ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

THE INFLUENCE OF THE NUMBER OF RIPPLE OF POLYACRYLONITRILIC FIBERS COTTON TYPE ON YARN PROPERTIES

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Abstract: *In this study we aimed the influence of the number of undulations of polyacrylonitrile fibers, cotton type, on the properties of yarns with Nm50/1 fineness, made on BD 200 the rotor spinning machine. Rotor spinning of the synthetic fibers is largely influenced by some characteristics of the fibers as being: the quality and quantity of the avivage, frequency of undulations and the number of defects fiber.*
Tensile properties and structural characteristics aspect of the yarns carried on BD 200 rotor spinning machine are determined, at the fiber content, the structural model and the technological parameters of processing, by the result of the transfer of fibers proprieties, into the meaning fiber-yarn. The yarns structural compactness, determined by the degree of twisting and tensional properties are defining for the quality of yarns and warrants the corresponding to their destination.
Structural characteristics of the yarns which are characterized by complexity and diversity of their actions were studied by determining the linear irregularity (U%) , standard deviatin (CV%) and the imperfections in the form of thinnin (S), thickening (G), neppines (N), relative to 1000 m yarn.

Key words: *fibers undulations fibers, linear irregularity, breaking length, rotor spinning machine, yarns resistance.*

1. INTRODUCTION

The rotor yarns are characterised by significant quality parameters, such as unevenness of linear density, the number of faults, and hairiness, which are better than those of ring yarns, and can be accepted as yarns of high quality [1]. The quality of the spun yarn can be significantly improved, while using equally raw material, by a suitable selection of the spinning system and the type of the spinning machine used [2].

Open-end (OE) rotor spun yarns have certain characteristics which differentiate them from conventional ring-spun yarns. This is because of differences which can be noted between their production method and structure [3]. In contrast to ring spinning, twisting during rotor spinning takes place from the inside onwards. Yarn elongation at break generally decreases as the rotor speed increases. This variation may be attributed to the increase in yarn tension at higher speeds and with bigger rotor diameters [4-7]. Rotor-spun yarns have therefore always been successful where they could be manufactured more cheaply than ring-spun yarns and proved suitable for the range of application in question [6-9].

Based on Uster Statistics it is apparent that the elongation at break of rotor-spun yarns is higher than that of comparable ring-spun yarns, albeit only marginally in some cases [10-13]. This is especially positively noticeable in the working capacity of rotor-spun yarn, in that the differences relative to ring-spun yarn are smaller than for countrelated yarn tenacity [12-14].

Rotor is the cheapest technique and produced yarn evenness is also better than ring yarn. It is also a fast process. But limitation of rotor yarn is less strength of the produced yarn. If it is possible to increase rotor yarn strength then the yarn will be the best one. So researchers should give emphasize on rotor spinning process.

2. EXPERIMENTAL PART

2.1. Materials and methods

The main features of polyacrylonitrile fibers, cotton type, studied by us are presented in Table 1.

Table 1: *The medium characteristics of fibers*

Characteristics		Options				
The number of undulations (ond./cm)		3.6	3.9	4.5	4.8	5.1
The length density	Tdtex	1.5	1.6	1.7	1.7	1.6
	CV_{Tt}	4.5	3.2	2.3	5.5	4.4
Breakout force	Pr (cN)	4.2	4.3	4.3	4.1	4.5
	CV_{Fr}	22.7	16.5	19.3	22.3	25.6
Elongation at break ε (%)		39.4	27.7	45.5	54.4	20.1
Tenacity	τ (cN/tex)	2.23	2.69	2.54	2.06	3.01
	CV	10.5	20.8	34.1	60.8	64.5
The degree of wrinkling (%)		12.0	11.0	16.2	15.1	11.5
Undulations stability(%)		93.4	94.5	91.4	54.0	54.8

All of the fibers were processed on BD 200 rotor spinning machine, achieving yarns with Nm 50/1 fineness, based on the same spinning plan and in preparation of spinning were used three mill passages. At the rotor spinning machine, for rotor, it was adopted a commonly speed, used in industrial practice, by 36 000 rev/min and for the carried cylinder, a speed of 6500 rev/min.

