of membrane is not necessary. There are various tensioning systems (figure 3) which are based on an aluminum frame with a hidden tensioning mechanism that keeps taut the surface of the fabric.

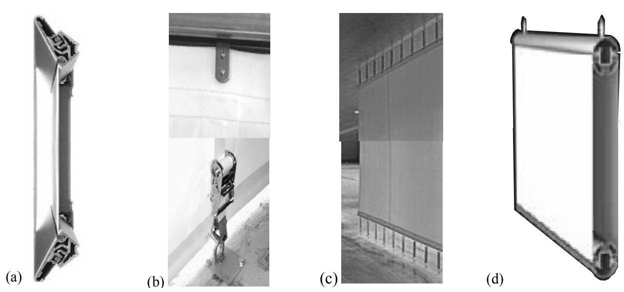


Figure 3: Partitions systems with potential to reuse after deconstruction: (a) hidden tensioning mechanism of polyester membrane [14]; (b) details of punctual connections, rackets and assembly of membranes partitions for industrial spaces; (c) tensioning the membrane by arranged springs in a predetermined measure so that the tension is uniform [15], and (d) double profile for tensioned PVC membranes in two opposite faces [16].

3.3. Inflatable partitions

The laminated fiberglass network with a polymeric film or ETFE are suitable for air inflatable structures because they ensure air-tightness. The inflated membrane partitions can be translucent, and are extremely lightweight, durable, waterproof and washable by hand. This type of partition requires predeterminated measurements and do not allow many changes during the assembly.

3.4. Multilayer partitions

Recent developments in construction materials was accelerated by industry demand for a range of products with higher strength, lower weight and cost as answers for optimization of technical and economic requirements of the 21st century [12]. The sandwich construction is a proven method for achieving greater rigidity by incorporating a core material between two outer layers [13].

According to Mendonça [17], the membranes can have a significant performance in thermal insulation by the addition of multiple layers and insulating material between them, with relatively low costs. Even it their low specific weight makes membranes bad soundproofing solutions, heavier coated membranes with absorbent materials or micro drill can however allow some damping effect. A membrane partition can also be filled with natural or synthetic fibers. An option is to construct the membrane partition in a multilayer sandwich panel with two coating membranes and a filler material between them. For example, the addition of cork or cellulose to the membrane, increase properties of thermal and acoustic insulation. Also can be applied other materials such as coconut fiber, hemp fiber, textile wastes, rockwool or three-dimensional textiles [8].

4. CONCLUSIONS

Textile Membrane partitions, as lightweight solutions, present some advantages when compared with heavyweight solutions, such as: less material used; less cost and impact due to transport to the building site; flexibility; and smaller assembly fittings. The application of membranes in interior dividing walls have several potentialities, such as: lightness and flexibility, ease of construction and deconstruction, mobility, translucency, thermal regulation, acoustic performance, low cost, custom-designed to specific applications, tied into existing walls and upper slab, recyclability and reutilization. Many new materials are still in the product development stage and will find their way into design solutions. The potential of architectural textiles to inform design decisions is limitless and growing as new textiles with improved textile properties are invented.

Interior conventional partitions have significant cost and impacts in a house and do not allow flexibility in the use of the space. Textile partitions promote modular, reversible (without use of permanent fixations or glue), and ease construction and deconstruction design specifications to achieve less environmental impacts and increase flexibility. Lightweight solutions means less material spent, what also means less transport impacts and a low environmental impact – textile membrane partition walls are a very relevant option to consider in the future of building construction industry.

5. ACKNOWLEDGEMENTS

The authors wish to thank FCT (Fundação para a Ciência e Tecnologia – Portugal) and COMPETE (Programa Operacional de Fatores de Competitividade - Portugal) for supporting the AdjustMEMBRANE Project with the reference PTDC/AUR-AQI/102321/2008.

6. REFERENCES

[1]. Rasmussen, J. (2008). State of the industry 2008, Part I. *Specialty Fabrics Review*, (May, 2008) 28–35, ISSN: 00198307.

[2]. Garcia, M. (2006). Prologue for a History and Theory of Architextiles. *Architectural Design*, WILEY, J & SONS, Vol. 76, No. 6, (November/December, 2006), 13-20, ISSN: 00038504.

[3]. Adanur, S. (2002). *Handbook of Weaving*, CRC Press, Taylor & Francis, ISBN: 9781587160134, New York.

[4].Engelsman, S., Spalding, V. & Peters, S. (2010). *Plastics in Architecture and construction*, Birkäuser GmbH, ISBN: 9783034603225, Germany.

[5]. Textile world (2009). Quality Fabric of the Month. *Textile World*, *Available from:* http://www.textileworld.com/Articles/2009/June/QFOM_Kenaf_From_Temporary_Tensile_Architecture_Into_Paper_Products.html, Accessed: 19/06/2012.

[6]. Pfundstein, M., Gellert, R., Spitzner, M. & Rudolphi, A. (2007). *Insulating Materials – Principles, Materials, Applications*, Birkhäuser GmbH, ISBN: 978-3764386542, Germany.

[7]. Drew, P. (2008). *New Tent Architecture*, Thames & Hudson, ISBN: 9780500342435, London.

[8]. Krüger, S. (2009). *Textile architecture*, Jovis Verlag, ISBN: 9783868590173, Berlin(82-83).
[9]. Macieira, M. (2012). *Architectural Membranes: Potencial application in the interior of buildings* (*in Portuguese*), Master Thesis in Architecture (Construction & technology), University of Minho, Portugal.
[10]. Addis, W. & Schouten J. (2004). *Principles of design for deconstruction to facilitate reuse and recycling*, CIRIA, ISBN: 9780860176077, London.
[11]. Lewis, J. (1999). *A Green Vitruvius: Principles and Practice of Sustainable Architectural Design*, James & James, ISBN: 9781873936948, Dublin.
[12]. Miravete, A. (1994). *Los nuevos materials en la construcción*, INO reproducciones, ISBN: 9788460508236, Spain.
[13]. Davies, J. (2001). *Lightweight sandwich construction*, Blackwell Science, ISBN: 978-0632040278, Oxford.
[14]. Kvdrat (2012). *Soft Cells*, available from: http://soft-cells.com/technical-details/components, acessed: 06/06/2012.
[15]. Ferrari (2012). *Interior architecture - Batyline Canatex*, available from: www.ferrari-architecture.com, acessed: 06/06/2012.
[16]. Barrisol (2010); *Products*; available from: http://pt.barrisol.com/produtos.htm, acessed: 07/06/ 2010.
[17]. Mendonça, P. (1997). *Intelligent uses of Textiles in Architecture (in Portuguese),* Master Thesis in Design and Marketing, University of Minho, Portugal.

ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

THE INFLUENCE OF SPECIAL TECHNOLOGIES ONTO SEA SWIMMING AND RESCUEING SUITS COMFORT

Ioan Neagu[1]

[1] *"Lucian Blaga"University of Sibiu, ROMANIA*

Corresponding author: Neagu Ioan, E-mail: ioan.neagu@ulbsibiu.ro

Abstract: By immersion of the human body in very cold water, hypothermia occurs, followed by a incapacity of resistance to cold water and, in a very short period of time, a sensation of cold is felt at muscle and nerve level, thus losing the capacity of self-rscue and swimming. Another consequence of hypothermia is the risc of ventricular fibrilation and cardiac arrest.Similar costumes/ suits are made out of Lycra, ensuring it fits the figure, also its flotability and comfort. Another type of material, that protects swimmers during harsh meteorological and cold water conditions is neoprene. The paper presents studies regarding different clothing structures assigned to swimming and rescueing suits on the sea, in order to establish an optimal structure, providing human body comfort and protection. These are intended for the personnel from navy petroleum industry, by using them during transportation by hellicopter or by ship to the drilling platform and for rescue in case of damage. For these reasons they should assure sea water impermeability, decreased thermal conductibility, strength to diluted solutions of petroleum-chemical products, reduced flammability level, mobility and flotability, as well as dressing in a short time. Comfort analyses were performed, for different clothing structures, in order to choose the optimal variant.

Key words: garment, cold water, heart attack, hypothermia, clothing comfort, swimming

1. RISKS AND METHODS OF COUNTERING THE UNFAVOURABLE METEOROLOGICAL FACTORS AT SEA

People wrongly believe that when they swim, they do not need a life jacket. It is important to know that body-heat loss is 25 times higher than in normal conditions, at the same temperature, this loss can be substantially reduced through swimming and wearing thermal protective clothing. The best choice of flotation equipment suitable for immersion in cold water is one that offers maximum thermal protection like a one-piece survival suit.

If the subject is situated in cold water, besides the so-called flotation, in order to retard the beginning of the hypothermia, the body heat can be used [1]:

- If the human body is alone, the feet affixing to the chest and putting the arms together will help to conserve/preserve the body heat.
- If the bodies belonging to a group, they should stay gathered as closer as possible, thus preserving the body heat.

In order to compare the situations with/without thermal protection, experiences regarding some swimmers in a swimming pool with cold water were conducted. A significant difference favourable for to the second situation was noticed. This difference is materialized in oxygen and physical efforts consume diminishing, as well as an occurence of risk of strokel [2]. In case of a severe hypothermia, incarnated by a rectal temperature decreasing at 22^0 C and pulse default, by means of a prolonged heart massage, the affected person can be animated/vitalized/vivified. Hypothermia victims can be efficiently treated in hospitals that are not equipped for a cardio-pulmonary by-pass [3].

The notices made onto a heterogen group of rowers hazardous at severe hypothermia were opportune/desirable; more practicing concerning the cold water survival, in order to be saved have been performed.The body weight was associated with the higher cooling speed. The rough manipulation of pacients suffering of severe hypothermia, during their displacement, conducts to the risk of ventricular fibrillation or heart attack producing [4].

For the anti-thermal clothing design, a poly-urethane foam layer containing a certain quantity of polyol having different functional groups as hydroxyl (-OH-), as well a a quantity of isocyanat, were utilized. Thus water durability and endurance was improved [5]. In case of suit made of two pieces for lifeguards, consisted of LYCRA, a perfect fit on the body, flatability and wearing comfort are provided [6].

A dry suit made of laminated nylon and neoprene, provided with a “velcro” zip, offers protection, in order to rescue the swimmers in unfavourable weather, as well as under cold water conditions. In order to assure the comfort, the suit should be correctly sized, in term of body height and bust perimeter. The suit can be weared as an alternative at bath suit or underclothes. All accessories necessary for the marine rescuing swimmer should be weared, when this suit is used [7].

2. THE CHARACTERISTICS OF SEA SWIMMING AND RESCUING SUITS

The suit consists of: properly suit, suit lining and floater pilllow.

The properly suit is made of Golf” relon fabric, doubled, “sandwich” type and vulcanized, orange colour, dyed with dispersion dyes showing endurance to vulcanization conditions. Vulcanization is performed with solutions of rubber having as symbols F.R.-6 (3 layers) and S.A.-106 (2 layers). Fabrics 8075 and 8075/1 are achieved. Total water tightness is performed by means of a tight zip, as well as by facial tightness, obtained with a clamps systme which casts the face mask, made of rubber, tight on the figure. The tightness is made by the doubling the seams on both sides, by affixing some little bands with a width of 3 cm, made of 8075/1 type textile support.

In order to insert air in the suit, with the purpose of augmenting of thermal insulation level and flotability, the suit is provided with a blowing valve/vent. Having a layered structure, the lining of the suit, has a thermal-insulation role. The main factor producing shipwrecked’s death is the decreasing of body temperature below 32 ^{o}C, due to the heat exchange by convection between body-environment, the coefficient of water thermal conductibilty being much higher than that of air’s ($\lambda_{apă}$ = 0,51; λ_{qer} = 0,02). The heat loss is proportional with the difference between body and water heats, being influenced by water movement, as well (waves and streams). The thermal-insolated effect of the used materials, in order to obtain the suit lining is based onto their porous composition (fine granulation or small cells limited by tight walls).

The materials the lining is made of assures the storage of a thermal-insulated air thin layer between them and body, having as consequence body heat losses mitigation.

The first material layer, placed under the properly suit, is made of polyester thin film having on both sides a thin layer of alluminium, the glossy side being the inside one. The aluminium thin layer’s fineness and the suppleness are very important for breaking strength assurance of the aluminium coated composite, which are subjected during the item wearing a lot of requisitions at inflection, compression, etc. Aluminium film provides thermal-reflectant attributes to the material (a screen re-transmitting the caloric radiations is created).

The next layer of lining is made of a poly-urethane foam having a thickness of 2 mm or a P.C.V. foam with a thickness of 2÷3 mm, flexibile, increasing thermal-insulation level of body.

The last layer of lining is made of woolen non-wooven (one or more layers), quilted on a relon lining thin layer.

The suit lining is laced at the weather proof. .

For the rescuing operation the suit is provided with a rescuing trace allowing the lifting of the victim on the ship or in the helicopter.

At the feet zone, P.C.V. boots are applied by pasting and tighting, possessing non-slipped soles.

In the ankles and hands wrists zones, the suit is provided with fixing and body fitting clamps.

For flotability assurance, the suit is provided with a pneumatic disposed around the neck, maintaining the head over beneath the water, providing the floating in a convenient position.

The suit, in terms of the seazon, can be weared over different clothing structures. Thus, in the zone of bust, the clothing structures are: undershirt and shirt for summer; undershirt, shirt and pull-over/sweater for autumn; undershirt, shirt and pull-over/sweater and training suit for spring undershirt, shirt and pull-over/sweater and quilted jacket for winter.

3. THE INFLUENCE OF THE SPECIAL TEXTILE TECHNOLOGIES OVER PRODUCT COMFORT

3.1. General considerations

In order to define the clothing comfort, but also in order to design the clothing types and structures, several calculation patterns of the main influencial comfort parameters were used. The purpose of using these methods was to determine the air passing and vapour and also thermal resistance and the balance of the thermal exchange. The thermo-physical comfort variation limits were established(specific density, relative hunidity and air temperature, wind-speed), having been adopted according to aeason and the geografic area of usage of the clothing items. Changes in the structure of the analyzed clothing items were made, thus creating a number of 194 clothing ensemble choices for each season, each containing swim and marine rescue suits.The influences of the polyurethane, batting, PVC foam, cotton and rubber fabric were analyzed. The general ecuation for the responsive function was determined, for which $x_1, x_2, x_3,,,,,,x_n$ are independent variables(thickness of the clothing ensemble), a, b, c, ... are the regression factors/ coefficients, automaticaly calculated by using a graphics software, and y is the dependant variable (the thermo-physiologic comfort parameter). A probability level of P = 95% was adopted, hence a level of significance of 0,05.

The values of the coefficients of the regression ecuations were automatically calculated for each type, based on assigning minimum values for „Student" errors for the coefficients of the regression ecuations, which were automatically calculated through the method of the least squares.

The coefficients of simple correlation were checked-out, by using r' criterion, noticing their positive values very appropriate by unit, meaning a rigurous dependence of the independent variable x, onto dependent variable y.

On the basis of values obtained, bi-dimensional and tri-dimensional dependence plots were realized, for very each case regression equations being generated.

3.2. The influence of rubbering, filming, poly-urethane foams realization, Polyvinyl chloride (P.V.C.), and non-wovens

- In case of using rubbered or un-rubbered fabrics with different characteristics, the values of comfort parameters increase in proportion with the augmentation of their thickness. The rubbering of the support conducts to higher increasing of air passing endurance, the other's parameters increasement being negligible/inessential.
- On the basis of the modification of rubbered fabric and metal polyester layer 's thickness, the values of comfort parameters are correlated with the nature of thermal insulated foam layer:
  - ✓ In case of poly-urethane foam made suits, increases for air passing endurance are achieved; the other comfort parameters are lower;
  - ✓ In case of P.C.V. foam made suits, the increases are generally smaller;
- The values of comfort parameters are better for the assembles with poly-urethane foam, in comparison with those made with P.C.V. foam.
- Analysing the global comfort indice, the highest values were obtained for the two modalities of swimming and rescueing suits. For winter, under the most unfavorable conditions, the 184 clothing assemble mode has the value for the global comfort index 218. This assemble shows, besides its components, cotton wool having a thickness of 2,15 mm.
- On the basis of body-clothing-environment relation analysis, the following were assumed:
  - ✓ The comfort parameters show much higher values (air and vapours passing endurance) or lower (air permeability) than those concerning the classic clothing items, the changes being a result of special characteristics of the analysed textile materials.
  - ✓ The sum of the themal conductibility coefficient and thermal endurance has much higher values than those obtained without assuming the physical effort intensity.

- ✓ Human physiology parameters have higher values, for the capacitive thermal-insulation indice and for the imposed thermal endurance compared with the values regarding the classic clothing items.

4. CONCLUSIONS

The evaluation method of the influence of special technologies of textiles processing provides the achievement of some optimal clothing assembles protecting the human body against the action of harmful factors from the environment.

Also, the following considerations can be made:

- Swim and marine rescue suits must be drawn and made according to season.
- For the winter season, that demands the existence of unfavourable weather conditions, including water temperatures close to 0^{0} C, swim and marine rescue suits with increased thickness of the clothing layer must be adopted.
- In order to ensure the dimentional comfort, these suits, although they have a certain degree of elasticity, must be drawn for different sizes, according to the height of the body and bust circumference.
- The design of the suits can be made according to the gender of the person wearing it , taking the body-build differences in both men and women into consideration.
- To maintain the swim and marine rescue suit performances temporally the folding and temporary storage conditions/ terms must be respected, so as not to cause an accidental adhesion of the overlapping rubber areas.

5. REFERENCES

[1] Vinkovic, M., Orientation lines in artistic designing of children's clothing, Tekstil, Volume: 52, Issue: 8, pp. 357-367, 2003.

[2] Lin, Chin-Mei; Lin, Ching-Hui; Hsiao, Pei-Chen; et al., The Application of Geometric Form in Clothing Design, Book Series: *Advanced Materials Research*, Volume: 331, Book Editor(s): Wang, R; Liu, H.W., pp. 670-674, International Conference on Textile Engineering and Materials (ICTEM 2011), Tianjin, CHINA, SEP 23-25, 2011.

[3] Claire Margnier-Jean, Patti Loue-Milanese, Methode de coupe – Vétements enfants, Nouvelle edition, Edité par M.P.G.L., 156 – 158, Avenue Parmentier, 75010, Paris, 1997, pp.25-29.

[4] Meng, Yuwei; Mok, P. Y.; Jin, Xiaogang, Computer aided clothing pattern design with 3D editing and pattern alteration, *Computer-Aided Dedign* Volume: 44 Issue: 8 Pages: 721-734, aug. 2012.

[5] Roncea, A., Cresterea si dezvoltarea copilului functie de perioadele varstei, 2012, http://www.ingrijireacopilului.ro/articole/8.-cresterea-si-dezvoltarea-copilului-in-functie-de-perioadele-varstei.html

[6]*** The Importance of Lifeguard Suits, *Swimming Blog – Swimsuit, Swim Gear and Swimming Blog*, 2012. http://blog.djsports.com/

[7] IRS, SR ISO/TR 10652 Sisteme de mărimi standard pentru îmbrăcăminte, Colecția standarde internaționale ISO/Technical Report, București, 1996.

TECHNICAL SOLUTIONS FOR MODELING PANTS PATTERNS IN CORRESPONDENCE WITH WOMEN'S CONFORMATIONAL PARTICULARITIES

Sabina Olaru [1], Elena Spînachi [2], Emilia Filipescu [3]

[1] *National R&D Institute for Textiles and Leather, Bucharest, ROMANIA*
[2] *SC Gemini CAD Systems SRL, Iasi, Romania*
[3] *Faculty of Textile, Leather and Industrial Management, "Gheorghe Asachi" Technical University, Iasi, ROMANIA*

Corresponding author: Olaru Sabina, E-mail: sabina.olaru@certex.ro

Abstract: The geometric method used in patterns design of different products categories, gives good results for garments manufacturing in industrial system, meaning type representative bodies. The quality of the results is due to the fact that in geometric method the completion of the basic patterns is achieved by prototype implementation followed by viewing the correspondence between the body and the garment, by dressing the human body or industrial mannequin. In the case that the garment, designed and manufactured for type representative bodies according to the standards is dressed by persons that do not fit the type bodies for whom the product was made, the fenomena called *"draping defects"* apprears. These unconcordances between wearer body and product obtained in industrial system is due to the conformational features of potential users such as: buttocks prominence and form, hips prominence and form, pelvis width and length, ratio between front and anterior-posterior diameters of the pelvis.
Anthropometry researches have shown that for a standardized value of the hip perimeter the secondary dimensions of the area (posterior buttock arch, length from waist the buttock point, lower arch of torso) may have different values. In this context, the paper aims to analyze the shape and size of the women's pelvis and to develop the technical solutions to adapt the basic pattern for "trousers with adjusted silhouette" to concrete particularities of the body shape.

