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STUDY OF THE INFLUENCE OF WOOL TYPE USED IN A YARN, IN TERMS OF TENSION

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Abstract: *The use of yarns for manufacturing textiles is increasing in modern times, and new, better methods for making yarns are employed. Yarns are the elements of which textiles are made. In order to diversify the assortment of textile products, more and more types of yarn are made, called heterogeneous yarns, which are yarns made using different types of fibers or filaments.*
From a technological standpoint, the purpose of mixing fibers is to seek to improve certain physical and mechanical characteristics such as fineness, strength, uniformity etc., which influence the properties of the textile products. A significant increase in yarn strength is achieved by introducing in a mix of wool fibers a certain percentage of synthetic fibers, such as polyester, which have double or even triple the strength of wool fibers. Synthetic fibers however have the downside of having a low hygroscopicity. For this reason, the yarns commonly used are those which have a a natural component, namely wool.
One of the main objectives of mixing is to better use the available raw materials. Thus, from soft yarns one can make soft fabrics and knits, and, with the same quantity of raw material, can obtain a larger surface of fabric or knits, with direct impact on costs. With regard to the quality and properties of the textile products, the decisive element is not only the type of the fiber and the proportion in which it is present in the mix, but, fundamentally, the right choice of characteristics for those components (length, fineness, cross-section).

Key words: *fibers, fineness, tensile properties, traction resistance, quality, uniformity, wool*

1. INTRODUCTION

In this study, we looked at two batches of yarn with 45% wool, and 55% PES-Grisutin, from France. The yarns in the two batches have the same fineness T_{tex} = 25 (N_m40/1) and the same twist of 450 turns/m, as they are meant for textile works. The difference in the batches consists in the fact that the wool used for the first batch is from China, and the wool used for the second batch is from Indonesia.

The tensile properties of the yarns in the two batches were analysed and it was discovered that the second batch shows improved properties due to the wool from Indonesia. The conclusion is that the wool from Indonesia has tensile properties superior to those displayed by the wool from China.

Textile products (knits, unconventional textiles etc.) are made from yarn positioned in a certain order, called structure [1], [2] . The yarn represents the element on which making a textile product is based, and the stucture of the product represents the way in which the yarn fibers were mixed. In order to diversify the assortment of textile structures, different types of fibers are mixed and yarns are produced based on these mixes. Mixed yarns are yarns which different types of fibers in their composition, and they are called heterogeneous yarns[3].

From a technological standpoint, the purpose of mixing fibers is to seek to improve certain physical and mechanical characteristics such as fineness, color, strength, uniformity etc., which influence the properties of the textile products. A significant increase in yarn strength is achieved by introducing in a mix of wool fibers a certain amount of synthetic fibers, such as polyester, which have double or even triple the strength of wool fibers. Polyester fibers have a much lower density compared to natural fibers, which, when the fibers are mixed, leads to the manufacture of lighter, more comfortable textile products [3]. As a consequence to the way fibers are allocated in the transversal section of the yarn, the visual characteristics of the product will be affected as well. Synthetic fibers however have the downside of having a low hygroscopicity.

From an economical point of view, in order to cut costs, the goal is to obtain cheaper mixes by replacing the more expensive fibers with less expensive ones or by changing the proportions of the components in the mix. One of the main objectives of mixing fibers is to obtain superior value from the raw materials. Thus, from soft yarns one can make soft fabrics and knits, and, with the same quantity of raw material, can obtain a larger surface of fabric or knits, with direct impact on costs.

With regard to the quality and properties of the textile products, the decisive element is not only the type of the fiber and the proportion in which it is present in the mix, but, fundamentally, the right choice of characteristics for those components (length, fineness, shape of the cross-section). Since the number of fibers in the yarn's cross-section has limited value, in order to obtain finer yarn, it is necessary to use finer fibers. And since the fineness of natural fibers is also limited, it becomes clear that synthetic fibers must be used. Synthetic fibers such as polyester, when mixed with wool fibers, improve the maintainability of the textiles made from the resulting yarn, as well as shrinkage and dimensional stability.