Linear density of yarns made by us was checked through the gravimetric method, according to SR EN ISO 2060. The tensional properties of the yarns were determined on electronic dynamometer Mezdan TensoLab 10 yielding the stress-strain diagrams, on which we have calculated the indices for assessing these proprieties.

-yarns tenacity ,determined by the formula:

$$\tau_F = \frac{P_r}{Tt} \quad \text{(cN/tex)} \tag{1}$$

where: P_r is the breaking load force (cN);

- length breaking, determined using the equation:

$$Lr = \frac{P_r \cdot Nm}{1000} \quad \text{(km)} \tag{2}$$

Structural characteristics and the appearance of yarns were determined using USTER electronocapacitive installation. Capacitive electronic control methodology together with the gravimetric control methodology form an evaluation system of the irregularity, so it has an indisputable technological utility. The complexity and diversity of expressions of the structural features and layout of the yarns were studied by determining the linear irregularity ($U_{\%}$), standard deviations ($CV_{\%}$) and imperfections in the form of Thin (S), Thick (G), Neps (N), relative to 1000 m yarn.

Control of regularity of linear density, on short parts of yarns and the control of frequent defects are performed according to standardized procedure for testing yarns [15]:

-capacitive transducer or the slot in the block called evenness tester of the electronocapacitive USTER is chosen depending on the values of yarns numbering, in this study carried out for Ttex 20 (Nm50/1) is the 7th slit of the capacitive measuring device;

-measuring domain 100%; Normal test mode; test speed of 25 m/min; analysis time 5 min/sample;

-yarn tested-length: 1000m (8 formats yarn x 1 sample/format);

-control indicator imperfections limits: -50% thinning (step 3); Thickening +50% (step 3); Neps +200% (step 3).

The recorded values will be compared with nomograms,from USTER statistics yet for assessing the quality of the Nm 50/1 yarn, by polyacrylonitrile cotton type fibers, made on the BD200 spinning rotor machine.

The properties of blended rotor spun yarn depend upon various factors such as fibre characteristics, machine variables and processing variables. Twist factor is one of the main processing variables in the rotor spinning system.

2.2. Results and discussions

For the Nm 50/1 yarns, made on BD200, rotor spinning machine, using all the cotton type polyacrylonitrile variants, we have determined the average values of the physical and mechanical properties and the structural and layout characteristics, shown the Table 2.

As seen in the graphic representation of Fig. 1, the length breaking of the yarns decreases with increasing of undulations frequency, except yarns spun from fibers which have an average number of undulations of 5.1 ond/cm, but the fibers tenacity is 26%, 10%, 15%, 33% higher than the tenacity of fibers from the other variants.

From the graph shown in Fig. 2, it is observed that the value of the coefficient of breaking strength variation increases with the increasing of frequency undulations. In textile manufacturing processes the most important factor that acts against the fibers is tensile fibers.

Under the action of traction forces, the undulations, specially at chemical fibers, support irreversible changes, which will reflect the default in appearance and properties of finished products. U_{ef} linear and CV_{ef} quadratic irregularity, presented in Fig. 3 and Fig. 4 register minimum values for the fineness of Nm 50/1 yarns, which are obtained from fibers with the lowest frequency of undulations.

If a fiber is required to a tensile strength less than a density decreases force, the undulations do not disappear, but they change all the features so that the changes can be appreciated simply through the degree of reduction of the frequency undulations.

Irregularity assessment of the linear irregularity or standard deviaton are done by specific indices of testing methods, of which the function is different from producer to consumer:

- the producer is more interested in measuring efficiency through the consistent pace and interpretations;
- it studies the compatibility consumer studies the compatibility between the yarns indices and indices used in the design and the impact of irregular shapes on the appearance of finished products.