Key words: pattern, design, pants, draping, defect

1. INTRODUCTION

The geometric method used in patterns design of different products categories, gives good results for garments manufacturing in industrial system, meaning type representative bodies. The quality of the results is due to the fact that in geometric method the completion of the basic patterns is achieved by prototype implementation followed by viewing the correspondence between the body and the garment, by dressing the human body or industrial mannequin [1,2].

In the static position of the human body, the garment comes into direct contact with some areas, depending on the product category. Relevant parts of clothing are called "support surface" or areas for "static contact". Between the body and the product, a high correlation must be ensured in the contact areas, ensuring the quality of system functioning both in static and in dynamic.

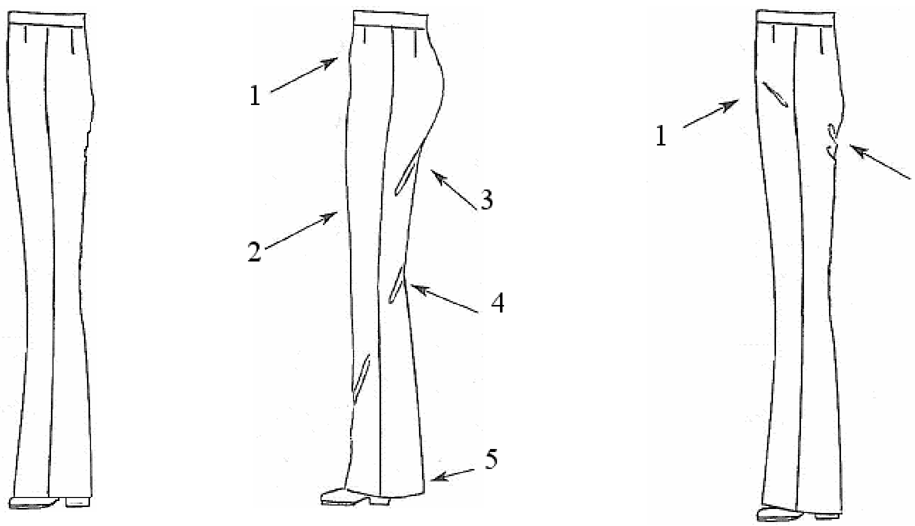
The correlation between the body and the product depends on several factors: the amount and accuracy of information about body shape and size, the method used in the construction of basic pattern, raw material behavior while wearing the product.

In static load, the body-product corrleation requires the achievement of equality between the product force on the body and the reaction force of support areas of the body. Balancing these forces depends on the size of the static contact areas and on the unevenness of the body support surfaces. The balance of the system is relatively stable over time and more difficult to be established as the bodies present deviations from standard bodies certified by standards.

In the case of design deficiencies or of bodies that deviate considerably from the typology, quality defects occur appointed by a general term "*draping defects*" or "*static uncorelation defects*".

They can occur in different areas of the body, by the appearance of fixed or free folds with different orientations and depths, disorders of the nominal position of the main elements of the product. Their remedy is dependent on causes that have generated them and is usually achieved with additional consumption of labor and raw materials.

Figure 1 shows the position of pants on body, for the reference situation, when the product is dressed by a person with standard body type (a) and for two different situations, thr product is dressed by a person with prominent buttocks (b), respectively by a person with flat buttocks and hips.



a) b) c)

Figure 1: Visualization of the body-product correspondence

The quality requirements (visualized in Figure 1 a)) of product design for a body type were evaluated by dressing the product and can systematize as follows:

- the outer seamis upright, as well as the stripes;
- the termination line is in horizontal position;
- the product doesn't have folds on sewing directions or on the front and back elements surfaces.

The lack of correlation between the body with prominent buttocks and the product designed for a body type, displayed in Figure 1 b) shows that:

- the front part of the pants is too long in the abdomen area;
- the back part of the legs, in the hip, knee and ankle regions, the product is very close to the body;
- on the back of the product, tense folds appear, positioned in the area below buttocks;
- on the back of the product, tense oblique folds appear, positioned in the region below the knee;
- the termination line in the back departs from legs; the initial position is changed in which the line termination is horizontal.

The lack of correlation between the body with flat buttocks and the product designed for a body type, displayed in Figure 1 c) shows that:

- the pants front in the hip region is too short, reason why the fixed oblique folds appear;
- the pants back is oversized on the seam along the spine (free oblique folds appear positioned in the region of the buttocks); the termination line rises in front and falls in back (the normal position is horizontal, both front and back).

2. SIZING OF CONSTRUCTIVE PARAMETERS FOR TROUSERS PATTERN CORRELATED WITH THE SHAPE OF THE SUPPORT REGION

In the basic pattern design for pants, sizing on horizontal lines (hips and waist) and anterior-posterior constructive equilibrium determines the quality of the correspondence between the support surface (pelvis area) and product design (Filipescu, 2003) [3].

For the present research, we used the algorithm for pants basic pattern design (Filipescu et al., 2007) [4], for a body type characterized by the following values of the perimtres:

- perimeter hips, Pş = 100 cm;
- waist perimeter, Pt = 72 cm.

Figure 2 shows the pattern of pants, front and back element, the surface taken from knee line to upper contour lines.

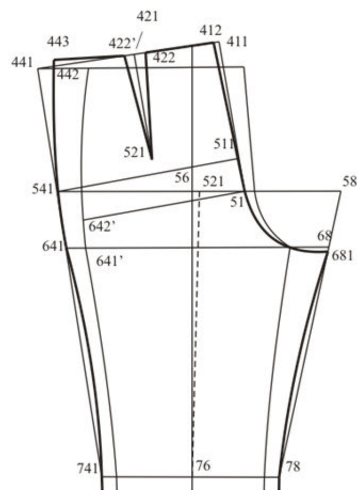


Figure 2: Constructive elements of pants patterns

The trouser pattern design, the pelvis shape and size are very important in sizing structural segments on the hips line for back element (Figure 2):

- the distance on hips line, from the line of symmetry of the back to the contour line along the spine (d = $\overline{521\ \ 51}$);
- the step width (lp = $\overline{51\ \ 58}$).

According to information from the specialized literature (Atelier, 2006) [5], these parameters change in correspondence with the hips and buttocks shape, which have a high variability among adult women.

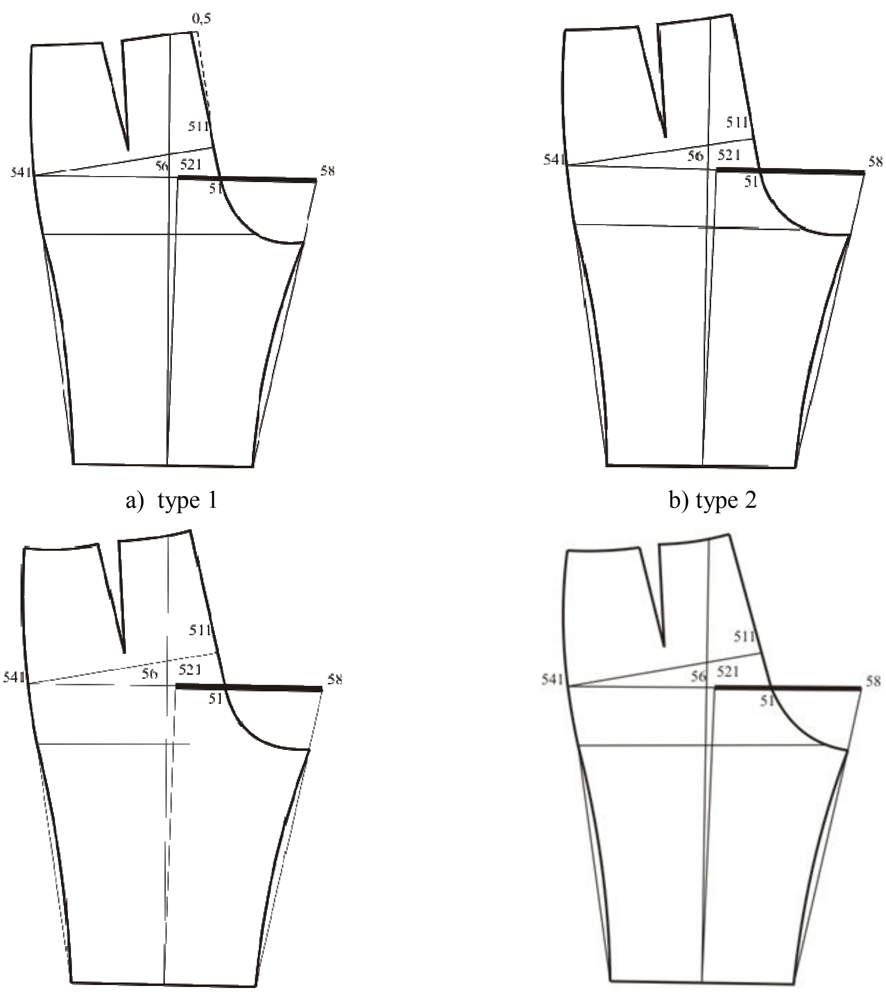
Of the many forms of the pelvis, anthropometric reserachs conducted identified the following variants that appear with greater frequency among women (Atelier, 2006) [6]:

- type 1, normal, characterized by the hips and buttocks at an average level of development;
- type 2, characterized by narrow hips and prominent buttocks;
- type 3, characterized by broad hips and flat buttocks;
- type 4, characterized by flat buttocks and hips.

For all the variants mentioned above through, was applied the same algorithm for the design of the back element, is different from one body to another is shown in the dimensioning of two segments on the hips line, d = $\overline{521\ \ 51}$ and l_p = $\overline{51\ \ 58}$. Further is presented the design steps for constructive segments influenced by pelvis shape for women, Figure 3 showing the related patterns:

- moving the strip line, $\overline{56\ \ 521}$ =1 ÷ 2 cm (exemplified to 1,5 cm);
- calculating the back segment width on hips line ($l_{sş}$) with the relationship: $l_{sş}$ = Pş+1 cm=26 cm;
- positioning the point 51 (d = $\overline{521\ \ 51}$), according to the specific features of each variant;

- positioning on front pattern the point 642 '(as in Figure 2) as follows: $\overline{641' \quad 642'} = 3 \div 5$cm (we worked with 4 cm), indicating that the value of this segment should be correlated with the degree of adjustment of the product, lower value of this segment are recommended to very adjust pants and very high values for large pants;
- joining by straight line the point 642' with point 51 on the hips line;
- by point 51drawing a perpendicular on $\overline{51 \quad 642'}$, which extends above the waist line;
- by point 541 (on hips line) is drawn a parallel to $\overline{51 \quad 642'}$, giving constructive point 511, $\overline{541 \quad 511} = l_{sş}$=26cm;
- is measured by drawing the segment $\overline{541 \quad 521}$ on hips line and placing the length measured from point 521 to a point noted with 58, so that $\overline{521 \quad 58} = \overline{521 \quad 541}$;
- after positioning point 58, it shall be measured by drawing $l_p = \overline{51 \quad 58}$, the segment will have different values in the studied variants;
- moving the line along the spine $\overline{411 \quad 412}$=0,5 cm and finalized the contour line along the spine.



a) type 1 b) type 2

c) type 3 d) type 4

Figure 3: View of back element pattern for the variants analyzed

In Table 1 are tabulated values of the two constructive segments involved in sizing the back element pattern, according to the particular shape of the pelvis, for the studied variants.

Table 1: Values of parameter d respectively l_p (cm), for the studied variants

Studied variants	$d = \overline{521\quad 51}$			
	Calculus relation	Value (cm)	Calculus relation	Value (cm)
Type 1	$1/4\, l_{sş}$	6,5	measured by drawing	13,5
Type 2	$1/4\, l_{sş} - (0,5 \div 1)$	6	measured by drawing	14,5
Type 3	$1/4\, l_{sş} + 0,5$	7	measured by drawing	12,5
Type 4	$1/4\, l_{sş} + (1 \div 1,5)$	7,5	measured by drawing	12

3. CONCLUSIONS

The pelvis shape for women, characterized by the degree of prominence of the hips and buttocks, support surface for products presents a high variability in the population of adult women. In order to ensure the dimensional and shape correspondence between the body and product in the pelvis region is necessary for sizing pants pattern, especially back element, in the pattern design algorithm used for pants in industrial system to intervene with concrete information about hips and buttocks prominence.

The design of the pants for adjusted and semi-adjusted silhouette is necessary that the size of the segments line on hips line $d = \overline{521\quad 51}$ and $l_p = \overline{51\quad 58}$ to be done separately, depending on the specific form of the pelvis area.

From the values shown in Table 1, it is clear that small values of segment d are correlated with higher values for the step width. Lower values of the parameter d are recommended for people with narrow hips and prominent buttocks (type 2). High values of the parameter d are specific to the flat buttocks and hips, for which step width is low.

The research results are recommended in the pants pattern design in individual system to achieve this type of product but by adapting quite easy and accurate patterns built for type bodies.

4. REFERENCES

[1] Olaru S., Mocenco A., Teodorescu M., Niculescu C., Salistean A., Grupe conformaționale pentru populația feminină din România și recomandări vestimentare specifice, Industria Textila, vol. 62, nr. 3, 2011, pag. 155-160

[2] Olaru S., Filipescu E., Niculescu C., Indicatori morfologici de caracterizare a formei toracelui si a bazinului la femei, pentru proiectarea imbracamintei in sistem individual, Industria Textila, vol. 62, nr. 6, 2011, pag. 289-295

[3] Filipescu E., Structura şi proiectarea confecțiilor , Ed. PERFORMANTICA, 2003

[4] Filipescu E., Avădanei M., Structura şi proiectarea confecțiilor textile, Îndrumar de laborator, Ed. Performantica, Iaşi, 2007

[5] Revista Atelier, nr. 12/2006

[6] Revista Atelier, nr. 7/2006

ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

APPLICATION OF ACTIVATED CARBON FROM COTTON WASTE FOR TEXTILE DYE REMOVAL

Novica Djordjevic[1], Dragan Djordjevic[1], Snezana Urosevic[2], Milena Miljkovic[3]

[1]*University of Nis, Faculty of Technology, Leskovac, SERBIA*
[2]*University of Belgrade, Technical Faculty, Bor, SERBIA*
[3]*University of Nis, Faculty of Mathematics and Natural Sciences, Nis, SERBIA*

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

Abstract: Modelling of adsorption of textile dyes from aqueous solution on activated carbon produced from waste cotton fibers from the weaving plants was investigated. These airborne waste fibers are formed as a by-product in the weaving process using cotton yarns on looms. The aim is to use the waste cotton material, make it into activated carbon and use it for coloration reduction, i.e. removal of textile dyes by adsorption on activated carbon. The dye used is a triazo class dye with four sulfo groups and one amino functional group. Based on the results, it can be said that the activated carbon derived from waste cotton fibers is an efficient adsorbent for the removal of textile dye from aqueous solutions, waste water after dyeing, for example. The dye was quickly adsorbed in the first ten minutes, and then the adsorption rate decreased gradually and reached equilibrium in about 60 minutes. At lower dye concentrations, a slightly higher degree of dye removal is achieved. The percentage of dyeing efficiency is reduced with increasing the initial dye concentration in the solution, which is reflected in the fact that the degree of dyeing decreased with increasing the initial dye concentration. However, the actual amount of dye adsorbed per unit mass of fibers increases with increasing dye concentration.

Key words: activated carbon, waste, cotton fibers, adsorption, textile dye.

1. INTRODUCTION

One of the main methods for removing pollutants from wastewater is the use of porous solid absorbents. Porous materials properties that make them useful for the treatment of water are high porosity and surface area, as well as the physical and chemical nature of the internal adsorption surfaces. Large amounts of waste water polluted with dyes are discharged from the textile industry, leather and laundries. Pollutants include dyes, suspended solids, alkali, heavy metals and organic matters [1, 2].

In reference works there are several studies on the adsorption of dye on different materials. These include basic dyes on carbon, peat, wood and pith. Some studies indicate that the absorption rate is determined on the basis of the adsorption equilibrium (unfavorable, linear, favorable or completely irreversible) and control mechanism (external diffusion, internal pore diffusion, inner solid-phase diffusion or longitudinal diffusion) [1-3].

This paper deals with the modeling of adsorption of textile dyes from aqueous solution on activated carbon produced from waste cotton fiber from the weaving plants. These airborne waste fibers are formed as a by-product in the weaving process using cotton yarns on looms. The aim is to use the waste cotton material, make it into activated carbon and use it for coloration reduction, i.e. removal of textile textile dyes by adsorption on activated carbon.

2. EXPERIMENTAL

Activated carbon obtained by chemical and physical modification of waste cotton fibers from the weaving plants was used as an adsorbent. After the collection of waste fibers, they were washed in warm distilled water (40^{o}C), dried and subjected to the treatment by concentrated sulfuric acid (1 g of waste fiber: 6 g H_2SO_4) for 24 h at room temperature. The samples were then heated at 180^{o}C for 1 hour, followed by rinsing with distilled water and neutralization to pH=7 (with sodium bicarbonate). After drying, the obtained residue (activated carbon) was milled and then sieved to a particle size of 0.5 mm. Thus prepared activated carbon was used in the experiment.

Adsorption test was performed in Erlenmeyer flasks in which the adsorbent (activated carbon) was suspended in textile dyes solution (adsorbate). Erlenmeyer flasks were placed on the shaker with 140 rpm/min at a temperature of 20°C and shaken for a given time. The amount of activated carbon was 2 g, while the solution in a constant volume of 100 cm^3, contained dye concentrations of 10, 30, 50, 70 and 100 mg/dm^3. Processing time, with continuous stirring, was 10, 20, 30, 50 and 60 min. Experiments were conducted at neutral pH of the dye solutions, since there are no major variations in the wide range of pH.

The dye concentrations mentioned were taken for the simple reason that they mostly correspond to the amount of dye remaining in the waste solution after dyeing cotton textiles. It was found that the adsorption equilibrium time of dye adsorption on activated carbon was achieved in 60 min, and an extension of time of treatment did not significantly change the adsorption.

Upon completion of the adsorption, dye solutions and activated carbon were passed through a filter paper. This was followed by determination of the absorption of the solution on a UV-VIS spectrophotometer (Cary 100 Conc UV-VIS, Varian) at 605 nm (maximum wavelength of the spectrum of the dye solution used).

SEM measurements were carried out on a JEOL JSM - 6610LV device using a secondary electron detector. Also, as the SEM is equipped with EDS X-rays detector, characteristic X-rays of major elements (> 10 wt.%) were measured.

The degree of dye removal (dye exhaustion) was calculated based on the dye concentration before and after treatment [2,3]:

$$R = \frac{C_0 - C_t}{C_0} \cdot 100 \quad \textbf{(1)}$$

where C_0 and C_t are the initial and final concentrations of dye solutions, respectively.

The amount of dye adsorbed (adsorbate) per unit mass of activated carbon (adsorbent), qt (mg/g), was determined as follows [2,3]:

$$q_t = \frac{(C_0 - C_t) \cdot V}{M} \quad \textbf{(2)}$$

where: M, g - mass of adsorbent, V, dm^3 - volume of solution from which adsorption is carried out.

The dye used is a triazo class dye with 4 sulfo groups and one amino functional group. It is a dye that belongs to the group of azo dyes, CI Direct Blue 71, soluble in water, 10 g/dm^3 (60°C), 20 g/dm^3 (97°C) and exists in the anionic form, soluble in ethanol and insoluble in other organic solvents, Fig. 1. It is used for dyeing cotton and viscose fibers, rayon, paper, leather and, to a lesser extent, nylon [4-7].

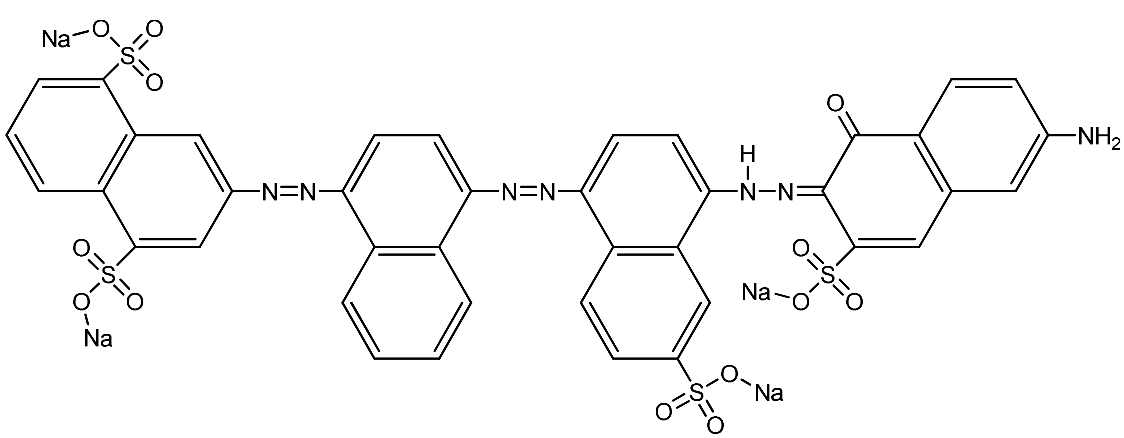


Figure 1: Structure of textile dye

3. RESULTS AND DISCUSSION

The activated carbon used is relatively fine bulk material with heterogeneous porous particles of diverse shapes and forms. Within larger particles there are conspicuous cracks, cavities and channels that form the basis of the microporosity of materials, Figure 2.