2. THE EXPERIMENTAL PART

In order to study the tensile properties of yarn, the following physical and mechanical characteristics are looked at: the tensile strength of the yarn, elongation, the stress-elongation diagram and the irregularities in all these characteristics. Tensile strength is one of the main characteristics of yarn because it influences the way yarn behaves during processing – the preparation for weaving or knitting determines the technological parameters for tuning the machines, as well as the productivity level of the machines. Also, tensile strength of the yarn is a qualitative property because its value has inpact on the value of the product. For these reasons, this characteristic is specified in internal rules and standards by the minimum accepted value based on raw materials, manufacturing technology and intended use. The indicators for determining the yarn's tensile strength are [4]:

- skein breaking strength – the maximum value of the force applied on the skein which leads to breaking (cN), and for thick yarn, N
- variation coefficient % of breaking strength,
- specific breaking strength, this measurement is used to compare the breaking strengths of yarns of different thickness. It is calculated by dividing the beaking strength of the yarn to the initial fineness (tex), and it is measured in cN/tex

The tensile strengths of the yarns and the values of the variation coefficient depend on the nature of the raw materials, fineness of the yarn, the technology used for producing the yarn and the intended use. Yarns have mechanical characteristics which allow them to be transformed in textile patterns. These characteristics are determined by the corresponding characteristics of their components and are affected overall by a number of aspects, primarily by the yarn's structure.

Heterogeneous mixes are blends of fibers which have different mechanical characteristics. The mix obtained from two different components are binary mixes. In this paper we studied the tensile properties of two batches of binary mix yarns, with 55%PES from France called Grisutin and 45% wool. The yarns in the two batches have the same length density T_{tex} = 25 (N_m40/1) and the same twist of 450 turns/m, intended for woven textile patterns. The only difference between the two batches of yarn is the wool component used in the binary mix – in the first batch, the wool mixed with PES is from China, and the wool used in the second batch is from Indonesia. The study of the tensile properties of the yarns in the two batches is in fact, in this case, the study of the influence of the wool component in the binary mix from an origin point of view, and the way in which these tensile properties are affected by the geoclimatic area of origin and how this affects tensile strength. The study was done using the tensile testing dynamometer Uster R Tensojet, shown in figure 1. Ten tests were also carried out for each of the batches, to obtain the values for skein breaking strength, elongation on break (%), yarn tenacity, the stress-elongation diagrams of the yarns.

The stress-elongation curve shows the interdependency between elongation and the force applied to stress the yarns. This curve allows an early appraisal of the processing capacity and the durability of the products by indicating resistance to repeated stress during processing. The stress-elongation curve enables the calculation of the following indicators: maximum elongation upon breaking and mechanical work upon breaking. The mechanical work upon breaking indicates the capacity of a yarn to withstand the stress of processing and can be described as the quantity of energy needed to break the yarn [5]. It is expressed as the surface delimited by the stress-elongation curve and the coordinate axis, and it represents the product between stress and elongation and is measured in cN cm.

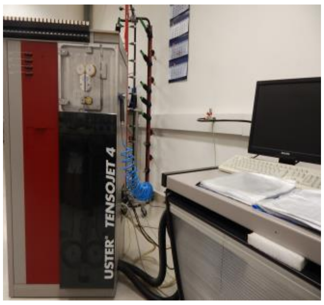

Fig. 1: *The USTER® TENSOJET 4 machine* [6].

The following data was obtained based on the tests on the yarns from the two batches:

Figure 2 shows the resistance to breaking dispersion diagram for the first batch, pointing out the irregularity in resistance to breaking for the ten tests done on the first batch.

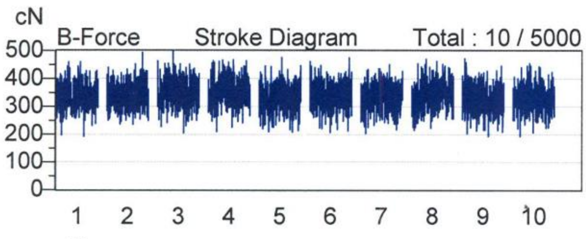

Fig. 2*: The resistance to breaking dispersion diagram for the yarn in the first batch*

Figure 3 shows the dispersion diagram for elongation upon breaking for the yarn in the first batch, pointing out the irregularity in elongation upon breaking for the ten tests done on the first batch.