Table 2: *Physico-mechanical properties and structural characteristics of the yarns Nm 50*

Characteristics			Options				
Undulations (ond./cm)			3.6	3.9	4.5	4.8	5.1
The density length		Ttex	20.6	20.1	20.4	19.9	20.0
		Nm	48.7	49.8	49.1	50.22	49.9
		CV_{Nm} (%)	4.5	3.2	2.3	5.5	4.4
Breakout force		Pr (cN)	224.4	211.2	200.9	171.4	222.2
		CV_{Pr} (%)	10.6	10.4	10.6	11.4	12.7
Elongation at break ε (%)			21.7	18.0	22.9	21.2	18.2
The breaking length Lr (km)			10.9	10.5	9.9	8.6	10.5
Torsion		T (ras/m)	942	952.9	938.7	990.6	953.6
		CV_T (%)	4.2	3.5	5.0	3.8	3.8
USTER values	Linear irregularity	U_{ef} (%)	14.5	14.9	16.3	15.1	15.8
	Quadratic irregularity	CV_{ef} (%)	16.7	16.9	17.9	17.2	17.4
	1000 m imperfections yarn	Thin, S	14	15	49	-	20
		Thick, G	58	14	90	-	65
		Neps, N	50	8	54	-	59

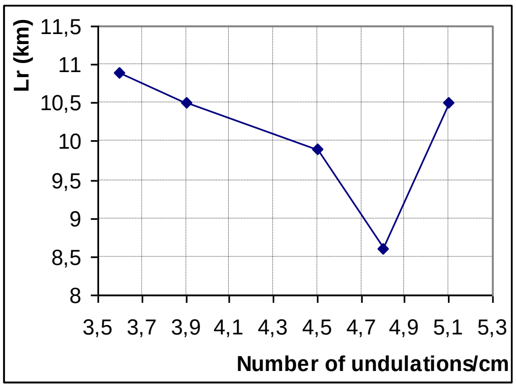

Fig. 1: *Frequency undulations influence on the length breakage of the Nm50/1 yarn*

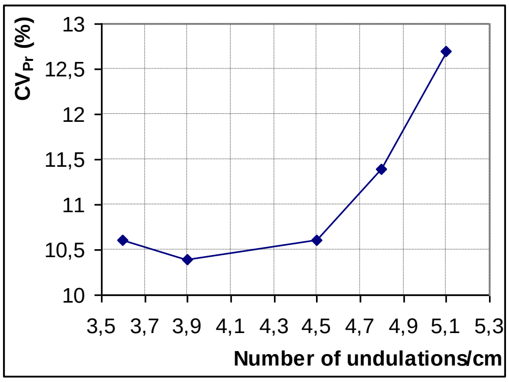

Fig. 2: *Frequency undulations influence on the coefficient of variation of the force breaking of the Nm50/1 yarn*

Yarn imperfections variation, obtained from Nm 50/1 fiber fineness, made by BD 200 rotor spinning machine, is shown in Fig. 5, 6 and 7, in which, it is found that in case of the variant where the number of undulations is 4.8 ond /cm, there were no thinning, thickening and neps on 1000 m yarn, tested on USTER electronocapacitive installation. As seen in Fig. 8 the coefficient of variation of the twist yarn is influenced by the frequency of undulations because it represents a measure of orientation of fibers in the simple yarn structure technologically.

The linear density irregularity on short piecewise is higher than that prescribed in regulations (CV=13%). By framing CV_{ef} values for these five variants studied, through USTER statistics, the obtained values fall on the global fabrication step of 75%, reflecting the realization of an inferior quality yarn, so the price-quality ratio is inappropriate.

Values obtained in the case of imperfections in the form of thinning and thickening are included on the global stage (50%), corresponding to an average level of quality and reflecting the appropriate processing phases that carry out the rolling operations, in the technological flow. Values obtained when the neps fits into the global stage (75%) corresponding to an inferior quality level caused by quality of raw materials or processing machine phases on the trenching/card from the technological flow.