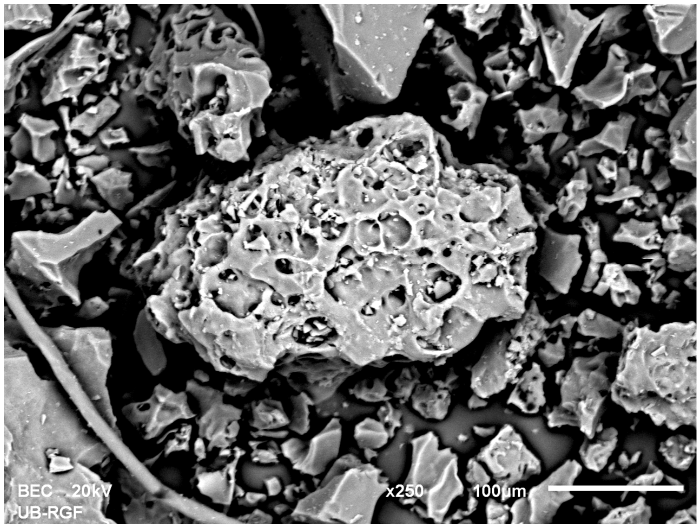


Figure 2: Micrograph of the adsorbent used (activated carbon)

A survey of the table with the results of line spectrum (Table 1), which refers to a number of point analyses along a specific line in the graph of the activated carbon samples, approximately at the same distance between themselves (a few tens of microns - depends on how you choose) can give the information on the chemical composition at a very close range, i.e., this analysis and the results are generally used when a gradual change in the chemical composition of the sample is expected.

Table 1: Results of line EDS spectrum of activated carbon with mass percentages of the individual elements

Spectrum	C	O	Na	Al	Si	S	Ca	Total
Line Spectrum (1)	59.86	33.66	4.58	0.07	0.00	1.82	0.00	100.00
Line Spectrum (2)	63.68	25.49	6.64	0.00	0.00	4.19	0.00	100.00
Line Spectrum (3)	65.19	23.69	2.79	0.00	0.31	8.02	0.00	100.00
Line Spectrum (4)	60.32	33.35	4.77	0.00	0.00	1.55	0.00	100.00
Line Spectrum (5)	60.67	32.92	4.74	0.07	0.00	1.60	0.00	100.00
Mean	61.95	29.82	4.70	0.03	0.06	3.44	0.00	100.00
Std. deviation	2.35	4.83	1.36	0.04	0.14	2.79	0.00	
Max.	65.19	33.66	6.64	0.07	0.31	8.02	0.00	
Min.	59.86	23.69	2.79	0.00	0.00	1.55	0.00	

The effect of contact time on the removal of textile dyes by an adsorbent is shown in Figure 3. The dye was quickly adsorbed in the first ten minutes, and then the adsorption rate decreased gradually and reached equilibrium in about 60 minutes. At the beginning, the adsorption rate was high because the dye ions were adsorbed by the outer surface of activated carbon. When the adsorption of the exterior surface reached saturation, dye ions were adsorbed by the interior surface of particles.

Dye exhaustion is the highest at lower initial concentrations, but after the calculations, it can be seen that the exhaustion is nevertheless the highest at the highest initial concentrations.

Example, Figure 3:

- for dye concentration of 10 mg/dm^3 about 60.59% of dye is exhausted in 10 min, which amounts to:
  10 mg/dm^3 × 60.59% / 100 = **6.06 mg/dm^3** are exhausted after 10 min of adsorption.
  and

- for dye concentration of 100 mg/dm^3 about 57.99% of dye is exhausted in 10 min, which amounts to:
  100 mg/dm^3 × 57.99% / 100 = **57.99 mg/dm^3** are exhausted after 10 min of adsorption.

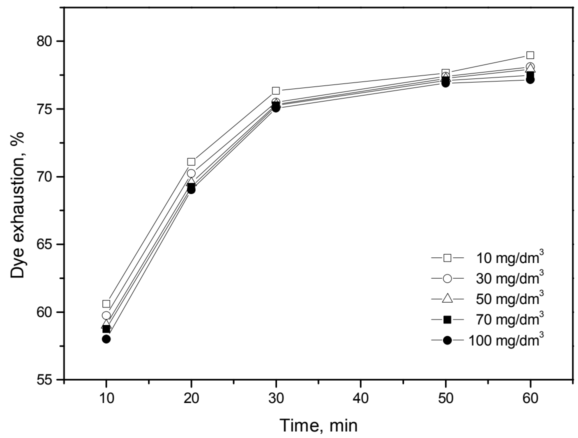


Figure 3: The effect of adsorption time on the amount of exhausted textile dyes on the activated carbon depending on the initial dye concentration

Adsorption efficiency depends on several parameters: ambient temperature, pH, mechanical mixing, the diffusion rate of the dye, and the like. Thus, for example, as a rule, increasing the temperature of the solution increases the dyeing rate or diffusion rate, but also with increasing temperature the equilibrium dye exhaustion is reduced.

In the first phase of the transition of the dye from the solution to the adsorbent surface the adsorbent rate depends on the degree of mixing of the dye solution. It reaches its maximum value at a vigorous mixing. With the increase of flow speed of the solution, the thickness of the boundary layer decreases and the dye mass transfer rate increases proportionally. Final balance is achieved when the dye mass transfer rate becomes independent of further increase of the flow rate. When this requirement is satisfied, the adsorption rate is primarily determined by the rate at which dye can penetrate into the interior of the adsorbent.

The third process is characterized by permeation of adsorbent with dye solution. Dye diffuses through the adsorbent structure, sometimes several times depending on the share of bonding force exerted by the adsorbent. If this is seen as a process of diffusion with simultaneous adsorption, dye penetration rate is then determined by the dye adsorption range, and by resistance of the adsorbent structure to dye flow.

Figure 4 shows the dependence of the degree of dye exhaustion on the initial and current dye concentrations for different times of adsorption. At lower dye concentrations a slightly higher degree of dye removal is achieved. In reality, however, larger quantities of dye are adsorbed on ash at largest initial concentration of textile dyes. Higher initial dye concentration provides greater driving force to overcome the resistance to dye mass transfer between the water and solid phase. In addition, an increase of the initial dye concentration increases the number of collisions between the dye anions and adsorbent, which favors the adsorption process. So, the initial concentration of dye does not affect the time of reaching the balance, but determines the rate of dye mass transfer through the solution to the surface of adsorbents of the same mass as the agitation rate is constant.

Figure 5 shows dye concentration in the solution depending on the duration of the adsorption on activated carbon. It can be noticed that in all cases the longer duration of the process reduces the dye concentration in the solution, as was expected, and somewhat more intensely at higher initial concentration of dye.

The percentage of dyeing efficiency is reduced with increasing the initial dye concentration in the solution, which is reflected in the fact that the degree of dyeing decreased with increasing the initial dye concentration. However, the actual amount of dye adsorbed per unit mass of adsorbents increases with increasing dye concentration. The fact that dye sorption increased at lower and decreased at higher initial concentration is related to dynamic processes in the solution during dyeing.

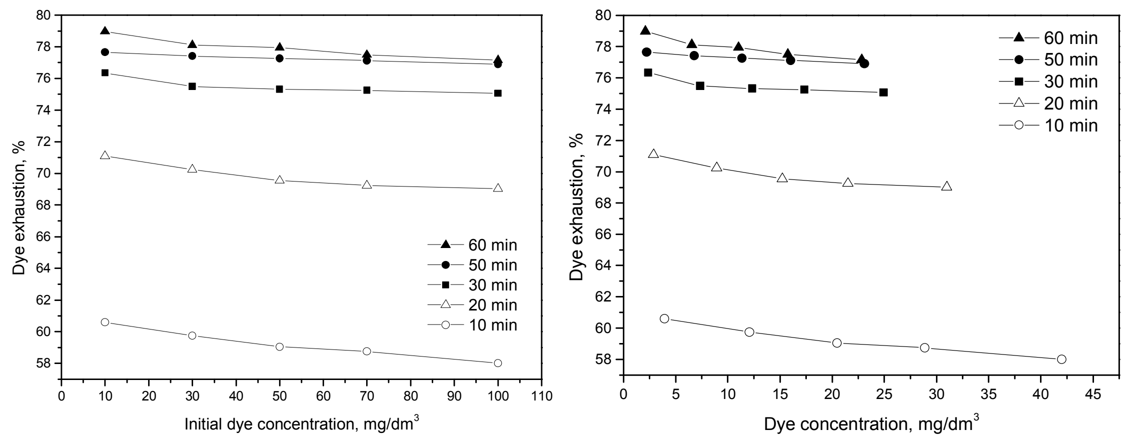


Figure 4: The effect of the initial and current dye concentrations in the solution on the amount of textile dye removed

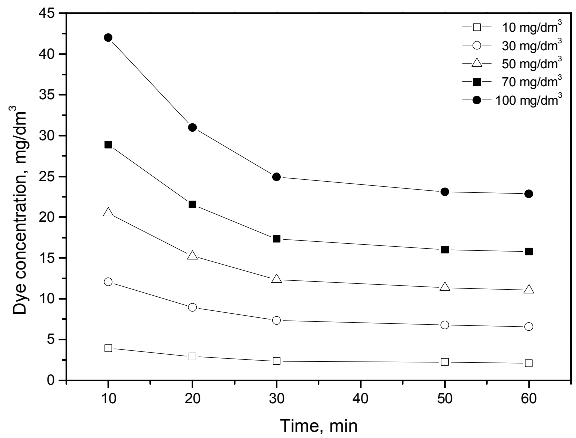


Figure 5: Textile dye concentration variations in the solution in time depending on the initial concentration

The results of the changed adsorbed amount of adsorbates on adsorbents during time, for different starting dye concentrations, as well as the dye exhaustion in relation to the adsorbent amount, are showed on diagrams on the figure 6. The continuity of changers in the period of time is present, i.e. longer time brings larger amount of adsorbed dye per adsorbent mass, i.e. there is the highest adsorption at the highest applied dye concentrations.

Also, evident is the continuous increase of the amount of exhausted dyes compared to the mass of adsorbent. In this diagram there is a curve (10 mg/dm^3) for the lowest initial concentration, while in the lower right corner shown is the secondary diagram with all the initial concentrations.

Namely, in the lower right corners of the diagrams, inserted is a complete diagram showing the same dependency but for all dye concentrations. Practically, one curve (with the lowest dye concentration) was taken out of the secondary diagram and given enlarged for a clearer perception of the change in the adsorbed amount of adsorbate on the adsorbent over time. At a given initial dye concentration, a major change of the adsorbed dye occurs in the first 10 minutes of dyeing process, while in the later stage of adsorption these changes are minor.

For example, for the initial dye concentration of 10 mg/dm^3:

- q_t increases from 0 to 0.202 mg/g during the dyeing from 0 to 10 min, and
- q_t increases from 0.202 to 0.263mg/g during the dyeing from 10 to 60 min.

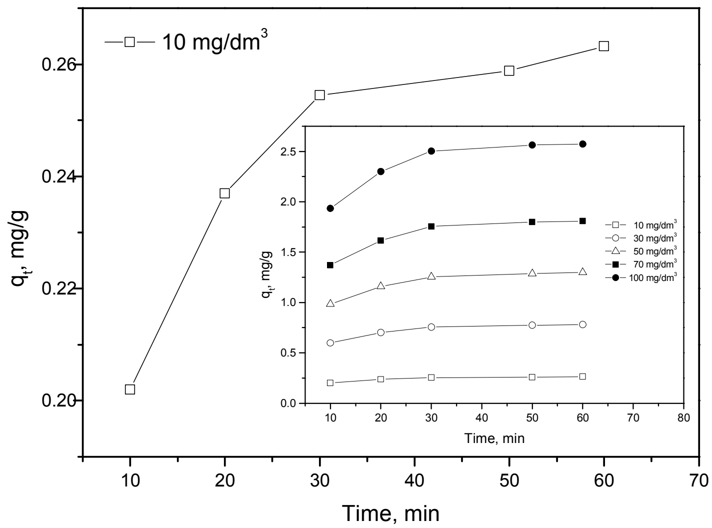


Figure 6: Adsorbed amount of textile dye during time

4. CONCLUSION

It should be noted that activated carbon derived from waste cotton fibers can be an effective adsorbent for the removal of textile dyes from aqueous solutions with a logical tendency of application in industrial environments. The characterization of other, similar in nature, solid waste, can help shed light on the adsorbate-adsorbent interaction, which leads to optimization and greater efficiency of the adsorption process as an environmentally very friendly process.

Based on the experimental results the following conclusions can be drawn:

- Prolonged contact time means a greater amount of dye on the activated carbon, i.e. the dye concentration in the solution decreases with the duration of the adsorption.
- The percentage of the removed dye decreases with increasing the initial dye concentration in the solution, but the actual amount of the adsorbed dye increases with the increase of dye concentration.

The results obtained in this work indicate the possibility a practical application of removal of water coloration after dyeing in the textile industry thus providing support of environmental protection both from economic and practical standpoint.

5. REFERENCES

[1] Hameed, B.H., Krishni, R.R. & Sata, S.A. (2009) A novel agricultural waste adsorbent for the removal of cationic dye from aqueous solutions, *Journal of Hazardous Materials*, 162 (2009) 305–311, ISSN 0304-3894.

[2] Safa, Y. & Bhatti, H.N. (2011) Adsorptive removal of direct textile dyes by low cost agricultural waste: Application of factorial design analysis, *Chemical Engineering Journal,* 167 (2011) 35–41, ISSN 1385-8947.

[3] Malik, P.K. (2004) Dye removal from wastewater using activated carbon developed from sawdust: adsorption equilibrium and kinetics, *Journal of Hazardous Materials,* B113 (2004) 81–88, ISSN 0304-3894.

[4] Sawada K. & Ueda, M. (2003) Adsorption behavior of direct dye on cotton in non-aqueous media, *Dyes and Pigments,* 58 (2003) 37–40, ISSN 0143-7208.

[5] Chairat M., Rattanaphani, S., Bremner, J.B. & Rattanaphani, V. (2005) An adsorption and kinetic study of lac dyeing on silk, *Dyes and Pigments,* 64 (2005) 231-241, ISSN 0143-7208.

[6] Burkinshaw S.M. & Gotsopoulos, A. (1999) Pretreatment of cotton to enhance its dyeability; Part 2. Direct dyes, *Dyes and Pigments,* 42 (1999) 179-195, ISSN 0143-7208.

[7] Carrillo F., Lis, M.J. & Valldeperas, J. (2002) Sorption isotherms and behaviour of direct dyes on lyocell fibres, *Dyes and Pigments,* 53 (2002) 129-136, ISSN 0143-7208.

ANALYSIS OF COTTON DYED WITH ONION EXTRACT

A. Gomez[1], V. Soto[2], P. Monllor[3], M. Bonet[4]

[1, 2, 3, 4] *Universitat Politècnica de València. Plaza Ferrandiz y Carbonell 0380. Alcoy. Spain*

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

Abstract: Nowadays developed countries are concerned about environmental issues and some laws are focused on preserving it. This means that some industrial procedures must be redesigned and the ancestral ones can be reconsidered as a valuable alternative to the nowadays process. The textile sector is one of those which has pollutant processes and one of the most related is the wet process, mainly dyeing and printing. Different dyes are considered in order to replace the ones used recently as their chemist implies they are pollutants. Natural resources are seriously considered as the alternative for a friendly environmentally dyes process. The aim of this paper is to evaluate the dyeability of some onion spicies (*Allium Cepa*). The conducted experiment was based on the onion extraction and lately dyeing procedure. Different concentrations were used for the extraction. An exhaustive analysis was performed on the dyed samples. Cotton fabrics were visually analysed but obiosuly results are showed based on colorimetric measurements. Lately, they were washed as ISO standard states in order to evaluate the dyed samples colour fastness. Results show onion is a chance for dyeing and that different colours can be obtained depending on the onion spicie despite lightness differences are not significant.

Key words: Natural dye, cotton, onion, red onion, dye, fastness.

1. INTRODUCTION

Pharmacological, medical or other applications from natural dyes are seriously considered to treat textile fabrics, mainly with natural fibres. Novel finishes are being under research in order to determine new properties for fabrics so as to offer new properties mainly for technical textiles [1].

Nowadays industrialised countries are more concerned about environmental issues. Diverse rules and laws related to en ironment are being published. The companies are being invited to produce under biodegradable processes. Synthetic dyes can produce some allergies. Both are reasons which explain the increasing interest on natural dyenig.

The natural dyes are seriously being considered as natural dyes and ecofrendly in nature [2]. The aim of this work was to determine if onion is one alternative to obtain cotton dyed with a suitable colour. The colorimetric values were analysed and moreover, the colour fastness was evaluated to determine if ti was worthless or not to dye with onion extracts.

2. EXPERIMENTAL

2.1 Materials

Dyeing solution was prepared from two onion species (Allium cepa), the conventional one and the red one. Both of them were bought at a local market.

A plain fabric 100% cotton was used for dyeing.

2.2. Methods

Onion was peeled and weighted until a fixed quantity. Lately, about 1L was added, stirred and heated up to boiling temperature, then it was kept at this temperature during 1 hour. Afterwards, solution was filtered and collected. When cooled water was added until it reached the total amount of 1 litre. Onion concentrations are shown in table 1.

Table 1: Onion concentration

MATERIALS	CONCENTRATION	
ONION (*Allium Cepa*)	10 g/L	50 g/L
RED ONION (*Allium Cepa*)	10 g/L	50 g/L

Samples were dyed buy mixing fabric and solution in a multidye. Dyieing solution was kept at 90º C for 1 hour.

2.3. Colour fastness

Colour fastness was evaluated according with UNE EN ISO 105 C10. Dyed samples were treated one cycle as the standard stated. It was washed for 45 minutes at 30º C and when dried both colour staining and change in colour were evaluated.

2 4. Change in colour

One of the colour systems on which most colorimetric studies are based is the CIE L*a*b*system [3,4]. Some measurements in a Minolta C3600-d reflexion spectrofotometer were made, and we determine chromatic values CIE L*a*b* space (ΔEab). Tests were developed in agreement with the standard guidelines for textile fabrics [5, 6]. ΔEab Values and whiteness are calculated directly by the spectrophotometer software according to their respective standards [5, 6].

3. RESULTS

Reflectance specta has been studied for both conventional and red onion. Figure 1 shows the results and for onuion extract it seems, as it was predictable, higher values for the more concentrated extract. However, it is siurprising the behaviour observed for red onion, apparently it seems not to be big differences between the more and the less concentrated extract.

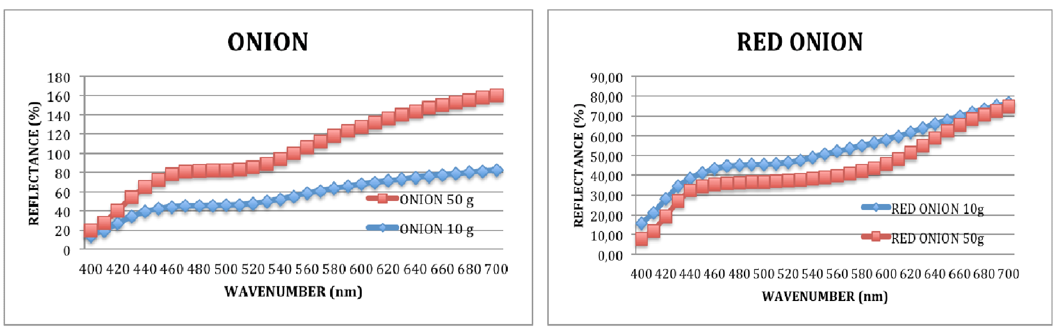


Figure 1: Reflectance for cotton dyed.

In order to determine if there are some differenes, table 2 shows colour measurements based on CIELab. It can be seen that some changes in colur occur when it is dyed with red or conventional onion.

Table 2: CIEL*a*b* values

MATERIALS	CIE		
	L*	a*	b*
ONION (*10 g*)	77,0081	5,0283	13,4173
ONION (*50 g*)	70,0799	6,5295	11,661
RED ONION (10 g)	79,7772	8,4556	17,81
RED ONION (50 g)	74,3237	10,355	23,9775

CIEL*a*b* values are analised based on lightness/darkness (L*), redness/greenness (a*) and yellowness/blueness (b*). When results are analysed, it can be noticed no high differences between onion and red onion, red onion is slightly lighter than the conventional one though. When the comparison is stablished between differences in onion concentration results evidence no significative differences. As a conclusion it should be stated that there are no differences about lightness/darkness.