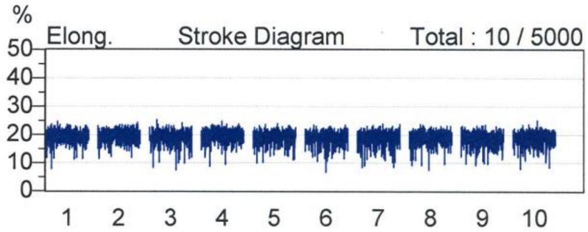

Fig. 3*: The dispersion diagram for elongation upon breaking for the yarn in the first batch*

Figure 4 shows the stress-elongation diagram which indicates the variation in pull force and the elongation upon breaking for the ten yarns in the first batch.

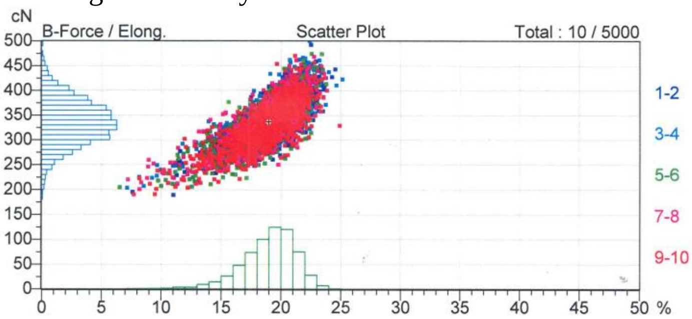

Fig. 4:*The stress-elongation diagram of the yarns în the first batch*

Table 1 shows the individual values for the pull forces în the ten yarn tests, and the elongation upon breaking relative to these forces. The statistical and mathematical processing of this data produces the tenacity, the arithmetic mean and the variation coefficient for the yarns în the first batch**.**

Table 1*: The statistical and mathematical processing of individual data for the yarns in the first batch*
Total 10/5000 Single test (4)

Nr.	**B-force cN**	**Elong %**	**Tenacity cN/Tex**	**B-Work cN cm**
1/500	336,0	19,16	13,44	2206
2/500	341,5	19,27	13,62	2245
3/500	348,6	19,03	13,94	2280
4/500	349,3	19,48	13,97	2318
5/500	326,7	18,87	13,07	2124
6/500	336,0	18,62	13,44	2166
7/500	333,8	18,88	13,35	2174
8/500	341,2	18,86	13,65	2223
9/500	326,5	18,67	13,06	2110
10/500	328,0	18,73	13,12	2130
Mean	336,6	18,96	13,47	2198
Cv	13,28	12,24	13,28	20,51
s	44,69	2,32	1,79	450,7
Q95	1,239	0,06	0,05	12,49
Min	189,3	6,53	7,57	451,0
Max	499,9	25,12	20,00	3659
Po.o1(0)				
P0.05(2)	190,5	7,21	7,62	531,3
P0.1 (5)	201,0	7,71	8,04	56,135
P0.5(25)	215,7	10,08	8,63	863,1

The second batch taken for analysis is the woollen yarn

Figure 5 shows the dispersion diagram for resistance to breaking for the yarn in the second batch, pointing out the irregularity in resistance to breaking for the ten tests done on the second batch.

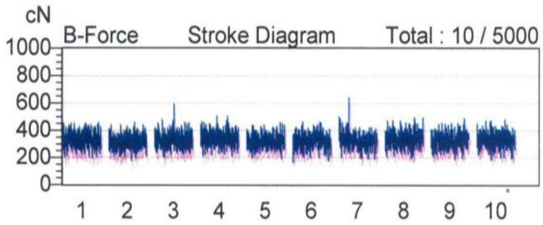

Fig. 5*: The dispersion diagram for resistance to breaking for the yarn in the second batch*

Figure 6 shows the dispersion diagram for elongation upon breaking for the yarn in the second batch, pointing out the irregularity in elongation upon breaking for the ten tests done on the second batch.