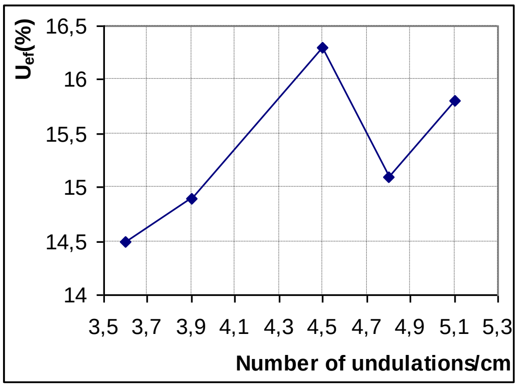

Fig. 3: *Influence of undulations frequency on linear irregularity of Nm50/1 yarn*

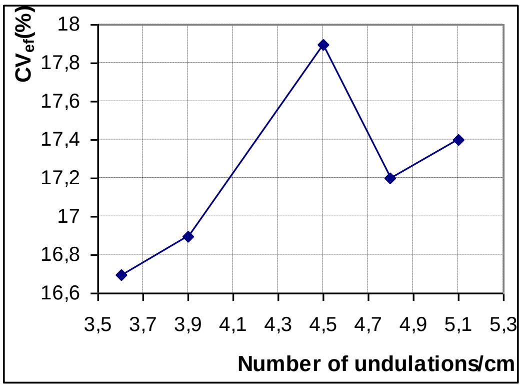

Fig. 4: *Influence of undulations frequency on quadratic irregularity of the Nm50/1 yarn*

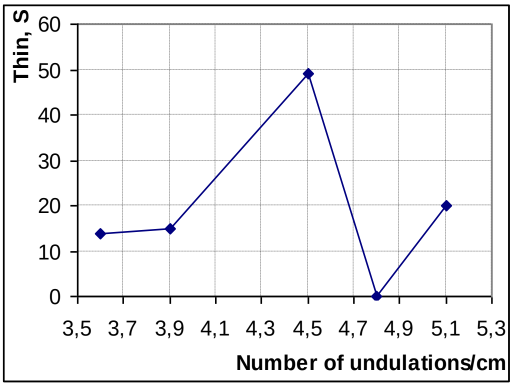

Fig.5: *Influence of undulations frequency on thinning of the Nm50/1 yarn*

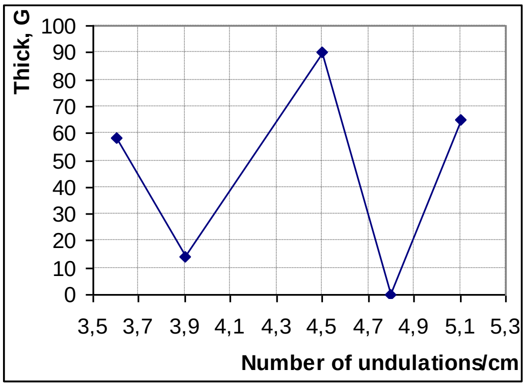

Fig. 6: *Influence of undulations frequency on thickening of the Nm50/1 yarn*

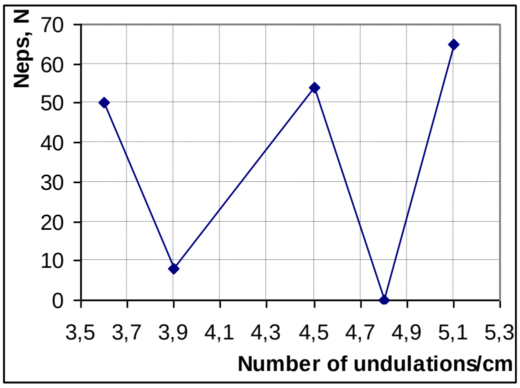

Fig. 7: *Influence of undulations frequency on neps of the Nm50/1 yarn*

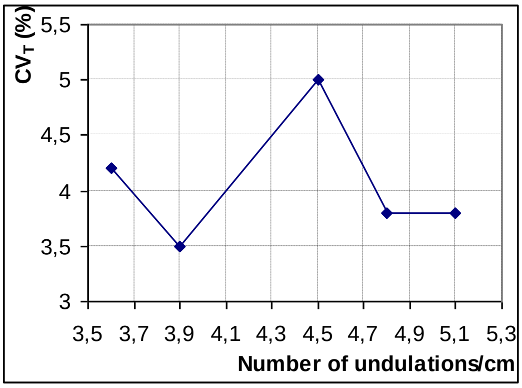

Fig. 8: *Influence of undulations frequency on the non-uniformity of twist for the Nm50/1 yarn*

2. CONCLUSIONS

Polyacrylonitrile fibers, cotton type, behave well in OE rotor spinning process.