If the analysis is focused on redness/greenness it can be clearly appreciated the influence of the concentration. When higher amount of onion was used in the extract, higher values for a* were obtained, this means that the dyed fabric showed more redness than the ones with low quantity of onion in the extract. If the study is referred to the comparison between onion and red onion as it could be predictable, red onion shows higher values for a*, obviously red onion should reflect more redness (a* higher).

Yellowness and blueness inlfluence shows surprising results as the behaviour is complealy different for conventional onion and red onion. The b* increases when concentarion is higher for red onion but not for conventional one. Furthermore it is remarkable that red onion presents more yellowness tan the conventional one. This result was not predcitable as it seemed conventional onion might show more yelloness than the red one.

Obviously, it is not only important to evaluate the dyeing result but the colour fastness is another importan aspect to consider. Every sample was treated in the same conditions as the satndard stated and lattely evlauated. Table 3 shows results for conventional onion and table 4 shows results for red onion.

Table 3: Colour fastness for dyes with onion.

ONION CONCENTRTION (g/l)		10	50
CHANGE IN COLOUR		3/4	3/4
ASSESSING STAINING	Co	4/5	4
	Wo	5	5

Table 4: Colour fastness for dyes with onion.

RED ONION CONCENTRATION(g/l)		10	50
CHANGE IN COLOUR		4	3
ASSESSING STAINING	Co	4/5	4/5
	Wo	5	5

It can be clearly appreciated that samples dyed with red onion extracts show slightly higher variation in colour than the samples dyed with conventional onion. However, it can be easily noticeable that staining in wool fabrics si perfect as no change in colour can be observed and for cotton only slight differences are observed.

6. CONCLUSIONS

Onion has shown that it is possible to dy cellolose with onion. The main point which sould be remarked is that all the cotton samples were dyed although the colour was not as predictable as it should be expected. About lightness and darkness no significative differences were observed. However, the chromatic values showed some differences compared with results should be expected. The conventional onion showed lower yellowness (higher b*) than the red one. As it could be expected, redness (a*) is higher for the red onion. Referring to colour fastness results show some change in colour but not high intensities for cotton samples washed with dyed fabrics and no differences for wool samples.

This means that some improivements can be done in further studies but onion seems to have some possibilities to be considered as a natural dye for cellulosic fibres in order to improve the environment preservation.

7. REFERENCES

[1]. M. Yushuf, et al. Assessment of colorimetric, antibacterial and antifungal properties of woollen yarn dyed with the extract of the leaves of henna (Lawsonia inermis)Journal of Cleaner Production 27 (2012) 42-50.
[2] A. Isnayat, et al. Applications of eco friendly natural dyes on leather using different modrants. Proc. Pakistan Acad. Sci. 47(3). 2010. 131-135.
[3]. J.R. Aspland, *Textile chemists and colorists,* 25(1), 34 (1993)
[4]. W.F.Billmeyer, M. Saltzman in "Principles of Color Technology" 2nd edition. John Wiley & Sons, New York, NY, 1982
[5]. Standard ISO105-J01:1997. Textiles. Tests for colour fastness. Part J01: General principles for measurement of surface colour
[6]. Standard ISO105-J03:1997. Textiles. Tests for colour fastness. Part J03: Calculation of color differences.

A STUDY ON THE CHANGE OF TRANSPORT AND SELECTIVE PROPERTIES OF ULTRAFILTRATION POLYMER MEMBRANES AFTER VACUUM METALLIZATION WITH IRON-CHROMIUM-NICKEL ALLOY

Violeta Ognianova Slavova[1], Stoiko Petrov Petrov[2], Georgios Priniotakis[3]

[1] TU – Sofia, College in Sliven; 8800 Sliven, 59 Bourgasko Shaussee Blvd, BULGARIA
e-mail: v_slavova@ mail.orbitel.bg
[2] University "Prof. Assen Zlatarov, 8010 Bourgas, Prof. Yakimov Blvd 1, BULGARIA,
e-mail: stpetrov@btu.bg
[3]Technological Education Institute of Piraeus, Thivon 250 & P. Ralli 12244 Aegaleo, Athens GREECE e-mail: gprin@teipir.gr

Corresponding author: Georgios Priniotakis, E-mail: gprin@teipir.gr

Abstract: The possibility for vacuum metallization of ultrafiltration polymer membranes with iron-chromium-nickel alloy was studied after preliminary modification with Sn^{2+} in acid medium. The change of transport and selective characteristics of the vacuum metal coated membranes was studied, as well as the durability of the vacuum obtained coating during membrane performance. Two types of polyacrylonitrile membranes with differing characteristics and structure were studied to find the effect of exposition on the vacuum metallization, the possibilities for preliminary chemical modification of membrane surface. The metal coating was prepared in vacuum installation BUP-5 by sputtering flat target of iron-chromium-nickel alloy (H18N9T) with size ø 100 x100 mm, at distance target/membrane $L_{M-N} = 180$ mm and specific sputtering power $N_p = 5{,}4$ W/cm^2. A comparison of the efficiencies of the initial non-treated and non-metalized membrane (87 l/m2h) and chemically modified non-metalized one (93 l/m2h) with the efficiency of a membrane coated with X18H9T, it can be seen that the latter had lower efficiencies for water regardless of the sputtering time. The second type of membranes used for the present studies (PAN-II) have much higher water efficiency compared to the PAN-I membranes, measured as initial structures. The higher efficiency leads to lower selectivity of these membranes (compared to PAN-I), as determined by the experimental data. It was interesting to find how this higher efficiency would be affected by the vacuum metallization. With the increase of coating time from 5 to 25 s, their efficiency increased from 380 to 505 l/m2h (Fig.5). The value of the efficiency at exposition time of 25 s (185 l/m2h) was close to these of chemically non-treated and non-metalized one (87 l/m2h) and chemically treated non-metalized one (350 l/m2h) membranes.

Key words: polymer membranes, modification, vacuum metallization, coating.

1. INTRODUCTION

As polymer systems, the membrane structures can be metalized using either chemical or physical methods. The process of metallization provides possibilities to change membrane transport and selective properties thus making them applicable in various fields of science and technology. The preparation of the metal coatings depends on polymer characteristics, metallization methods and the technological parameters of the process.

Two types of polyacrylonitrile membranes with differing characteristics and structure were studied to find the effect of exposition on the vacuum metallization, the possibilities for preliminary chemical modification of membrane surface. The structure and the basic transport and selective characteristics of the membranes were studied.

2. EXPERIMENTAL

The metal coated membranes are polymer membranes covered with thin metal layer. Metal can be deposited on membrane surface by several methods: magnetron sputtering, chemically – in a solution, vacuum coating methods, including ion bombardment and thermal evaporation. [1, 2].
The process of metal coating of membranes has a number of specific characteristics related to the type of polymer material and the method of metallization.

The membranes used for the present studies were prepared under laboratory conditions by the phase inversion method, known also as the method of Loeb. The first membrane (PAN I) had the following composition: PAN – 16.25 mass%, PM

MA – 0.25 mass%, $CuSO_4.5H_2O$ – 1.5 g/l. The other membrane (PAN II) had the following polymer composition: PAN – 14.25 mass%, PMMA – 2.25 mass%. The use of PMMA of modifying polymer gives membranes of higher efficiency. The change of transport characteristics of these membranes were due to the incompatibility of the two polymers. The addition of PMMA in the polymer solution during the phase inversion leads to formation of membranes of higher porosity which stipulates the lower selectivity of the membranes. This, in turn, determines the necessity for additional modification which can be accomplished either in the polymer solutions or on the working surface of the membranes obtained.

The metal coating was prepared in vacuum installation BUP-5 (Russia) by sputtering flat target of iron-chromium-nickel alloy (H18N9T) with size ø 100 x100 mm, at distance target/membrane $L_{M-N} = 180$ mm and specific sputtering power $N_p = 5,4$ W/cm^2.
Magnetronic deposition of iron-chromium-nickel alloy was carried out at initial vacuum in the operation chamber $P_i = 1.10^{-3}$ Pa, medium Ar with purity of 99,99% and working pressure in the chamber $P_w = 4.10^{-2}$ Pa. Five deposition times were used: 5, 10, 15, 20 and 25 s. At the end of the process of deposition, the membranes were cooled to room temperature in the Ar medium and then they were taken out in air. The power of the direct current source of the magnetron was 8 kW with smooth current control 0÷10 A.

The performance characteristics of the metalized membranes - permeation flux (J) and retention (R) were determined on a laboratory apparatus "Sartorius" SM-165 (England) by the following equation:

$$J = \frac{V(t)}{Sbt}\left(m^3/m^2h\right) \quad R = \frac{C_0 - C_i}{C_0}.100\left(\%\right) \qquad \textbf{(1)}$$

where V(t) denotes the volume of passed liquid (m^3); Sb – effective area of the membrane (m^2); t – time (h); C_0 - initial concentration (kg/m^3); C_i - concentration of the filtrate (kg/m^3).

Membrane selectivity was measured using the calibrant "Albumin" – human serum /M_w=67000/ (Fluka) with initial solution concentration 1 g/l. The separation ability of the membrane compared to the calibrant was determined spectrophotometrically at wave length λ=280 nm on a UV/VIS spectrophotometer "Unikam"-8625- France.

The micrographs have been taken on a scanning Electron Microscope JEOL JSM-5510. Prior to viewing the membrane sample was fractured in liquid nitrogen gold coated.

3. DISCUSSION

Knowing and controlling the process of interaction between the metal layer and the polymer membrane is very important for the vacuum metallization, since it determines the type and quality of the metal coating.[3, 4]. The factors determining the process are the material of substrate (membrane) and coating, the preliminary treatment of the membranes and the technological and conditions and parameters.[5]. One of the conditions for better metallization (better adhesion between the polymer and the metal coating) is the preliminary treatment of the polymer surface. It ensures activation of the polymer surface to facilitate the formation of nuclei for the following vacuum metallization.[6]. For this purpose, the opportunities for modification of the polymer structure with various chemical components were preliminarily studied.[7, 8]. In this case, the most suitable turned out to be the aqueous system containing 50 g/l $SnCl_2.2H_2O$, 100g/l HCl – referred to further as "the modifying system". The preliminary chemical modification of both types of membranes with the aqueous system selected appeared to be good enough which can be seen in Fig.1 where the efficiencies of modified and unmodified membranes are shown for comparison (***Fig* 1.**)

The preliminary chemical modification of the membranes improves the adhesion between the polymer and the metal coating which is determined by the processes taking place within the system. The treatment with the aqueous solution activated the polymer surface, so the deposition of Sn(II) onto polymer surface did not occur in the sensibilizing solution but during the following washing of the polymer surface when, due to hydrolysis:

$$\mathbf{SnCl_4^{2-} + H_2O \longrightarrow Sn(OH)Cl + H^+ + 3Cl^-} \quad \mathbf{(2)}$$

the scarcely soluble product $\mathbf{Sn(OH)_{1.5}.Cl_{0.5}}$ is formed. It remained on membrane surface due to laminar coagulation and can form a layer of tens to thousand Å.

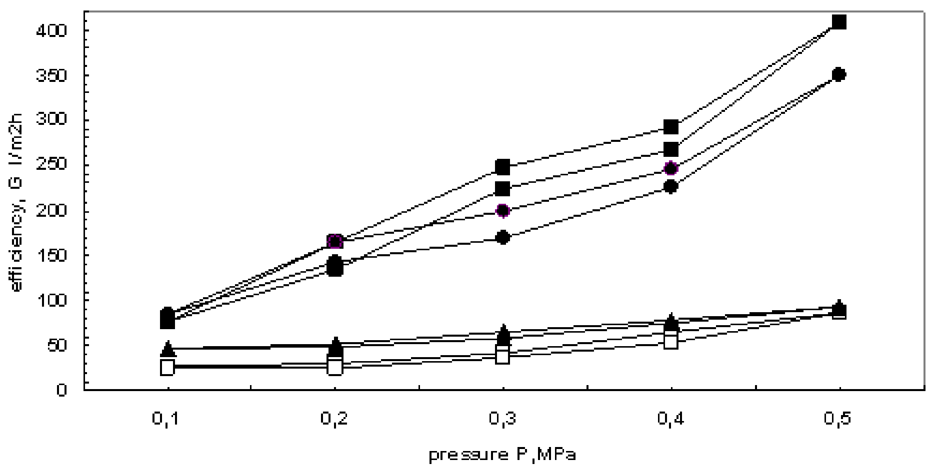


Figure 1: Hysteresis curves of modified and unmodified ultrafiltration membranes □-.PAN I ▲- PAN I mod ■-PAN II ●- PAN II mod.

The modified membranes were vacuum metalized under the conditions described in the Experimental section and their basic characteristics were studied.

As can be seen from Fig.2, the water efficiency of chemically modified and vacuum metalized membranes decreased from 80 l/m^2h to 45 l/m^2h with the increase of exposition from 5 to 25 s.(***Fig*.2**)

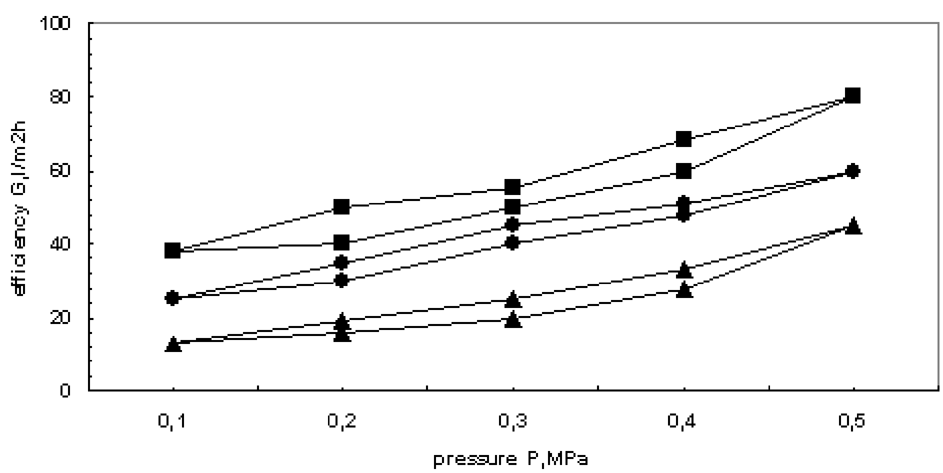


Figure 2: Hysteresises of membranes PAN-I chemically treated with the modifying system and vacuum metalized with H18N9T alloy ■-5sec ●- 15sec ▲-25sec

During the process of metallization, membranes efficiency significantly decreased compared to the chemically modified ones. Thus, this process is used to correct the selective layer of the membrane.

A comparison of the efficiencies of the initial non-treated and non-metalized membrane (87 l/m^2h) and chemically modified non-metalized one (93 l/m^2h) with the efficiency of a membrane coated with X18H9T, it can be seen that the latter had lower efficiencies for water regardless of the sputtering time.(Fig.2).

The coating deposited in vacuum is not strong enough mechanically, as studied by the method of replication. The adhesion between the polymer and the metal layer depends on the surface energy of the polymer. The adhesion was measured by the method of sticking tape and the strength of the adhesion was calculated by the relationship[9]:

$$A = \frac{S}{S_0} \quad \text{where: S – area of the remaining coating} \qquad (3)$$

S_0 – total area of the glued tape.

The method of "sticking tape" was used to study the adhesion between polymer and nickel deposited electrolytically without palladium catalyst. The results obtained from these experiments proved the stability of the metal coatings during their performance. Some additional studied showed also that the adhesion metal-polymer can be strengthened by preliminary deposition of a sub-layer of oxides of the metals used for the coating. Thus, carrying out chemical modification, followed by deposition of metal oxide sub-layer and main coating, better mechanical strength of the modified membrane structure can be obtained. The basic characteristics of such membranes are presented in Fig.3.

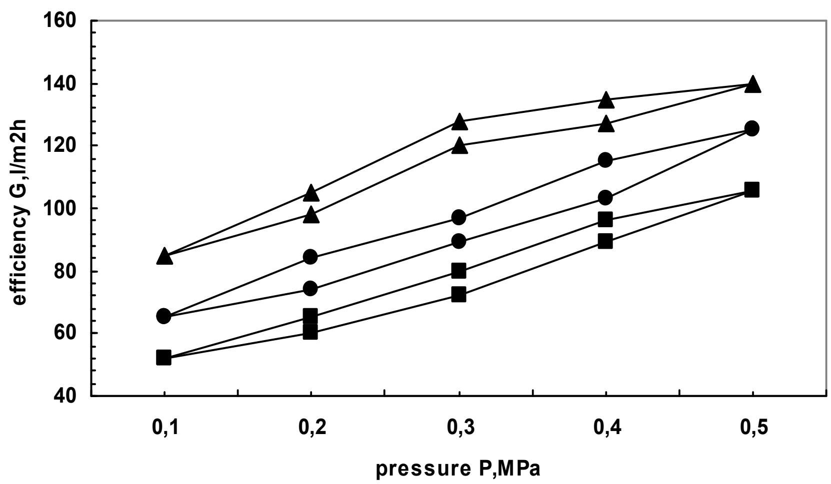


Figure 3: Hysteresis curves of PAN-I membranes chemically modified and vacuum metalized with H18N9T, with additional sub layer of the oxides of the alloy metals. ■-5sec ●- 15sec ▲-25sec

It can be seen from the membranes hysteresis curves that their water permeability increased from 106 l/m^2h to 140 l/m^2h with the increase of sputtering time from 5 to 25 s. This tendency was contrary to the one discussed above for membranes of the same polymer composition but having only main coating. This was probably due to the additional sub-layer of the oxides of the metals of the sputtered alloy and the possibility for formation of a uniform metal surface on the membranes.

The second type of membranes used for the present studies (PAN-II) have much higher water efficiency compared to the PAN-I membranes, measured as initial structures. The higher efficiency leads to lower selectivity of these membranes (compared to PAN-I), as determined by the experimental data. It was interesting to find how this higher efficiency would be affected by the vacuum metallization. (***Fig*.4**)

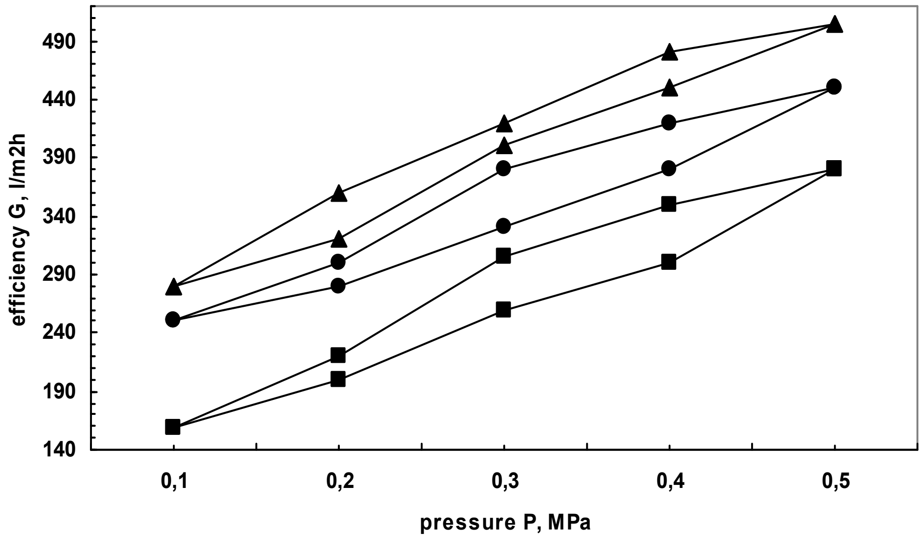


Figure 4: Hysteresis curves of PAN-II membranes chemically modified and vacuum metalized with H18N9T alloy with sub layer of the oxides of alloy metals. ■-5sec ●- 15sec ▲-25sec

With the increase of coating time from 5 to 25 s, their efficiency increased from 380 to 505 l/m^2h (Fig.5). The value of the efficiency at exposition time of 25 s (185 l/m^2h) was close to these of chemically non-treated and non-metalized one (87 l/m^2h) and chemically treated non-metalized one (350 l/m^2h) membranes.

Similar to the other type of membranes studied, the small exposition times have higher effect on the surface in the presence of an sub-layer of metal oxides The deposition of an additional oxide sub-layer gives a system where it is possible to obtain denser structure through the interaction between the metal oxides and small number of atoms, which could lead to destructive processes in the selective layer of the membrane under longer exposition. When only metal coating is deposited, membrane characteristics depend simply on the thickness of the metal coating.