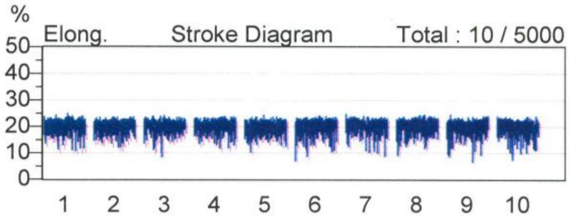

Fig. 6: *The dispersion diagram for elongation upon breaking for the yarns in the second batch*

Figure 7 shows the stress-elongation diagram which indicates the variation in pull force and the elongation upon breaking for the ten yarns in the second batch.

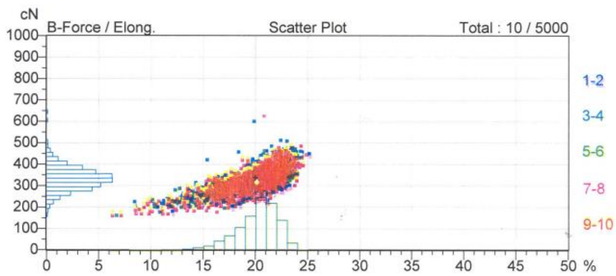

Fig. 7: *The stress-elongation diagram of the yarns în the second batch*

Table 2 shows the individual values for the pull forces în the ten yarn tests, and the elongation upon breaking relative to these forces. The statistical and mathematical processing of this data produces the tenacity, the arithmetic mean and the variation coefficient for the yarns în the second batch**.**

***Table 2**: The statistical and mathematical processing of individual data for the yarns in the second batch*
Total 10/5000 Single test (4)

Nr.	B-force cN	Elong %	Tenacity cN/Tex	B-Work cN cm
1/500	344,1	20,23	13,76	2308
2/500	324,8	20,10	12,99	2182
3/500	339,1	20,18	13,56	2281
4/500	351,2	20,23	14,05	2363
5/500	331,1	19,79	13,24	2198
6/500	329,1	2003	13,16	2204
7/500	333,3	20,10	13,33	2236
8/500	346,6	20,26	13,86	2336
9/500	334,7	19,68	13,39	2221
10/500	338,9	19,40	13,56	2217
Mean	337,3	20,00	13,49	2255
Cv	14,64	11,35	14,64	20,21
s	49,36	2,27	1,97	455,7
Q95	1369	0,06	0,05	12,63
Min	167,1	6,20	6,69	374,1
Max	647,1	25,08	25,88	4316
Po.o1(0)				
P0.05(2)	185,7	7,01	7,43	448,6
P0.1 (5)	187,8	8,42	7,51	624,1
P0.5(25)	209,8	10,90	8,39	872,5

By comparing the values found for the tensile properties we got, for the first batch, a mean pull force of 336,6cN and the mean mechanical work upon breaking of 2198 cN.cm, and for the second batch, a mean pull force of 337,3 cN and the mean mechanical work upon breaking of 2255 cN.cm. We can see that the second batch has slightly higher values for these tensile properties.

3. CONCLUSIONS

Based on the study of the tensile properties of the two batches of yarn with 45% wool and 55% PES, with a fineness of T_{tex}=25 and twist of 450 turns/m, it was concluded that the yarns in the second batch show improved properties due to the wool component of the mix. The conclusion is that the wool from Indonesia used in these yarns has superior tensile properties compared to the wool from China, used in the yarns from the first batch.

REFERENCES

[1] D. Bordeianu, V. Gribincea, ,"*Fibre textile- Proprietăţi generale* ", Editura Performantica Iaşi, 2002

[2] D. Bordeianu "*Fibre textile*", Editura Universităţii din Oradea, 2005

[3] D. Avram, M. Avram, L. Buhu *"Structura firelor*", Editura Gh. Asachi Iaşi, 2002

[4] C.Preda, C.Preda, „*Metode şi aparate pentru controlul calităţii materialelor textile destinate confecţionării produselor de îmbrăcăminte*" Editura BIT, Iaşi,1996

[5] D. Oana, I.P. Oana *"Structuri textile – Colecţie de aplicaţii practice*",Editura Universităţii din Oradea, 2005

[6] D. Oana, M. Şuteu, I. Oana, *Studiul neregularităţii alungirii firelor de lână în amestec cu mătase naturală cu ajutorul aparatului Uster® Tensojet 4,* Analele Universitaţii din Oradea, 2015-