The undulations frequency influences the tensile properties and structural and appearance characteristics of the yarns.

From these experiments it follows that the best results can be obtained when using fibers with low frequency undulations.

From the experimental obtained results can be estimated the optimal undulations frequency, to 3.6 ond /cm. From these fibers were made yarns, in three steps of twisting.

The increased twist coefficient has not ensured an increased resistance of the yarns, but influenced considerably the number of breaks.

REFERENCES

[1] G. Basal, W. Oxenham, "*Comparison of Properties and Structures and Compact and Conventional Spun Yarns*", Textile Research Journal, vol. 76, No. 7, pp. 567, 2006.

[2] M. Ben Hassen, M. Renner M., "*Experimental Study of High Drafting System in Cotton Spinning",* Textile Research Journal, vol. 73, No. 1, pp. 55, 2003.

[3] L. R. Manea,, R. Scarlet, A. L. Leon and I. Sandu, "*The Control of Process of Nanofibers Production Through Electrospinning",* Revista de Chimie, 52, nr. 5, pp. 640-644, 2015.

[4] E. Y. Mogahzy, "*Yarn Engineering*", Indian Journal of Fibre & Textile Research. vol. 31, pp. 150-159, 2006.

[5] H. J. Hyrenbach, "*The benefits of rotor yarn structure in terms of processing characteristics and application*", Melliand Textilberichte, No.4, pp. 42, 2002.

[6] K. Yong, I.Kim, "*Quantitative Grading of Spun Yarns for Appearance*" Journal of Textile Engineering. Vol. 52, No. 1, 2006

[7] L. Hristian, D.L. Bordeianu, P. Iurea, I. Sandu, K. Earar, *„Study of the Tensile Properties of Materials Destined to Manufacture Protective Clothing for Firemen",*Revista de Materiale Plastice, Vol. 51, no. 4, pp. 405-409, 2014.

[8] T. Jackowski, B. Chylewska, D. Cyniak, *„Cotton Yarns from Rotor Spinning Machines of 2nd and 3rd Generation*"", Fibres & Textiles, Vol. 8, No. 3, pp. 12-15, 2000.

[9] W. Polini, L. Sorrentino *Influence of winding speed and winding trajectory on tension in robotized filament winding of full section parts,* Composites Science and Technology, Vol. 65, Issue 10, pp. 1574-1581, 2005.

[10] D.L. Bordeianu, *"Tehnologii si utilaje in filaturi"* vol. 1, Ed. Ancarom, Iasi, 1997.

[11] L. R. Manea, E. Nechita , M. C. Danu and M. Agop "*On the Complex Systems Deformation Thermodynamics at Nanoscale"*, J. Comput. Theor. Nanosci. 12, pp. 4693-4699, 2015.

[12] M.S. Neculăiasa, L. Hristian *Metrologie Textilă* Vol. I, pg. 326, Ed. Performantica, Iaşi, 2004, ISBN 973-7994-36-1

[13] K. Earar, M.N. Matei, A.V. Sandu, L. Hristian, C. Bejinariu, I.G. Sandu, "*The Role of Functional Polymers in the Optimisation of Acrylic Biomaterials used in Amovable Prosthetic Restoration I. The experimental protocol using the Iosipescu test"* Revista de Materiale Plastice, Nr. 1, 52, 2015, pp. 98-103

[14] D.L. Bordeianu, L. Hristian "*Aspects concerning the cleaning of simple and twist cotton-type yarns"* Buletinul Institutului Politehnic Iaşi, Tomul LIX (LXIII), Fasc 1-2, Secţiunea Textile Pielărie, pp. 9-16, 2013.

[15] http://www.uster.com/de/service/uster-statistics/