The studies of membrane selectivity towards calibrant Albumin showed dependence proportional to their efficiency. The structures of the initial membranes determine their selectivity while the presence of an oxide sub-layer changes it within certain interval. These changes, however, are small. For the membranes with polymer composition PAN-II modified chemically with the solutions described above and vacuum coated with X18H9T alloy, the selectivity towards Albumin increased from 46% (5 s exposition) to 52% (25 s) which is close to the values for the initial non-coated membranes. The membranes with the same polymer composition, same chemical modification and vacuum coated with X18H9T alloy but with additional sub-layer of metal oxides, the selectivity decreased from 40% (5 s exposition) to 26% (25 s).

For the chemically modified and vacuum metalized membranes with composition PAN-I, the selectivity towards Albumin increased with exposition time from 84 to 86% which is the same tendency observed for the other type of membranes studied. The selectivity of the membranes of the same polymer composition but with additional sub-layer of metal oxides remained the same (72%) regardless of the sputtering time.

To establish the stability of the metal coating of the membranes, their selectivity was studied at different intervals of flushing the porous structure of the membranes.

Table1

Membrane type	200 ml	500 ml	1000 Ml	1500 ml
PAN-II without sub-layer	84	83	85	84
PAN-II with sub-layer	73	72	72	73
PAN-I without sub-layer	50	51	52	50
PAN-I with sub-layer	27	28	26	27

The flushing was carried out in regime of ultrafiltration with water volumes from 200 to 1500 ml (Table 1). The change of the selectivities of the membranes studied was found to be insignificant and within the preciseness of the experimental method used.

The following dependence was observed for the membranes having an additional sub-layer of metal oxides: the values of the selectivity remained almost unchanged which means that the additional sub-layer improves the adhesion between the main metal coating and the polymer substrate.

4. CONCUSSIONS

The present studies showed that in the method of vacuum metallization for modification of polymer membranes in order to obtain different structures and properties, the preliminary treatment of the of the membrane polymer surface is a critical factor determining the process. The overall process depends on the initial structure of the membranes, the type of the polymer, the method of preliminary treatment and the sputtering time.

5. REFERENCES

[1]. Baker, R.W., *Membrane Technology and Applications*, 2nd edn, John Wiley &Sons, Ltd, Chichester, Chapters 2, 3, 5, 6 & 9, 2004.

[2]. Mulder, M., *Basic Principle of Membrane Technology*, 2nd edn, Kluwer Academic Publishers, Dordrecht, 1996.

[3]. Nunes, S.P. and Peinemann, K.V., *Membrane Technology in the Chemical Industry*, 2nd end, (eds S.P. Nunes and K.V. Peinemann), Wiley-VCH,Weinheim, 2006, pp. 1, Part 1.

[4]. Kato, K., Uchida, E., Kang, E.T., Uyama, Y. and Ikada, Y., *Progress in Polymer Science*, 28, 2003, pp. 209–259.

[5]. Lipin, Yu.V., A.V.Rogachev, V.V.Haritonov. Vacuum metallization of polymer materials, Khimiya, Moscow, 1977.

[6]. E.Sacher., Metallization of polimers.Edited. Proceedings of the Montreal Workshop on Polimer . Metallization held June 27-29, 2001 Kluwer Academic Plenum Publishers, NY 2002, pp.208

[7]. Charbonnier, Marlene; Romand, Maurice: Goepfert, Jves Goepfert. Ni direct electroless metallization of polymer by a new palladium-free process. Surface & Coating Technology, Apr.2006, Vol.200 Issu 16/17 pp.5028-5036.

[8]. Charbonnier, Marlene; Romand, Maurice: Goepfert, Jves Goepfert. Polymer pretreatments for enhanced adhesion of metals deposited by the electroless process. International Journal of Adhesives.2003., Vol.23.Issu 4 pp.277.

[9]. Mittal K. L. Surface chemical criteries of adhesion .-In. Adhesion Science and Technology. New York- London, Pergoman Press, 1975.

STUDY REGARDING THE OPTIMIZATION OF WOOL DYING WITH NATURAL DYES EXTRACTED FROM GREEN WALNUTS PART 2: MATHEMATICAL MODEL

M. Pustianu [1], M. Chindriş, A. Popa[1], E. Airinei[1], A. Bucevschi [1], C. Sîrghie [2], M. Dochia [2]

[1] *"Aurel Vlaicu" University of Arad, ROMANIA*
[2]Technical and Natural Sciences Research-Development-Innovation Institute
"Aurel Vlaicu" University of Arad, *ROMANIA*

Corresponding author: Monica Pustianu, E-mail: pustianumonica@yahoo.com

Abstract: To establish optimal conditions for dying with dye extracted from green walnuts husks was chosen for testing a central compose rotable second order program with two independent variables: concentration of dye and dying temperature. Using the values obtained for dye concentration absorbed in fibre were established the optimum working parameters for dying process with dye extracted from green walnuts husks.
In this program were included two successive directions: the programming of the experiments and experimental dates analyse. Active method of elaboration of empirical models involves obtaining experimental data as a result of controlled experiments (planned). If you give up the classic experimental program in favor of an active experimental program, dependent variable description (optimization parameter) presents a series of advantages, namely: considerable simplification of calculations, decrease the number of experiments, shortened research works and the consumption of raw materials, increasing the accuracy of determination of the regression equation coefficients.
In order for the research to present economic efficiency and to be carried out in a timely manner, it is necessary that the experimental part contains a minimum volume of determinations. By rotability the mathematical model obtained through statistical processing of factorial experiment allows to determine the answer, at equal distances from the experiment centre with the same precision, regardless of direction. In a rotable program standard deviation is the same for all points that are at the same distance to the centre of experimental region. The central compose rotable second order program contains experiments in the centre of the circle.

Key words: program of the order II central composed rotabil, naphtocquinone, regression equation, experimental matrix

1. INTRODUCTION

The dye extracted from green walnuts husks is used at natural fibres dyeing with or without mordents [1-6]. It was chosen for the study of wool fibre dying the tinctorial mechanism: wool-dyes complex.

The dyeing has been lead under the following conditions:
-x - the concentration of the dye (g plant/g fabric); 2% acetic acid; 2% sodium sulphate;
-y - the temperature (^{0}C); ratio 1:100; -M_{fabric} =1 g.
Before dying was made an activation of the wool fibre in the following conditions: 2% glacial acetic acid; ratio 1:100; - t =15 min; - T= 100^{0}C. [1-6]

2. EXPERIMENTAL PART

To establish the optimum dying conditions, experiments were conducted using a central, correlation, rotable, second order compound program with two independent variables [7, 8].

By this method were obtained some statistics mathematical models that can correlate the variation of the analysed indices with the parameters of the tinctorial process.

The variation limits and the code parameters [7,8], are presented in table 1.

Table 1: The variation limits of independent variables

Code value /real value	-1.414	-1	0	1	1.414
x-concentration (g plant/g fabric)	0,5	0,7	1	1,3	1,5
y-temperature (^{0}C)	80	84	90	96	100

Experimental matrix and measured values for the response function are presented in table 2:

Table 2. Experimental matrix and measured values for the response function

No.	Independent Variables				f(x,y)
	x (code)	y (code)	x (real) Dye concentration (g plant/g mat)	y (real) Temperature (^{0}C)	Adsorbed dye (g plant/g mat)
1	-1	-1	0,7	84	0,2621
2	1	-1	1,3	84	0,5944
3	-1	1	0,7	96	0,1630
4	1	1	1,3	96	0,3749
5	-1.414	0	0,5	90	0,1436
6	1.414	0	1,5	90	0,4963
7	0	-1.414	1	80	0,3542
8	0	1.414	1	100	0,2257
9	0	0	1	90	0,3663
10	0	0	1	90	0,3663
11	0	0	1	90	0,3664
12	0	0	1	90	0,3662
13	0	0	1	90	0,3663

The mathematical model of the dying process is a functional relation between the dependent variable f(x,y) and the independent variables x, y with general regression form:

$$f(x,y) = b_o + b_1 x + b_2 y + b_{11} x^2 + b_{22} y^2 + b_{12}\, xy \qquad \textbf{(1)}$$

The experimental results were processed in Excel and Professional MathCad for obtaining the regression equation [7,8].

For a model with two variables, the central composes rotable program contains experiences equally distributed on the circumference of a circle in x y plan, with the centre in (0, 0) plus one or more experiences in the centre of the circle. Points located on the circle form a regular polygon inscribed in a circle. These points represent the encoding program.

The coefficients of the regression equation were determined by the method of least squares, their meanings being tested using test Student, ($t_T = t_{\alpha,v} = t_{0,05;6} = 2,132$;) If $t_c > t_T$ -the term is significant) The insignificant coefficients are removed [7,8]. The coefficients of the regression equation are presented in table 3.

Table 3: Coefficients of the regression equation

b0	0,366361
b1	0,130357
b2	-0,06255
b11	-0,01204
b22	-0,02707
b12	-0,03009

To check the model adequacy, namely its ability to mathematically express the phenomenon studied, were calculated the Y_{calc} values and established the deviation A between the measured values and the calculated values, according to the table 4.

Note that only one of the individual deviations do not fit in the limit imposed by ± 10%, which indicates a good adequacy of the model [7,8].

Table 4.: Adequacy calculation model

No.	$f_{measured}$	$f_{calculated}$	Deviation "A"
1.	0,2621	0,23	12,51
2.	0,5944	0,55	7,43
3.	0,163	0,16	-0,89
4.	0,3749	0,36	2,65
5.	0,1436	0,16	-9,98
6.	0,4963	0,53	-6,11
7.	0,3542	0,40	-13,12
8.	0,2257	0,22	0,83
9.	0,3663	0,37	-0,02
10.	0,3663	0,37	-0,02
11.	0,3664	0,37	0,01
12.	0,3662	0,37	-0,05
13.	0,3663	0,37	-0,02

To verify deviation of the survey data from the mean value the Fisher-Snedecor test was used. The calculated value is greater than the critical value $F_c = F_{\alpha , v1, v2} = F_{0,05 ; 12, 4} =$ 5,91 which indicates that the deviations appear due to experimental errors.

The approximation quality of the mathematical model expressed by the standard error shows the scattering of the experimental values around the regression equation: 3 %

The simple correlation coefficients have the following values: $r_{xy} = 0$, $r_{xZ} =$ 0,8619 and $r_{yZ} = -$0,4135. The significance of the simple correlation coefficients is checked using the Student test. The value o for tc_{xy} shows that x and y are independent variables.

The multiple correlation coefficient has the value F= 137,71 that is greater than the critical value $F_{critical}$= 3,97 that shows that the independent values has a significant influence about the dependent variables.

The square of the correlation coefficient $R^2 = R_{xZ}$ is called coefficient of determination and expresses that part of the variation of variable Z which can be attributed to variable x. The calculated values are: R_{xz} = 0,743 and R_{yz} =0,1709. So, the influence of the x variable on the dependent variables is 74,3% and the influence of y variable on the dependent variables is 17,09%.

The coefficient of multiple determination 0,9649 shows that the influence of the two independent variables on the dependent variable is 96,29 %, the rest being caused by other factors.

The goal - function obtained for the adsorbed dye concentration is the following:

$$f(x,y) = 0,3663 + 0,1303\,x - 0,0625\,y - 0,012\,x^2 - 0,027\,y^2 - 0,03\,x\,y \quad \textbf{(2)}$$

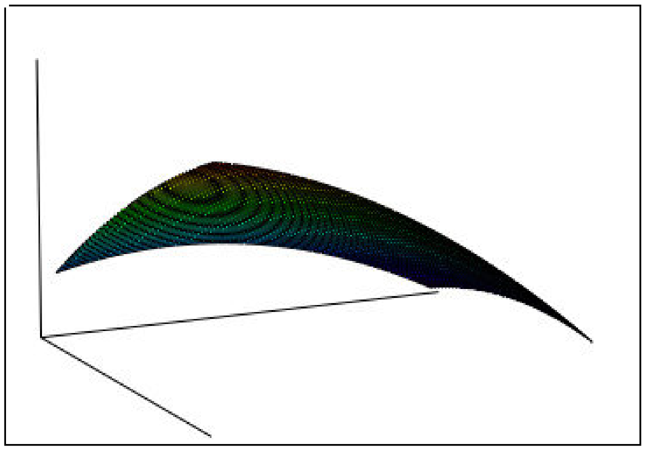
The obtained models can be viewed as geometric hyper-surfaces in the three-dimensional space of independent variables. The hyper-surface represents the response of the model, because the extreme points (maximum, minimum) of the hyper-surfaces present technological interest their exact location is searched or at least knowledge about the shape of the surface in the extreme field neighbouring. The response interpretation and search of extremes are more difficult and it is preferred to bring the surface into a form more accessible for the analysis using canonical transformation. Allowing a much easier localization of the extreme, the canonical transformation can be seen as an optimization method. [7].

The coefficients of the canonical form were calculated and the equation which resulted is:

$$F= 2,259 -0,0363X^2 -0,0027Y^2 \quad \textbf{(3)}$$

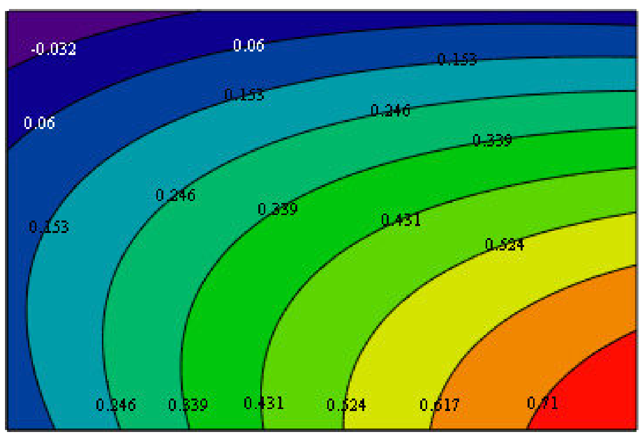
In figure 1 presents the plot which shows the dependence of the goal- function on the two independent variables. Figure 3 represents the response surface in space, the surface can be cut can be planes of type y = ct resulting response contours.

Figure 2 presents contour curves for various values of dye's concentration between 0,1436 and 0,5944. The response surface shown in figure 2 is an ellipse type [7]. The centre is elongated in the X axis because the b_{11} and b_{22} coefficients are negative and $b_{11} < b_{22}$. The extreme point is a maximum point.



M

Figure 1. The dependence of the goal-function on the independent variables



M

Figure 2. Contour curves for various values of the concentration of the adsorbed dye

3. RESULTS AND DISCUSSIONS OF THE OBTAINED MATHEMATICAL MODEL

By analyzing the expression of the obtained goal- function:

$$f(x,y) = 0,3663 + 0,1303\ x - 0,0625\ y - 0,012\ x^2 - 0,027\ y^2 - 0,03\ x\ y \qquad \textbf{(4)}$$

can be seen a big dependence between the dependent variable and the concentration of the dye used . Both independent variables influence the dependent variable, but differently. The x influence is 35,57% while y's influence is 17,06%. The existence of quadratic form for both parameters indicates that the response surface defined by the obtained mathematical model, is well-formed, reinforcing the hypothesis regarding the influence of both parameters on the dependent variable.

The ratio between the coefficients of the quadratic and free terms quantifies the speed of the dependent variable change variation to the variation of the two parameters. The variable x influences the outcome with 3,2% and the y variable influences the dependent variable with 7,37%.

The influence of the interaction of the two parameters on the dependent variable is 8,19%. The concerted increase of the two independent variables leads to a decrease of the dependent variable because the coefficient b_{12} is negative

Figure 3 shows the dependence of the goal-function on one of the two variables for all significant values of the parameters, given that the second one is constant. It can be observed how, for a constant value of the dye concentration, the graph representing the variation of adsorbed dye depending on the dye temperature indicates a maximum point close to 84^0 C that shows a influence of this parameter about the concentration of adsorbed dye.

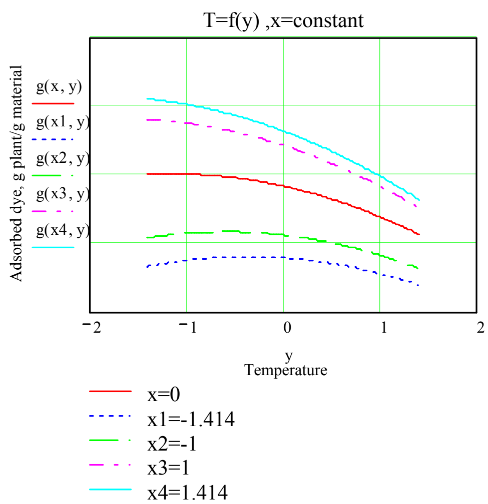


Figure 3. The dependence of the goal-function on all significant values of x parameters for y = constant

Figure 4 shows the dependence of the goal-function on one of the two variables for all significant values of the parameters, given that the second one is constant. From the graph it can be seen how the increase of dye concentration in bath leads at the increase of the quantity of dye absorbed on fibre.

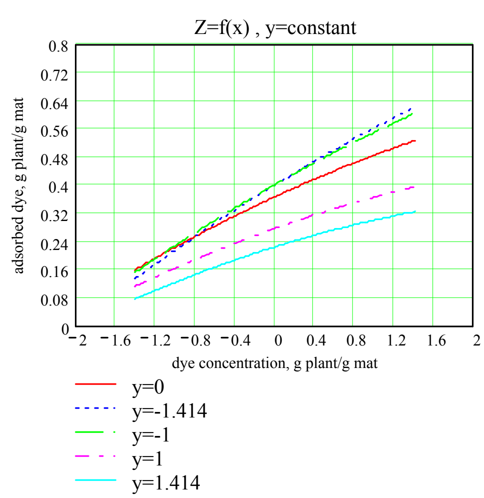


Figure 4. The dependence of the goal-function on all significant values of x parameters for y = constant

4. CONCLUSIONS

- optimum temperature for dying is 84^0C, in the following dying conditions: dye extract, % acetic acid; 2% sodium sulphate
- the quantity of adsorbed dye grows at dye concentration in bath growing
- the wash dyeing resistances at 40^0C are very good

5. REFERENCES

[1]. Taylor G.W., Natural Dyes in Textile Applications, *Review of Progress in Coloration and Related Topics*, 16 (1), 53-62, 1986
[2]. Wang Y.N., Wang H.X., Shen Z.J., Zhao L.L., Clarke S.R., Sun J.H., Du Y.Y., Shi G.L., Methyl palmitate, an acaricidal compound occurring in green walnut husks, *J. Econ. Entomol.,* 102 (1), 196-202, 2009
[3]. Chen Li, Jun-Xi Liu, Liang Zhao, Duo-Long Di, Min Meng, Sheng-Xiang Jiang, Capillary zone electrophoresis for separation and analysis of four diarylheptanoids and an α-tetralone derivative in the green walnut husks (*Juglans regia* L.), *Journal of Pharmaceutical and Biomedical Analysis*, 48 (3), 749-753, 2008
[4]. Buttery RG, Light DM, Nam Y, Merrill GB, Roitman JN., Volatile components of green walnut husks, *J. Agric Food Chem.*, 48 (7), 2858-2861, 2000
[5]. Segundo G.O., [Quinone natural pigments], Editorial Universidad Nacional Mayor de San Marcos, Ed. Salaverry García, Oswaldo, 277 p., 1998.
[6]. A.G.I.R., S.T.I.R., „The book of textile engineer", Vol.II, Part B, 2005
[7]. Mihail, R., Introduction to the strategy of experimentation with chemical technology applications, Scientific and Encyclopaedic Printing House, Bucharest, 1976.
[8]. Akhnazarova,S., Kafarov, V., *Experiment optimization in chemistry and chemical engineering*, MIR Publ., Moscow, 1982.

ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

EUROPEAN REGULATIONS REGARDING THE ENVIRONMENTAL IMPACT OF THE TEXTILE PRODUCTS

Mariana Rațiu[1]

[1]*University of Oradea, Romania*

Corresponding author: Ratiu Mariana, E-mail: mratiu@uoradea.ro

Abstract: In this paper, I present an overview of important regulations regarding the environmental impact of the textile products on the level of European Union.
There is always an environmental impact of the textile products, across the entire lifecycle. The most important environmental hazards from textiles are: use of chemicals, use of water, use of energy, generation of waste water contaminated with hazardous substances, hazardous and toxic waste generation.
The textiles and clothing sector is an important part of European manufacturing industry. Many of the new member states are very dependent upon the textiles and clothing industry in terms of value added and employment. Nevertheless, the total EU export in textiles and clothing decreased while the import increased dramatically over the last years.
The European textile industry has been facing a long period of decline, rising global competition, and relocation to low-income countries. Compared to the other main producers of textiles, like China and India, for instance, the European textile industry is disadvantaged due to the high labour costs and *higher environmental standards*.
There are a lot of regulations regarding environmental impact of the textile products, to the level of European Union, like in other few developed countries. All these regulations are necessary for the protection of the environment and consumer protection, in the context of sustainable development, and it should be harmonized and mandatory for all. Unfortunately, however, this will not happen soon.

Key words: directive, decision, communication, regulation, standard, environmental impact, textiles.

1. INTODUCTION

The textile products have been identified as having significant environmental impact across their lifecycle. The most important environmental hazards from textiles are: use of chemicals, use of water, use of energy, generation of waste water contaminated with hazardous substances, hazardous and toxic waste generation.

The environmental impact starts with the pollution caused by the production of the raw material: the use of pesticides during the cultivation of plants for the natural fibres, the erosion caused by the sheep farming or the emissions during the production of synthetic fibre. In the case of synthetics (which represent more than 60 % of fiber production), the most important resource is oil. Thus, production of synthetic fibers leads to exploitation fossil fuels, directly for production processes in the textile industry and indirectly for processes involved in extracting and refining the oil. [1]

Then there is the environmental impact in the process of production, where are used thousands of different chemicals and a high consumption of resources like water and fuel, that generates a significant amount of waste The next type of pollution is caused by the consumption and maintenance. Finally, there is the environmental impact caused by discarded products and packaging material.

In addition to the environmental impact of textile manufacturing activity, there is also a degradation suffered by textile materials within the environment whether by air pollution, wind, water and other agents. [2]

The regulations relating to the environmental impact of textiles differ from state to state and this can lead to a lot of problems, especially to difficulties relating to trade the textile products.

In this paper, I present an overview of important regulations regarding the environmental impact of the textile products on the level of European Union.

2. MAJOR EXPORTERS OF TEXTILES AND CLOTHING

World exports of textiles and clothing grew by 17 per cent in 2011. The top ten exporters each registered 13 per cent growth or more.

Bangladesh recorded the highest increase (27 per cent) while the lowest among the top ten was recorded by the United States with 13 per cent.

The order for the top ten exporters remains the same as in 2010. China was the leading exporter of textiles and clothing in 2011 with a 32 per cent share in world exports of textiles and 37 per cent in clothing. The European Union and the United States are the major markets for clothing, accounting for 45 per cent and 21 per cent respectively of world imports.

The top ten exporters of textiles and clothing in 2011: China, EU27, India, Turkey, Bangladesh, United States, Vietnam, Republic of Korea, Pakistan, Indonesia. [3]

According to the available figures, the European textile industry employs approximately 2,450,000 persons in more than 223,000 enterprises (Eurostat, 2009), out of which 96% are SMEs (Euratex, 2009). They account for 74.5% of sectoral value added in EU-27 and 75.3% employment (Eurostat, 2009). Textile and clothing sectors together account for 3% of total manufacturing value added in the EU. While clothing remains one of the largest consumer goods categories around the world, the textile industry also provides material for a vast number of other industries and a very large number of applications (Euratex, 2006). [4]

How we can see the textiles and clothing sector is an important part of European manufacturing industry. Many of the new member states are very dependent upon the textiles and clothing industry in terms of value added and employment. Nevertheless, the total EU export in textiles and clothing decreased while the import increased dramatically over the last years.

The European textile industry has been facing a long period of decline, rising global competition, and relocation to low-income countries. Compared to the other main producers of textiles, like China and India for instance, the European textile industry is disadvantaged due to the high labour costs and *higher environmental standards*.

3. EU REGULATIONS

The most important regulations regarding the environmental impact of the textile products on the level of European Union are:

* Directive 2008/1/EC of the European Parliament and of the Council of 15 January 2008 concerning *Integrated Pollution Prevention and Control (IPPC Directive)*. This Directive aims at minimising pollution from various industrial sources throughout the European Union. The subject to the IPPC Directive are the plants for the pre-treatment (operations such as washing, bleaching, mercerisation) or dyeing of fibres or textiles where the treatment capacity exceeds 10 tonnes per day; these plants are required to obtain an authorisation (environmental permit) to operate. According to the IPPC Directive, permit conditions must be based on Best Available Techniques (BAT). [5]

* Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as *to improve and extend the greenhouse gas emission allowance trading scheme of the Community (Emission Trading System Directive)*. Some big textile companies can be impacted by the ETS Directive if they have combustion installations with a total rated thermal input exceeding 20MW. [6]

* Commission Decision 2009/567/EC of 9 July 2009 *establishing the ecological criteria for the award of the Community Ecolabel for textile products*. [7] The European Ecolabel was established in 1992 and is a certification scheme to help European consumers distinguish more environmentally friendly products and services. All products bearing the Ecolabel, the ‘flower’, has been checked by independent bodies for complying with strict ecological and performance criteria. Pursuant to Regulation (EC) No 1980/2000, a timely review has been carried out of the ecological criteria, as well as of the related assessment and verification requirements established by Commission Decision 1999/178/EC of 17 February 1999 establishing the ecological criteria for the award of the Community eco-label to textile products as amended by Decision 2002/371/EC of 15 May 2002 establishing the ecological criteria for the award of the Community Ecolabel for textile products. Those ecological criteria and the related assessment and verification requirements were valid until 31 December 2009 at

the latest. In order to take account of scientific and market developments, it was appropriate to modify the definition of the product group and to establish new ecological criteria. These new criteria aim in particular at promoting the reduction of water pollution related to the key processes throughout the textile manufacturing chain, including fibre production, spinning, weaving, knitting, bleaching, dyeing and finishing. The criteria are set at levels that promote the labelling of textile products which have a lower environmental impact.

The new Ecolabel Regulation entered into force in February 2010. A number of its provisions are yet to be implemented.

There is a 2011-2015 Work Plan, with includes a strategy and a non-exhaustive list of product groups which should be considered as priorities for EU Ecolabel in the near future.

* Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on *classification, labelling and packaging of substances and mixtures*, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006. This Regulation should ensure a high level of protection of human health and the environment as well as the free movement of chemical substances, mixtures and certain specific articles, while enhancing competitiveness and innovation. A high level of human health and environmental protection should be ensured in the approximation of legislation on the criteria for classification and labelling of substances and mixtures, with the goal of achieving sustainable development. [8]

This act was amended by the Commission Regulation (EC) No 790/2009 of 10 August 2009 *amending, for the purposes of its adaptation to technical and scientific progress*. Two lists need to be amended to include updated classifications for substances already subject to harmonised classification and to include new harmonised classifications. [9]

* Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006, concerning the *Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)*, establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC. REACH Regulation aims to ensure a high level of protection of human health and the environment. The chemicals used in textiles has an issue for EU legislation for many years. The first legislation specifically related to textiles was established in 1979. In REACH Regulation the EU has imposed a strict control on European products and, consequently, purchasers need to mainly be aware of chemical use in imported products. [10]

* Communication from the Commission to the Council and the European Parliament of 28 January 2004 entitled: "*Stimulating technologies for sustainable development: an environmental technologies action plan (ETAP) for the European Union*" [COM (2004) 38]. In this act the European Union was adopted an action plan to promote environmental technologies (technologies whose use is less environmentally harmful than relevant alternatives) in order to reduce pressures on our natural resources, improve the quality of life of European citizens and stimulate economic growth. The action plan's objectives are to remove the obstacles so as to tap the full potential of environmental technologies, to ensure that the EU takes a leading role in applying them and to mobilise all stakeholders in support of these objectives. [11]

* Communication from the Commission of 27 January 2005: *Report on the implementation of the Environmental Technologies Action Plan in 2004* [COM (2005) 16]. This report summarizes the main achievements, outlines some actions by Member States on which the implementation of ETAP can build and highlights areas where efforts could be stepped up to make faster progress towards tapping the full potential of environmental technologies. [12]

* Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions *on the Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan* [COM (2008) 397]. This document presents the strategy of the Commission to support an integrated approach in the EU, and internationally, to further sustainable consumption and production and promote its sustainable industrial policy. The core of the Action Plan is a dynamic framework to improve the energy and environmental performance of products and foster their uptake by consumers. The approach will address products that have significant potential for reducing environmental impacts. The challenge is to create a virtuous circle: improving the overall environmental performance of products throughout

their life-cycle, promoting and stimulating the demand of better products and production technologies and helping consumers to make better choices through a more coherent and simplified labelling. [13]

* *The Reference Document on Best Available Techniques (BAT) for the Textiles Industry*. This document do not set legally binding standards, it provides general information on the textile sector and on the industrial processes used within the textile sector, it provides data and information concerning emission and consumption levels and describes the emission reduction and other techniques that are considered to be most relevant for determining BAT and BAT-based permit conditions. BAT is meant to give information for the guidance of industry, to seek collaboration with upstream partners in the textile chain, in order to create a chain of environmental responsibility for textiles. [14]

* *ISO 14001:2004*. ISO 14000 is one of ISO's most widely known standards and primarily concerned with environmental management, which can be applied to any organization in any sector. It will minimize harmful effects on the environment caused by the organization’s activities and achieve continual improvement of the company’s environmental performance. ISO 14001 is an Environmental Management System (EMS) which provides a structure for measuring and improving an organization’s environmental impact. [15]

* Regulation (EC) No 1221/2009 of the European Parliament and of the Council of 25 November 2009 *on the voluntary participation by organisations in a Community eco-management and audit scheme (EMAS)*, repealing Regulation (EC) No 761/2001 and Commission Decisions 2001/681/EC and 2006/193/EC. The objective of EMAS, as an important instrument of the Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan, is to promote continuous improvements in the environmental performance of organisations by the establishment and implementation of environmental management systems by organisations, the systematic, objective and periodic evaluation of the performance of such systems, the provision of information on environmental performance, an open dialogue with the public and other interested parties and the active involvement of employees in organisations and appropriate training. [16]

* The Oeko-tex 100 and Oeko-tex 1000 standard for textile products was developed by the International Association for Research and Testing in the Field of Textile Ecology. Oeko-tex is an Austrian initiative, but increasingly on other EU markets available. The standard contains analytical tests for specified harmful substances and gives limiting values based on scientific considerations. [17] Besides being a private label, a significant difference with the European Ecolabel is that initially it only covered issues relating to the health of users of the final textiles.

* Other ecolabels: *Blue Angel* (1977, Germany), Nordic Swan (1989, Finland, Iceland, Norway, Sweden and Denmark), *Umweltzeichen* (1991, Austria), *NF* (1991, France), *Milieukeur* (1992, Netherlands), *Good Environmental Choice* (1992, Sweden), *AENOR* (1993, Spain).

4. CONCLUSIONS

There is always an environmental impact of the textile products. The Life Cycle Assessment (LCA) is the major criteria to evaluate the product’s impact on environment. The environmental standards are very distinctive to each other. The specific focus of these standards makes the differences between them rather clear. When it comes to implementation of cost saving options on energy use, water use, raw material use, waste (water) treatment, recycling and eco-design, then Cleaner Production in combination with IPPC/Best Available Techniques is the method to choose. A major difference of Cleaner Production with the other environmental standards is that is does not lead to any certification, but directly aims to improve the efficiency of the production process. The other standards like ISO 14000, Ecolabel and Oeko-tex are certification programs and are specifically focused on the improvement of the environmental management (ISO), the textile product itself (Oeko-tex 100) and the avoidance of harmful and hazardous substances in the products (Oeko-tex 100 and Ecolabel) and the production process (Oeko-tex 1000). [18]

How we can see there are a lot of regulations regarding environmental impact of the textile products, to the level of European Union, like in other few developed countries. All these regulations are necessary for the protection of the environment and consumer protection, in the context of sustainable development, and it should be harmonized and mandatory for all. Unfortunately, however, this will not happen soon.

To save the European textile industry from being wiped out by its Asian competitive threats, the European Commission released a Communication on "The future of the textiles and clothing sector in the enlarged European Union". These policy suggestions for the future recommend concentration on innovation, research, fashion and design, creation and quality and the use of new technologies, together with positive industrial relations. [19]

Most studies emphasise that the industry is struggling to balance out between the sustainable development challenges it faces and the production cost pressures. The accomplishment of a more sustainable textile industry is bound to happen only through increased consumer demand and understanding of sustainability in the textile industry. [4]

5. REFERENCES

[1].Müller-Christ, G., Gandenberger, S. (2006). *Sustainable Resource Management - illustrated at the Problems of German Textile Industry*, Proceedings IFSAM VIIIth World Congress 2006 Berlin. Paper 00578, http://www.ctw-congress.de/ifsam/proceedings.html

[2].Slater, K. (2003). *Environmental impact of textiles: Production, processes and protection*, Woodhead Publishing Series in Textiles No. 27**,** http://www.woodheadpublishing.com

[3]. *International Trade Statistics 2012*, World Trade Organization, http://www.wto.org

[4]. Martinuzzi, A., Kudlak, R., Faber, C., Wiman, A., (2011). *Corporate Social Responsibility. Activities and Impacts of the Textile Sector*, Research Institute for Managing Sustainability (RIMAS) Working Papers, No. 2/2011, Vienna

[5]. Directive 2008/1/EC of the European Parliament and of the Council of 15 January 2008 concerning *Integrated Pollution Prevention and Control*, Official Journal of the European Union, L24, 29.01.2008

[6]. Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as *to improve and extend the greenhouse gas emission allowance trading scheme of the Community*, Official Journal of the European Union, L140, 05.06.2009

[7]. Commission Decision 2009/567/EC of 9 July 2009 *establishing the ecological criteria for the award of the Community Ecolabel for textile products*, Official Journal of the European Union, L197, 29.07.2009

[8]. Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on *classification, labelling and packaging of substances and mixtures*, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006, Official Journal of the European Union, L353, 31.12.2008

[9]. Commission Regulation (EC) No 790/2009 of 10 August 2009 *amending, for the purposes of its adaptation to technical and scientific progress, Regulation (EC) No 1272/2008 of the European Parliament and of the Council on classification, labelling and packaging of substances and mixtures***,** Official Journal of the European Union ,L 235, 05.09.2009

[10]. Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006, concerning the *Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)*, Official Journal of the European Union, L396, 30.12.2006

[11]. Communication from the Commission to the Council and the European Parliament of 28 January 2004 entitled: "*Stimulating technologies for sustainable development: an environmental technologies action plan for the European Union*" [COM (2004) 38], Brussels, 28.01.2004

[12]. Communication from the Commission of 27 January 2005: *Report on the implementation of the Environmental Technologies Action Plan in 2004* [COM (2005) 16], Brussels, 27.01.2005

[13]. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions *on the Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan* [COM (2008) 397], Brussels, 16.07.2008

[14]. *The Reference Document on Best Available Techniques for the Textiles Industry*, European Commision, Integrated Pollution Prevention and Control (IPPC) Department, 2003

[15]. http://www.iso.org

[16]. Regulation (EC) No 1221/2009 of the European Parliament and of the Council of 25 November 2009 *on the voluntary participation by organisations in a Community eco-management and audit*

scheme (EMAS), repealing Regulation (EC) No 761/2001 and Commission Decisions 2001/681/EC and 2006/193/EC, Official Journal of the European Union, L342, 22.12.2009
[17]. https://www.oeko-tex.com
[18].Van Yperen ,M. (2006). *Corporate Social Responsibility in the Textile Industry. International overview*, IVAM research and consultancy on sustainability, Amsterdam
[19]. Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions, *The future of the textiles and clothing sector in the enlarged European Union*, [COM (2003) 649], Brussels, 29.10.2003
[20]. http://eur-lex.europa.eu

ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

STUDY ON BICO FIBERS

Irina Tărăboanță[1]

[1] *Technical University"Gh.Asachi",Faculty of Textile,Leather and Industrial Management,Iaşi,ROMANIA*

Corresponding author: Tărăboanța Irina,e-mail: taraboanta.irina@yahoo.com

Abstract: Bico fibers include *bicomponent* and *biconstituent* fibers.*Bicomponent fibers* are synthetic fibers made from two polymers of different chemical and physical structure.They are produced by common melt-drawing processes similar to conventional synthetic fibers.[1]. The *biconstituent fiber* consists of a continuous matrix of one polymer in which a different fiber-forming polymer is dispersed as a second distinct discontinuous phase; it as mix-polymer fiber or fascicular microfiber because the microfibers are connected to each other and can't function independently from each other.[2]. Among bicomponent fibers, the bicomponent microfiber is different from the *core-sheath* type of bicomponent fiber.In theory bico fibers can be made from many polymers but in fact, they are made frequently from CoPET/PA because of cost factors. The *core-sheath* bico fiber, including such varieties as PE/PP, PE/PET and CoPET/PET are used as bonding fibers for hygiene and medical nonwovens.A cross-sectional morphology of bicomponent fibers can be classified into four main types*:"core-sheath","side-by-side","pie-wedge" and "islands in the sea".* The *core-sheath* and *side-by-side* bicomponent fibres are the basic structures of bicomponent fibres.Methods for the preparation of more complex bicomponent nanofibres such as *island-in-the-sea* and *pie-wedges* have yet to be developed. This four basic configurations can be adapted in function of the desired fibre or yarn properties.It is for exemple possible to limit the number of *islands* to produce conductive yarns. On the other hand it is possible to provide a hole in the *pie-wedge* configuration to split the filaments even more easily. The newly created bicomponent fibre have new properties and can be applied in many new applications.Bicomponent fibres are actually being applied in the production of : microfibres (hygiene), non-wovens, antimicrobial textiles, elastic fibres, conductive fibres and composites.

Key words: bicomponent fibers, biconstituent fibers, spinning, microfiber, mix-polymer

1. INTRODUCTION

Bicomponent and *biconstituent* fibers define *bico* fibers.

Bicomponent spinning involves the extrusion of two different types of the same polymer through the spinneret.Bicomponent extrusion can be simply thought of as two spinning machines working one inside the other.Another variation of filament yarn production is *biconstituent* spinning.[1], [2]The method of extrusion is similar to that of bicomponent spinning. According to the cross-sectional morphology, the bicomponent fibers can be classified into four main types*:"core-sheath","side-by-side","pie-wedge" and "islands in the sea"*.[3]

2. GENERAL INFORMATION

2.1. *Core-sheath* bicomponent fiber

Besides the *core-sheath* bicomponent fiber used as a crimping fiber, these fibers are widely used as bonding fibers in nonwovens industry. The sheath of the fiber is of a lower melting point than the core and so in an elevated temperature, the sheath melts, creating bonding pints with adjacent fibers - either bicomponent or mono component. The first commercial application of *sheath-core* binding fiber (I.C.I. Heterofil) has been in carpets and upholstery fabrics. The newest trend in bicomponent fiber production is to focus on tailoring a fiber according to the customer's needs. A considerable emphasize was put on the processing optimization (depending strictly on machinery used) and on the desired look of the final product. It appears that concentricity/eccentricity of the core plays an important role. If the product strength is the major concern, concentric bicomponent fibers are used; if bulkiness is required at the expense of strength, the eccentric type of the fiber is used.

Other uses of *core-sheath* fibers derive from characteristics of the sheath helping to improve the overall fiber properties.[4]. A *core-sheath* fiber has been reported whose sheath is made of a polymer having high absorptive power for water, thereby having obvious advantages for use in clothing. Other sheath-core fibers showed better dye ability, soil resistance, heat insulating properties, adhesion etc. Production of ceramic *core-sheath* bicomponent fibers is another application utilizing the difference of sheath and core. The fiber precursors are first spun in a *core-streath* arrangement and then cured by oxidation, UV and electron beam, heating or by chemical means.These fibers are used as a composite reinforcement.

The *core-sheat* bico fiber ,including such varieties as PE/PP, PE/PET and CoPET/PET are used as bonding fibers for hygiene and medical nonwovens [5].

Bicomponent microfibers are used for cleaning products and biconstituent microfiber nonwovens are used in garments, sports products, automatics and furniture.

The PE/PP and PE/PET "*core-sheach*" bico fiber and nonwovens of bicomponent microfiber are exported in the world.

Concentric core-sheath fibres are applied to produce fibres with a quality (expensive)and weaker external polymer layer around a chaper but more resistant core.

The bicomponent fibres can be classified into four cross-sectional morphologies which will be illustrated in the following image :

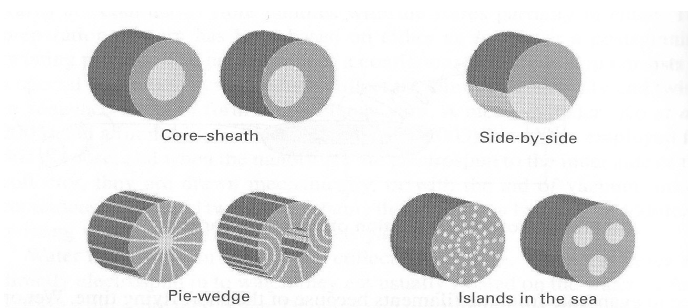


Figure 1 : Cross-sectional morphologies of the bicomponent fibres.[3]

Although the existing fibre-making technique is able to produce a bicomponent fibre of many cross-sectional structures, the production of bicomponent nanofibres has been limited to two basic types of cross-sectional structures, the *core-sheach* and *side-by-side* .These bicomponent nanofibres are electrospun via special spinnerets.Two polymer solutions flow within the spinneret as the sheath and core, or side-by-side, to the tip of the nozzle and then are subjected to a co-electrospinning process.The formation of bicomponent nanofibres is determined by the laminar bicomponent jet.

The *core-sheath* and *side-by-side* bicomponent fibres are the basic structures of bicomponent fibres.Methods for the preparation of more complex bicomponent nanofibres such as *island-in-the-sea* and *pie-wedges* have yet to be developed.

2.2.Matrix-fibril (biconstituent)bicomponent fibers and production

These are also called *islands-in-the-sea* fibers.Technically these are complicated structures to make and use. In cross section they are basically areas of one polymer in a matrix of a second polymer.These types of bicomponent structure facilitate the generation of micro denier fibers.

The *islands* are usually a melt spin able polymer such as nylon, polyester or polypropylene.

The sea or matrix can be formed by polystyrene water soluble polyesters and plasticized or saponified polyvinyl alcohol.The finer deniers that can be obtained are normally below 0.1 denier.[4]

Basically, these fibers are spun from the mixture of two polymers in the required proportion,where one polymer is suspended in droplet form in the second melt.An important feature in production of matrix-fibril fibers is the necessity for artificial cooling of the fiber immediately below the spinneret orifices.Different spin abilities of the two components would almost disable the spin ability of the mixture, except for low concentration mixtures (less than 20%).[4]

The universal sea-island bicomponent microfiber contains 37 islands and is available from Japanese, Korean, Taiwanese and mostly Chinese fiber makers.It is said that only bicomponent fibers with up to 64 islands have been commercialized in China.[5]

In theory, microfibers can be made from many polymers. The researchers used many polymers to test. In fact, they are made frequently from CoPET/PA because of cost factors.Producers always hope to decrease the component that forms the sea because this part often dissolves.

2.3. Side-by-side bicomponent fibers.

There are different techniques of bicomponent fiber and one method is *side-by-side* extension through one spinneret hole of two varieties of same polymer. As the two variants cool and solidify they adhere together as one filament.The filament is composed of both the fibers.Both polymers occupy an equal part of the fibre surface. Depending on the chosen polymers, the fibre may develop more crimp than the excentric *core-sheath* configuration.

Side-by-side can be formed by nylon 6 and nylon 6.6 solutions are extruded through one spinneret hole, a filament is obtained which consists of both the polymers attached *side by side*.

Thus the yarn obtained exhibits the characteristics of both nylon6 and nylon 6.6.[7].

The *side-by-side* cross-sectional morphologies is the basic structure of bicomponent fibres.

2.4. Pie Wedge bicomponent fibers.

This construction is made of sixteen adjoining *pie-wedges* .Each pie-wedge of polymer is flanked on both sides by another polymer type.The fibres are designed in such a way that mechanical action causes the different *pie-wedges* to split into microfibres of 0,1 to 0,2 denier.

3. CONCLUSIONS

According to the cross-sectional morphology, the bicomponent fibers can be classified into four main types*:"core-sheath","side-by-side","pie-wedge"* and *"islands in the sea"*.

The *core-sheath* and *side-by-side* bicomponent fibres are the basic structures of bicomponent fibres.Methods for the preparation of more complex bicomponent nanofibres such as *island-in-the-sea* and *pie-wedges* have yet to be developed.This four basic configurations can be adapted in function of the desired fibre or yarn properties.It is for exemple possible to limit the number of *islands* to produce conductive yarns. On the other hand it is possible to provide a hole in the *pie-wedge* configuration to split the filaments even more easily.

A important progress has been made in electrospinning in recent times, theoretical research on electrospinning nanofibres in a controlled way is still at an early stage.There is considerable potential for the improvement of the electrospinning process and for the modification of morphology and properties of fibers..

The properties and possible applications depend on both the properties and combination of the different polymers and additives and on specific configuration of the bicomponent fibre.

The newly created bicomponent fibre have new properties and can be applied in many new applications.

Bicomponent fibres are actually being applied in the production of : microfibres (hygiene), non-wovens, antimicrobial textiles, elastic fibres, conductive fibres and composites.

4. REFERENCES

[1].Reifler, F.,Sellami, F., Barbadoro, P., Hufenus, R., (2013). Overjacketing extrusion technology for novel bicomponent fibers, *Fiber Journal*, February 2013,pg.34.

[2].Houis, S., Schreiber, F., Gries, T., (2008),Fibre –Table according to P.A.Koch.*Bicomponent fibers,*Shaker:Aachen,Germany,pg.78

[3].Brown, P.J., Stevens, K.,(2007).*Nanofibers and nanotechnology in textiles,*Woodhead Publishing ISBN 978-1-84569-105-9,England

[4].*http://www.fibre2fashion.com/industry-article/textile-industry-articles/bicomponent-fibers/bicomponent-fibers

[5].*http://www.thefreelibrary.com/Outlook+of+microfiber+nonwovens+and+applications

[6].Fourne, F.,(1999) *Synthetic Fibers,*Hanser Publishers:Munich,Germany,pg.910

[7].* http://textilelearner.blogspot.ro/2011/08/spinning-process-of-filament-yarns

WOOL FABRIC DYEING BY SOME PLANT EXTRACTS

Snezana Urosevic[1], Dragan Djordjevic[2]

[1]*University of Belgrade, Technical Faculty, Bor, SERBIA*
[2]*University of Nis, Faculty of Technology, Leskovac, SERBIA*

Corresponding author: Snezana Urosevic, E-mail: surosevic@tf.bor.ac.rs

Abstract: One-bath dyeing procedures of wool fabric using aqueous extracts of plants - hibiscus, St. John's wort and marigold were investigated. On the basis of results obtained, it could be concluded that applied plant extracts have good reasons for commercial dyeing of wool fabrics designed for clothing that would not be a potential allergen during use, i.e. when in contact with human skin. The applied wool dyeing processes with plant flowers water extracts give a chance of commercialization of small plants for lesser batches, such as single examples and the like. The spectral characteristics lead to the conclusion that the dyeing occurs, with changes in shade, hue, and saturation of the dye. The dye exhaustion from the dyeing bath is slightly less (max 61%), which can be solved by using smaller baths and by addition of certain exhaustion improving agents. Spectral distribution of reflection curves are in correlation with the type of extracts and the mordant used as is indicated both by different spectral K/S values and CIEL*a*b* system parameters. At the same time, very good fastness characteristics of wool fabric dyeing are achieved. From environmental view-point it is a suitable replacement of synthetic dyes with "natural products", which may provide not only a strategy for reducing risks and pollutants but also opportunities for new markets and jobs developed by involving ecology in market policy.

Key words: dyeing, wool fabric, aqueous extract, hibiscus, St. John's wort, marigold, CIELab.

1. INTRODUCTION

Once widely used, dyeing of textiles with natural dyes quickly declined following discovery of synthetic dyes in 1856, until their use virtually ceased by the end of 1900. Recently, there is an increased concern for using natural dyes in textile dyeing, at least by the reason of strict environmental standards in many countries as a response to toxic and allergic reactions associated with the use of synthetic dyes. Also, human experience refers to belief that natural dyes are more environmentally friendly than their synthetic counterparts. As a rule, natural dyes have better biodegradability and, generally, higher environmental compatibility [1-5].

Analysis of some natural dyes reveals that almost 50% of all natural dyes, used for textile dyeing, are flavonoid compounds. The greater part of the rest of natural dyes belongs to the three classes of compounds – anthraquinones, naphthoquinones and indigoids. Though flavonoid compounds are not very light fast, anthraquinones and indigoids are known by their excellent light fastness [6-8].

The main task of this work consists in producing a sort of environmental textile – wool fabric dyed with plant extracts, which would, as a final product, be finished in garment industry, before use. Plant extract treatment not only dyes textile but also upgrades it with medical properties of used plants. Namely, in this study, dyeing is performed not only with one component – dye from the plant, but with extract that contains other medical ingredients beside dye ingredients. All of them are now bonded to textile making it a unique product having other medical constituents from the plants in addition to dye.

2. EXPERIMENTAL

In our experiments, we used a wool fabric (100%), twill weave 2/2, warp and weft fineness of 23 tex, warp and weft density of 24 cm^{-1} and 22 cm^{-1}, respectively, having surface mass of 215 g/m^2. Just before the treatment, crude fabric was slightly washed at 40^oC for 30 min.

For dyeing process, extracts of marigold, St. John's wort and hibiscus flowers were used, which were collected from the wide area of Leskovac, Serbia. Extraction was performed in distilled water according to literature [8]. It is a conventional extraction in 100 ml of boiling distilled water with plant drug concentration of 20% for 120 min. Filtering and cooling was made at the end before use.

All the treatments of wool fabric with plant extracts were processed according to general one-bath method. The procedure consisted of immersing textile material in the bath heated to 50^oC. The bath was constituted of dyeing extract with the addition of mordant. The temperature than was increased to 80^oC and the treatment was maintained for the next 45 min. Therefore, the treatment bath was an aqueous extract obtained after extraction + mordant, with or without potassium sodium tartrate and with the solution to fabric ratio of 50:1. After treatment the dyed samples were rinsed first with warm and then with cold distilled water, and afterwards washed with 1 g/l non-ionic detergent (Hostapal CV, Clariant) solution at 50^oC for 30 min, rinsed again with distilled water and dried at room temperature.

Reflection of textile samples was measured on Datacolor RX 600 spectrophotometer linked to a PC with appropriate software. In addition to degree of reflection, Kubelka-Munk functions were also obtained indicating the relationship between reflection coefficients and dye content on fibre (K/S). Using software, parameters of CIEL*a*b* system were obtained to define colour differences of dyeing.

Exhaustion degree of dyeing bath was monitored by absorption UV-VIS spectrophotometer (Cary 100 Conc. UV-VIS, Varian) at maximum absorption wave length (397 nm – St. John's wort extract; 365 nm – marigold extract; 521 nm – hibiscus extract) of tested dye (extract). The degree is expressed in % and calculated using difference between absorption value at the beginning (dyeing time =0) and absorption value after time t, in relation to initial absorption.

Table 1 shows the basic treatment procedures of dyeing of wool fabric with plant extracts.

Table 1: Treatment formulations – dyeing of wool fabric

Treatment	Content
I	Marigold extract, 3% $KNaC_4H_4O_6 \cdot 4H_2O$
II	St.John's wort extract, 3% $KNaC_4H_4O_6 \cdot 4H_2O$
III	Hibiscus extract, 3% $KNaC_4H_4O_6 \cdot 4H_2O$

Measuring of essential parameters for evaluating the dyeing efficiency was performed according the corresponding standards:

- Testing of light fastness of dyeing SRPS ISO 105-B01:2002
- Evaluation of fastness of dyeing to water drops SRPS F.S3.237
- Evaluation of fastness of dyeing to sea water SRPS F.S3.232
- Evaluation of fastness of dyeing to water SRPS F.S3.231

3. RESULTS AND DISCUSSION

It is quite clear that pH, temperature and dyeing time will affect the rate and efficiency of dyeing, affecting the end quality of textile product. It is known that the rate of every process means changing of initial material in time unit. Using this definition in our case, the dyeing process can be considered as a change of fibre reception of active components in time unit. Too high rate gives uneven dyeing, too low rate results in insufficient exhaustion and again uneven appearance of dyed product.

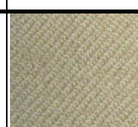
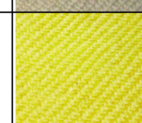
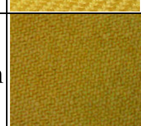
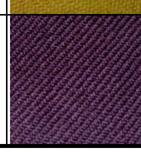
There is an essential effect of temperature on capability of wool dyeing with aqueous extracts of plants and, as seen in preliminary studies, colour strength is increased with dyeing temperature.

Namely, colour strength expressed by K/S values, at temperatures 80 and 100^{o}C, has very close values, therefore a lower temperature was chosen as a working temperature. Though it is known that higher dye reception at higher temperatures could be explained by greater fibre swelling and thereby increased diffusion of dye, we have taken into account all facts that involved economy and the possibility of fibre damaging at higher temperatures in acid conditions.

Effect of dyeing time was also preliminary investigated; dyeability is improved increasing dyeing time, and the best result was obtained after 60 minutes, taken into account the fact that longer dyeing time is not cost-effective and economically. The effect was evaluated on the basis of parameters of brightness L*, when it was observed that treatments longer than 60 min, for example 90 and 120 min, have values of L* parameter only 10 – 15% lower than that characterizing treatment working time (lower L* means darker sample). That means twice longer treatment time, lot of used-up energy for the effect which could barely be discerned.

Table 2 presents pictures and assessment of subjective color impression of wool fabric samples dyed with different treatments and without any additives (mordants). Comparing data from the table it can be concluded that applied formulations have fulfilled the task, i.e. fabric samples treated according to formulations have brighter and stronger colors of corresponding shades recognized subjectively. This subjective assessment is sufficient to assert, with high reliability and responsibility, that far more extracts remained on the samples treated with mordants- additives than without them.

Table 2: Pictures and subjective color impression of fabric samples after different treatments with plant extracts

Treatment	Sample color	Sample view	Treatment without mordant	Sample color	Sample view
untreated	pale-gray		untreated	pale-gray	
I	Yellow		I	Light yellow	
II	Yellow green		II	Yellowish brown	
III	Violet blue		III	Pale violet	

It was shown here too, that in reactions with low affinity reactants or when the formed chemical bond strength is insufficient a very useful role may have specific substances (mordants) which, in our case, undertake a moderator role taking their own part therein as, for example, second order reactants. Practically, that means in addition to direct binding of base reactants, binding through mentioned moderators can take place too. Percentage of realized bonds, directly or via moderators, and their strength depends on concrete case and they are of very complex nature.

Reflection curve of dyed textile samples represents physical characteristics of a specific dye. From reflection curves on Fig. 1 it can be seen that dye reception by textile substrate leads to reflection – remission drop (adsorption is increased). The area above reflection curve represents absorbed part of light energy and the area below remission curve – reflected light energy coming to observer's eye. On Fig. 1 plots of reflection parameters and on Fig. 2 absorption parameters (K/S) of dyed samples are shown versus wave lengths in visible spectrum.

Crude, undyed sample, in all cases has the highest reflection values, i.e. the lowest values for K/S parameter, indicating its brighter colour. From reflection curves it can be seen that, as a rule, both with dyeing or increase of dye concentration on textile substrate and with dark shades – with the same concentrations, reflection, i.e. remission value, declines.

Generally, according to reflection and K/S parameter plots shown, it could be concluded that curves are not clearly differentiated, i.e. maximum and minimum area (peaks), referring to basic or derived colours, rather it refers to different shades of basic colours.

For the treatment I (marigold extract) it can be established that reflection curve is very similar to crude – untreated sample having yellowish-orange shade. Therefore, curve form of dyed sample follows curve form of untreated sample only at lower reflection values meaning that it is a darker shade of the same colour. For this treatment, maximum absorption takes place at wave lengths of 500 to 550 nm corresponding to blue-green to green light colour (complementary colour), while maximum reflection in the range of 650-700 nm indicates orange to red reflected light colour (visible colour – sample colour).

For the treatment II (St. John's wort extract) reflection curve is slightly clearer with maximum absorption and reflection at about 550 and 650-700 nm, respectively. In this case too, it means reddish shade – dyeing of wool fabric sample.

The treatment III (hibiscus extract), according to plots in Fig. 1 and 2, has maximum absorption at wave lengths 550 to 600 nm, corresponding to yellow to yellow-green light colour (complementary colour), while maximum reflection at 450 – 500 nm refers to blue, i.e. green blue reflected light colour (visible colour – sample colour).

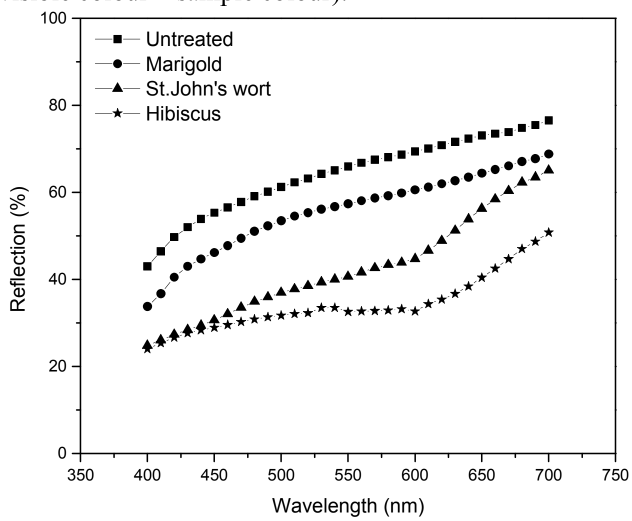


Figure 1: Reflection curves of wool fabric with treatment mode I, II and III

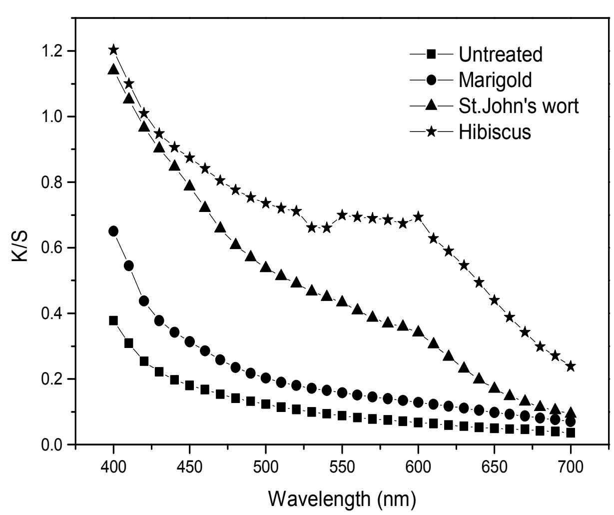


Figure 2: K/S curves of wool fabric with treatment mode I, II and III

The more-in-depth explanation of the ranges of shades achieved, results shown in Table 3 can be used, indicating parameters of CIEL*a*b* system for various dyeing of substrate – wool fabric.

Table 3: CIEL*a*b* parameters for wool fabric treated with marigold, St. John's wort and hibiscus extracts viewed under daylight.

Treatment	L*	a*	b*	C*	H*
-	82.97	-0.44	11.69	11.70	92.13
I	71.80	2.36	13.42	14.78	45.36
II	56.40	8.59	17.19	19.59	68.50
III	21.66	11.00	-0.31	10.59	154.02

Results of dye exhaustion from the dyeing bath are shown in Table 4. The aim is to make exhaustion degree as high as possible to reduce dye losses, which, remained after dyeing, constitutes waste coloured water, although there should not be a great concern because it contains easily degradable natural active agents with chemical substances – biomordants, not representing dangerous pollutants. Exhaustion range of tested dyes was from 54% up to 61%, depending on many parameters, but working under the same reaction conditions, excluding the common parameters it can be concluded that deciding and obvious contribution give used mordant and medium pH.

Table 4: Exhaustion degree after completion of fabric dyeing

Treatment	Exhaustion degree, %
I	61.32
II	54.25
III	55.28

Apart from obtaining appropriate dyeing on textile, it is also necessary to retain the dyeing during use. Table 5 shows results of testing fastness of dyeing on fabric to various treatments.

As per results from Table 5, light fastness ranges to 6 (treatment II) of maximum 8, which could be considered satisfactorily.

Fastness to water drops in all cases has the highest possible mark 5, meaning that these treatments are maximum resistant to the action of water drops.

As for fastness to sea water, results are very similar for all treatments.

Water fatness is somewhat better in relation to sea water fastness, the highest mark is close to the best mark, reaching 4 (treatments II-III) of maximum 5.

Fastness results show that by selection of treatments with various plant materials in the presence of mordant, a group having acceptable fastness properties of dyeing could be selected.

Table 5: The marks of various fastnesses of wool fabric dyeing with treatment modes I-III

Treatments	Light fastness of dyeing	Fastness of dyeing to water drops	Fastness of dyeing to sea water	Fastness of dyeing to water
I	4-5	5	3-4	3-4
II	6	5	3	4
III	4-5	5	3	4

4. CONCLUSION

The process of direct addition of the mordant into the dyeing bath can cause dye losses due to partial sedimentation, but such procedures are the basis of the one-bath dyeing process. For a dyeing plant, the use of separate mordant and dyeing baths are inconvenient, having in mind the dyeing time, further finishing or recycling of the mordant baths. The suggested one-bath method can be considered as a technical compromise necessary for possible implementation of technology in the modern dyeing plant.

The use of natural dyes is often associated with "poor fastness" and application with extensive use of labour force. The investigation results of this work show that a single-bath dyeing process with the plant extracts as "natural dyes" can be assumed and that acceptable fastness results can be achieved on wool as the substrate. In spite of paucity of various samples tested in this work, a wider range of shades was obtained.

The applied wool dyeing processes with plant flowers water extracts give a chance of commercialization of small plants for lesser batches, such as single examples and the like. The spectral characteristics lead to the conclusion that the dyeing occurs, with changes in shade, hue, and saturation of the dye. The dye exhaustion from the dyeing bath is slightly less (max 61%), which can be solved by using smaller baths and by addition of certain exhaustion improving agents.

The possibility of using a mixture of dyes and of changing the mordant composition enables the dyer to achieve various shades in the dyeing process comparable with the methods used nowadays. The simultaneous use of dyes and mordants in the same bath enables adjusting of shade depth and hue by choice of extract composition and quantity, as well as by using given concentrations and mixtures of the mordant. Such procedured should improve the reproductivity of dyeing compared to the methods of previous or subsequent mordant use, both being two-bath methods. Besides, this method allows correction or fine adjustment of the shade and hue depths by further addition of dye or mordant to the dyeing bath.

The testing of washing fastness, light fastness, water fastness and the like suggest the conclusion that the achieved bond between the plant extracts and the wool fabric could satisfy the requirements of practical use.

The assessment of chemical pollution by released waste waters from various dyeing processes currently in use shows that use of this dyeing process results in ecological improvements. However, detailed comparison should be made in direct work taking into account the process to be replaced. The fact is that, apart from processing chemical savings, the use of renewable natural sources for textile dyeing gives an opportunity for replacement of synthetic dyes by renewable plant materials, such as marigold, St. John’s wort, and hibiscus.

5. REFERENCES

[1]. Valbuena, T., Reche, M., Pascual, C., García-Ara, M.C. & Martín-Esteban, M. (2001) Allergic symptoms due to silk dress, *Journal of Allergy and Clinical Immunology,* 113 (2004) 133-136, ISSN 1398-9995.

[2]. Pratt, M. & Taraska, V. (2000) Disperse blue dyes 106 and 124 are common causes of textile dermatitis and should serve as screening allergens for this condition, *American Journal of Contact Dermatitis,* 11 (2000) 30-41, ISSN 1046-199X.

[3]. Bechtold, T., Turcanu, A., Ganglberger, E. & Geissler, S. (2003) Natural dyes in modern textile dyehouses - how to combine experiences of two centuries to meet the demands of the future?, *Journal of Cleaner Production,* 11 (2003) 499-509, ISSN 0959-6526.

[4]. Gulrajani, M. (1999) Natural Dyes - Part I: Present Status of Natural Dyes, *Colourage*, 46 (1999) 19-28, ISSN 0010-1826.

[5]. Colombini, M.P., Andreotti, A., Baraldi, C., Degano, I. & Lucejko, J.J. (2007) Colour fading in textiles: A model study on the decomposition of natural dyes, *Microchemical Journal*, 85 (2007) 174-182, ISSN 0026-265X.

[6]. Prusty, A.K., Das, T., Nayak, A. &. Das, N.B (2010) Colourimetric analysis and antimicrobial study of natural dyes and dyed silk, *Journal of Cleaner Production*, 18 (2010) 1750-1756, ISSN 0959-6526.

[7]. Bechtold, T., Mahmud-Ali, A. & Mussak, R. (2007) Natural dyes for textile dyeing: A comparison of methods to assess the quality of Canadian golden rod plant material, *Dyes and Pigments,* 75 (2007) 287-293, ISSN 0143-7208.

[8]. Kamel, M.M., El-Shishtawy, R.M., Yussef, B.M. & Mashaly, H. (2005) Ultrasonic assisted dyeing III. Dyeing of wool with lac as a natural dye, *Dyes and Pigments,* 65 (2005) 103-110, ISSN 0143-7208.

THE USE OF ATMOSPHERIC PLASMA TREATMENT TO IMPROVE ADHESIVE PROPERTIES OF BIOPOLYMER JOINTS PLA/PLA FOR INDUSTRY APPLICATIONS

Amparo Jordá Vilaplana[1], Maria Angeles Bonet Aracil[1] Lourdes Sánchez Nácher [2] Matías Monzó Pérez[2]

[1] *Universitat Politècnica de València Campus de Alcoi, Alcoy, SPAIN*
[2] *Instituto de Tecnologia de Materiales (ITM), Alcoy, SPAIN*

Corresponding author: Amparo Jorda Vilaplana, E-mail: amjorvi@upv.es

Abstract: Recently a remarkable growth in the biodegradable polymers applications has been observed in many industrial sectors. This kind of polymers offers a wide variety of properties such a traditional and easy processing conditions, good chemical barrier behaviour, surface finishing versatility, light, etc. What's more the main property of these polymers is their biodegradability and environmental friendly behaviour. One of the most important commercial biopolymer is polylactic acid or PLA. This is one polyester kind from renewable sources that its produced for anaerobic fermentation of substrates with carbon like glucose, lactose, starch, molasses, etc with microorganisms like lactobacillus bacterium.
Despite this, many polymeric materials offer very low surface energy values. So, in order to obtain polymeric joints, these surfaces are characterized by poor wettability properties by their hydrophobic behaviour. Therefore, this effect difficults the deposition of a layer of adhesive on the polymer surface. For solving this real problem we have used a surface treatment with plasma technology because is an environmental friendly technology and promotes high surface energy values on polymer surface, improves wettability property, and their adhesion properties too.
In this work we have used atmospheric plasma technology to modify wettability properties of a polylactic acid PLA, and to improve adhesion properties for technical applications.
The main aim of this work is to improve surface wettability of a PLA surface using an atmospheric plasma treatment for increasing adhesive strength joints PLA/PLA, using a biodegradable adhesive.
Wettability changes on PLA surface have been evaluated using contact angle measurements by means of four test liquids with different polarities, and atomic force microscopy (AFM). Characterization of the PLA/PLA joints with atmospheric plasma treatment with different conditions process has been carried out using mechanical test. The morphologies fracture surfaces have been analyzed by scanning electron microscopy (SEM) to determine the fracture mechanism. The obtained results show that the atmospheric plasma treatment is and effective method that produces an increase of the PLA surface hydrophilic behaviour, improving its adhesive strength joints.

Key words: polylactic acid, adhesive properties, atmospheric plasma, PLA/PLA, wettability, Biodegradable

1. INTRODUCTION

The main driver in the development and research of new organic materials are biodegradable or current environmental policies along with the awareness on the part of consumers regarding the use and consumption of low environmental impact materials or environmentally. One of the main fields of waste is the packaging of products, and especially power. The new trends of consumerism in today's society generally large amount of waste that must be managed properly to generate the least possible environmental impact. It is evident that plastics are an important part of this type of waste, and because of its nature petrochemicals, are difficult and expensive to recycle, especially for the problem of source separation.

Therefore, polymeric materials are occupying major lines of investigation because of the interest in replacing petrochemical-based materials by polymeric materials of natural origin. First, it addresses the problem of resource depletion from fossil forces and, secondly, the ease of disposal of waste or biodegradability.

Currently already trading some biodegradable polymeric materials of low environmental impact, with good technical characteristics in some industrial fields. The most important are the PLA polylactic acid, PHB polyhydroxybutyrate, polyhydroxybutyrate-valerate PHB-V, tps starch polymers, natural proteins.

The PLA is already being used successfully in some areas such as in medicine suture, prosthesis, implants and slow release capsules for drugs, in dentistry is used in dentures, veterinary, etc.. In the industrial field has interesting applications in the packaging of food products, such as food protective film high breathing and short-term storage as vegetables, bakery products and pastries, ... It is also used in products catering disposable as drinking cups, plates, bowls, cutlery, ... In the manufacture of films for the protection of crops in the field, containers for cosmetics, etc .... [1-5] the container-packing industry is one of the industries most interested in implementing this type of material, the high environmental impact and produce high volume packaging waste. In this field of application and due to the design requirements of the package is typically require adhesive properties. By the intrinsic nature of pla, and generally of polymers, has little wettability or surface wettability, which hinders the implementation processes of industrial adhesives.

This issue search warrants surface modification treatments to improve this low wettability. Different types of surface modification treatments, both physical and chemical. Chemical treatments, in general, the chemicals used attack the polymer surface generally originate waste, which by their nature are harmful to the environment. For this reason, treatments that do not generate waste are more interesting. Within this area, are optimal treatments based on plasma technology, as well as being environmentally correct, only modify the surface to be treated without changing the general behavioral properties of the material itself.

In the present study we used atmospheric plasma technology for its easy implementation in an industrial process of continuous production. Main objective arise in this experimental work to analyze the improvement of the adhesion of sheets PLA/PLA by applying an adhesive with low environmental impact. We examine the behavior of the polylactic acid atmospheric plasma treated and the effect of the variable parameters in the application of such surface modification treatment.

2. EXPERIMENTAL

Material:

The material used is polylactic acid, PLA, commercial brand Nature Works Cargill provided by LCC, USA. Injection process dimensiones 160 x 60 x 2 mm.

The adhesive used is the Fast EcoPoxy Hardener, provided by the company Ecopoxy systems with an optimized cure time 90 minutes at room temperature.

Liquids that have been used to determine the wettability of the surface of the PLA, by measuring the contact angle are stabilized diiodomethane 99% (Acros Organics), distilled water, formamide (reagent grade, Scharlau Chemie SA) and 99% glycerol (Scharlau Chemie SA)

Equipment:

Testing the adhesive bond strength of PLA / PLA are performed in a universal testing machine IBERTEST ELIB 30 (SAE Ibertest, Madrid, Spain) to a speed of 300 mm min-1 at room temperature with the load cell 5 kN. The test used to assess the strength of the adhesive bond shear has been the block according to the UNE-EN ISO13445 "Adhesives, determining the shear strength of adhesive bonds between rigid substrates by the block shear methods". The samples have dimensions of 25 x 25 mm being the punch of 10 x 25 mm.

The atmospheric plasma treatment is performed with a computer "Plasma Jet RD1004" (Plasmatreat GmbH, Germany). Used a circular nozzle with a speed of useful substrate to 40 mm min-1 and a distance from nozzle to substrate in the range between 2 and 45 mm. Under the test conditions were at speeds past to treat the surface of PLA under different plasma beam 100, 300, 700 and 1000 s-1 mm, and heights plasma nozzle / substrate different PLA: 6, 10, 14 and 20 mm.

To quantify the change of surface wettability using a team of contact angle measurement, using different contact liquids listed above, called Standard EasyDrop Krs brand FM140 model 110/220 V, 50/60 Hz

3. RESULTS AND DISCUSSION

The results obtained after the test in block shear foil adhesive bonding pla / pla with the use of adhesive with low environmental impact, "ecopoxy", show an interesting improvement in the resistance of these adhesive bonds when the sheet pla is pretreated by atmospheric plasma. The following table shows the results obtained experimental. Must be taken into account to optimize the response of the joint resistant PLA/PLA, once observed the improvement achieved in the following table are observed maximum strength values obtained after the shear test adhesive bonding pla / pla polymer sheet treated with atmospheric plasma at different heights nozzle-substrate: 6, 10, 14 and 20 mm and different speeds past the pla sheet under the plasma jet: 100, 300, 700 and 1000 mms-1.

Table 1. Maximum force obtained in shear tests, for different conditions of application of atmospheric plasma treatment.

Speed mm/s	Height 6 mm	Height 10 mm	Height 14 mm	Height 20 mm
	Strength Máx. (N)	Strength Máx. (N)	Strength Máx. (N)	Strength Máx. (N)
100	465,875	476,5	387,9	276,75
300	355,85	366,1	353,175	266,2
700	359,7	334,6	334,8	259,575
1000	327,275	303,2	256,3	207,825

These data show the significant increase in the resistance of adhesive bonds that are achieved under any operating parameter of atmospheric plasma. Keep in mind that the ultimate strength of the adhesive bond on the same sheet without surface treatment pla is 159.65 N, so that the analysis of the numerical data in table i can see how in certain conditions of application atmospheric plasma treatment can almost reach triple the adhesive bond strength.

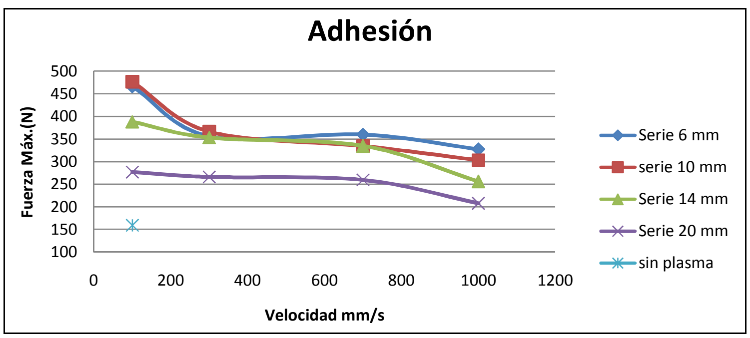


Figure 1. Variation of force as it changes over the last speed and heights.

Graphically shows more clearly the effects of the conditions of application of the surface treatment on the maximum resistance to shear, Figure 1. As speed increases past the sheet under the plasma decreases the maximum strength of the adhesive bond as the effects of treatment are less. While for lower elevations between the PLA substrate and the nozzle offers greater adhesive bond strength. Under these conditions, the surface treatment is more aggressive, and its mechanism of action on the polymeric surface are more pronounced, leading to a considerable improvement of the adhesion properties of the PLA.

From the standpoint of the morphological study of adhesive bonds, may corroborate previous quantification of improved adhesion to the atmospheric plasma treatment. For samples that have low resistance to breakage by shear surfaces are obtained characterized by breaking the adhesive found in only one of the parts of the test piece, the adhesive surface being completely smooth and homogeneous. This is due to breakage of adhesive type as there is a lack of adhesion of the adhesive on the polymeric surface and almost be said to be "off" opposing little resistance. This type of morphology is obtained to break plasma treatment conditions of high speed passing and / or high distances nozzle / substrate.

Furthermore, the shear fracture morphologies that are characterized by rougher surfaces, with some of the adhesive on both sides of the shear specimen are those which correspond to cohesive failure of the adhesive itself. Or what amounts to the same, high resistance to breakage of the adhesive bond binding indicative of PLA / PLA by using an adhesive is optimized. This second type of morphology corresponds to conditions of atmospheric plasma pretreatment in passing low speeds and / or low distances nozzle / substrate. In Figure 2 and 3 shows in detail these types of morphologies of different breaks shear adhesive joints.

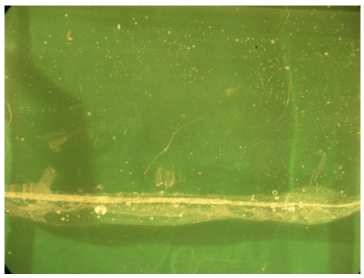
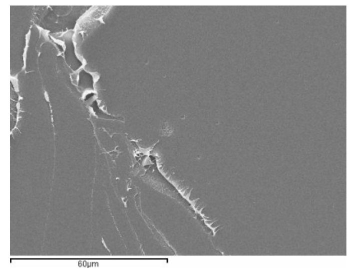



Figure 2. Morphology of type shear ultimate smooth, a) Macro-8X, b) SEM micrograph at 1000 magnification.

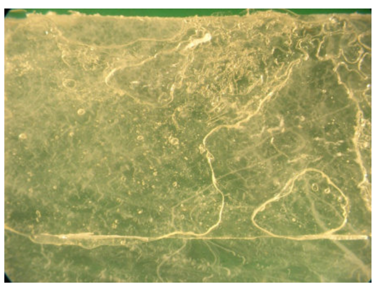
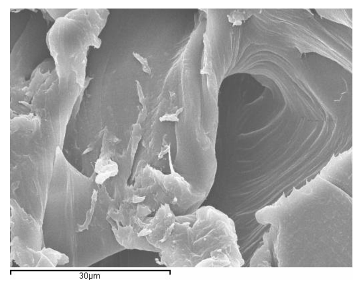



Figure 3. Morphology of rough typology ultimate shear, a) macro-8x, b) SEM micrograph at 2000 magnification.

These results demonstrate that the atmospheric pressure plasma surface treatment improves the adhesion properties of polylactic acid. The mechanisms of action of the plasma, both physical and chemical, favor wettability of the adhesive on the surface of polymers.

One of the effects of atmospheric plasma action on pla studied causes for surface functionalization species interaction ionized air generated by the plasma, increase the wettability of the same, but this increase is a function of the application conditions surface modification treatment. For this reason it is necessary to optimize the parameters of atmospheric plasma processing: speed and distance last nozzle / substrate. One of the main indicators of the hydrophilicity or hydrophobicity of the surface of solids, are the values of contact angles of different reference liquids on a surface. [6]

Table 2 shows the data of the contact angles measured for liquids of different polarities on the untreated surface of the pla sheet.

Table 2. Contact angles obtained on untreated pla with different test liquids.

PLA VIRGIN				
SAMPLE	WATER	FORMAMIDE	DIIODOMETHANE	GLYCEROL
AVERAGE	**73,44**	**47,07**	**36,96**	**79,14**

The results obtained in measurements of the contact angles of these reference liquids after performing atmospheric plasma treatment show a remarkable decline, indicative of better wettability of the surface. As an example, figure 4 shows this variation for different speed and altitude last nozzle / substrate 6 mm.

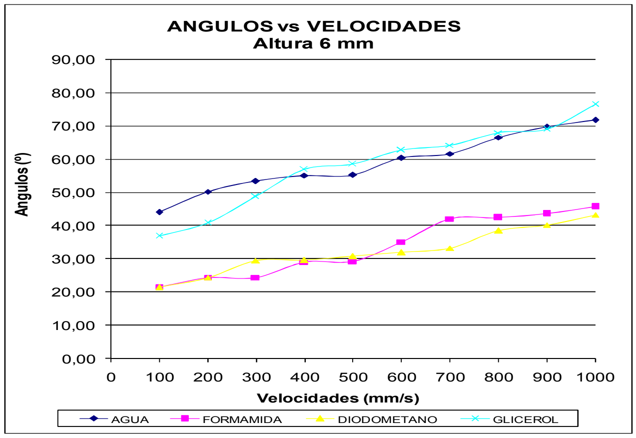


Figure 4. Variation in the contact angles obtained on pla with different test liquids to a height of 6 mm and different speeds past.

In conclusion, it appears that at greater distances substrate / nozzle and greater treatment speed, the contact angle increases, thus decreasing hydrophilicity. This study aims to improve the hydrophilicity of the substrate to improve the adhesive surface interaction. Optimal working conditions of atmospheric plasma pretreatment are slow speeds (6-10 mm) and slow speeds (100-700 mm s1).

4. CONCLUSIONS

Atmospheric plasma treatment significantly enhances the wettability of PLA polylactic acid, significant reductions quantified by contact angle. Hydrophilic behavior improves optimal substrate for further treatment. The optimal conditions of application of the surface modification treatment is kept low in the range of heights of nozzle / substrate [6.10 mm] and low / medium speed past [100-700 mm s-1] to the same heights. For these conditions, optimize maximum strength of the adhesive bond PLA / PLA, compared with the untreated sample, increased adhesion is practically tripled.

5. REFERENCES

[1]. Fujita, M., A. Takemura, H. Ono, M. Kajiyama, S. Hayashi and H. Mizumachi (2000). "*Effects of miscibility and viscoelasticity on shear creep resistance of natural-rubber-based pressure-sensitive adhesives*" Journal of Applied Polymer Science 75(12): 1535-1545.
[2]. Hong, S.G. and C.K. Chan (2004). "*The curing behaviors of the epoxy/dicyanamide system modified with epoxidized natural rubber*" Thermochimica Acta 417(1): 99-106.
[3]. Hong, S.G., C.K. Chan, C.C. Chuang, C.W. Keong and Y.P. Hsueh (2005). "*The curing behavior and adhesion strength of the epoxidized natural rubber modified epoxy/dicyandiamide system*" Journal of Polymer Research 12(4): 295-303.
[4]. Shenton, M.J., G.C. Stevens, N.P. Wright and X. Duan (2002). "*Chemical-surface modification of polymers using atmospheric pressure nonequilibrium plasmas and comparisons with vacuum plasmas*" Journal of Polymer Science Part a-Polymer Chemistry 40(1): 95-109.
[5]. Abenojar, J., R. Torregrosa-Coque, M.A. Martinez and J.M. Martin-Martinez (2009). "*Surface modifications of polycarbonate (PC) and acrylonitrile butadiene styrene (ABS) copolymer by treatment with atmospheric plasma*" Surface & Coatings Technology 203(16): 2173-2180.
[6]. Lasprilla, A.J.R., G.A.R. Martinez, B.H. Lunelli, A.L. Jardini and R. Maciel Filho (2012). "*Poly-lactic acid synthesis for application in biomedical devices - A review*" Biotechnology Advances 30(1): 321-328.

The editors take no responsibility of the results, opinions and conclusion expressed in the published papers