TOWARDS IMPROVING MEASUREMENT METHOD FOR MECHANICAL PROPERTIES OF TEXTURED FILAMENT/ELASTANE HYBRID YARNS

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ABSTRACT: *The mechanical properties of hybrid yarns containing elastomeric component are rather difficult to measure. A standard approach to measuring tenacity and elongation cannot be applied to this type of yarn. The main reason is the high elasticity of both elastane and textured filaments. An attempt was made in this study to solve the problem by measuring the mechanical properties of textured filament/elastane hybrid yarns under pretension force which is higher than standard ones. Several pretension forces were applied: 1.5 cN, 4.5 cN, 7.5 cN, 10.5 cN and 13.5 cN. Textured polyamide 6.6 was used as a spirally covering filament, while the core yarn was LYCRA® elastomeric yarn with various linear densities. The results indicated that with an increase in the pretension force, the elongation of the polyamide/ LYCRA® hybrid yarns decreased whereas, the pretension forces had little effect on the tenacity values for investigated samples. These preliminary results are promising, however, the method must be further developed to be ultimately applicable to all complex yarns containing elastomer filament.*

Keywords: *tenacity, elongation, textured filament, polyamide, Lycra, hybrid yarn.*

POBOLJŠANJE METODE MERENJA MEHANIČKIH SVOJSTAVA TEKSTURIRANI FILAMENT/ELASTAN HIBRIDNIH PREĐA

APSTRAKT: *Merenje mehaničkih svojstava hibridnih pređa koje sadrže elastansku komponentu vrlo je komplikovano. Standardni pristup merenju prekidne jačine i istegljivosti ne može se primeniti na ovaj tip pređa. Glavni razlog je velika elastičnost kako elastanskih, tako i teksturiranih filamenata. U okviru ovog istraživanja, rešavanju navedenog problema se pristupilo merenjem mehaničkih svojstava teksturirani filament/elastan hibridnih pređa uz prednaprezanje veće od standardnih vrednosti. U ovom radu je primenjeno nekoliko različitih sila predzatezanja: 1,5 cN, 4,5 cN, 7,5 cN, 10,5 cN, i 13,5 cN. Kao spiralno omotavajući filament korišćen je tekstirirani poliamid 6.6, a za jezgro hibridne pređe upotrebljene su Lycra® elastomerne pređe različitih finoća. Rezultati su pokazali da se sa povećanjem sile predzatezanja, izduženje poliamid/Lycra®*

hibridnih pređa smanjuje, uz slabo izražen uticaj sile predzatezanja na vrednosti prekidne jačine ispitivanih hibridnih pređa. Ovakvi rezultati su obećavajući, međutim, metoda se mora dalje razvijati da bi bila generalno primenjiva na sve složene pređe koje sadrže elastanski filament.

Ključne reči: *prekidna sila, izduženje, teksturirani filament, poliamid, Lycra, hibridna pređa.*

1. INTRODUCTION

Spirally covered yarns are hybrid yarns where one or more yarns (cover) are winded around another yarn (core). The main reasons for producing this type of yarn are protection and improvement of the mechanical properties of the core, control of core elasticity and improving structural and comfort properties of the core [1]. In this research, hybrid yarns comprise a core of bare and twistless elastic yarn spirally single-covered by polyamide 6.6 [2]. The linear density ratio of elastomer and polyamide yarn can be adjusted by changing the fineness of the elastomer or polyamide yarn or changing the draft ratio of the elastomer during the covering process. In this study, the elastomer draft ratio was the same for all the samples, and the same polyamide filament was always used, to exclude the effect of that yarn properties [3], [4].
There is no data in the literature about the measurement method for the mechanical properties of the covered yarn. This is mainly because standard pretension forces for elastomer or polyamide yarn measurements result in poorly distributed results, so it is impossible to connect between production properties and yarn type [5].

2. MATERIALS AND METHODS

In this research, testing was done in three phases. Firstly, the polyamide filament's linear density and mechanical properties were measured before making covered yarn. Breaking force and elongation of polyamide 6.6 textured yarn were measured at 6 different pretension forces (PF): 1.5 cN, 4.5 cN, 7.5 cN, 10.5 cN, 13.5 cN and 16.5 cN. The second step was the preparation of covered hybrid yarn samples. In the third phase, linear density, elongation, and breaking force of covered hybrid yarn were measured.
Five types of spirally covered polyamide/elastomer hybrid yarns were produced for this research. Textured polyamide 6.6 yarn with a linear density of 22 dtex containing 7 monofilaments produced by Fulgar SpA, Italy, covered bare elastomeric yarns with 1550 turns per meter. Core was LYCRA® elastomeric yarn with linear density: 17 dtex, 22 dtex, 33 dtex, 44 dtex and 78 dtex. Produced hybrid yarns are given in Table 1, where PA/EL shows the ratio of real linear density of polyamide 6.6 and linear density of stretched elastomer. From each type of hybrid yarn, eight bobbins were produced at the same positions on the covering machine RPR type GSP22, four were twisted in the S direction, while for the other four, Z torsion was applied. Temperature and humidity were controlled during the production process in the 25 – 30°C temperature range and relative humidity

range of 55 - 60%. All samples were conditioned for 7 days in the same conditions as they had been produced.

Table 1: Polyamide/Lycra® hybrid yarns used in the study

Sample	Elastomer core			PA/EL
	Type	Linear density [dtex]	Filament count	
17 LYCRA 22/7 T 1550 SC	LYCRA® 16AL	17	1	4.4
22 LYCRA 22/7 T 1550 SC	LYCRA® 16AL	22	1	3.4
33 LYCRA 22/7 T 1550 SC	LYCRA® 926L	33	2	2.3
44 LYCRA 22/7 T 1550 SC	LYCRA® 162C	44	4	1.7
78 LYCRA 22/7 T 1550 SC	LYCRA® 162C	78	5	1.0

The linear density of the samples was measured by Mesdan lab electronic wrap reel for yarns, according to the UNI EN ISO 2060 test method. The same method was used for measuring the linear density of polyamide 6.6 yarn, used in this research. The measurement was conducted on the polyamide filament from two bobbins, which were used for producing all 40 sample bobbins [6].

Breaking force and elongation were measured using the Tomsic Tenso Tester, at 300 m/min speed. The sample's initial length was 0,200 m. A testing procedure was performed for each bobbin at one pretension force twenty times. Measurements were done at the following pretension forces: 1.5 cN, 4.5 cN, 7.5 cN, 10.5 cN and 13.5 cN. Some of the pretensions were impossible to apply for all yarn samples. Table 2 gives maximal pretensions on the sample yarns and their average factual (measured) linear density.

Yarn tenacity is calculated according to the following formula:

$$T = \frac{F_b}{T_{dr}} \cdot 0.1 \qquad (1)$$

Where T is tenacity in cN/tex, F_b is breaking force in cN, and T_d is measured average linear density of the yarn sample in dtex.

Table 1: Factual linear density and maximal possible pretension forces for tested samples

Yarn	Average factual linear density [dtex]	Max. used PF [cN]
17 LYCRA 22/7 T 1550 SC	21.60	13.5
22 LYCRA 22/7 T 1550 SC	28.41	13.5
33 LYCRA 22/7 T 1550 SC	30.04	13.5
44 LYCRA 22/7 T 1550 SC	33.10	10.5
78 LYCRA 22/7 T 1550 SC	39.55	7.5

3. RESULTS AND DISCUSSION

The average tenacity of the yarns with different pretension forces is given in Figure 1. According to the results, it can be concluded that an increase in pretension forces does not cause a significant difference in the tenacity of the hybrid yarns.

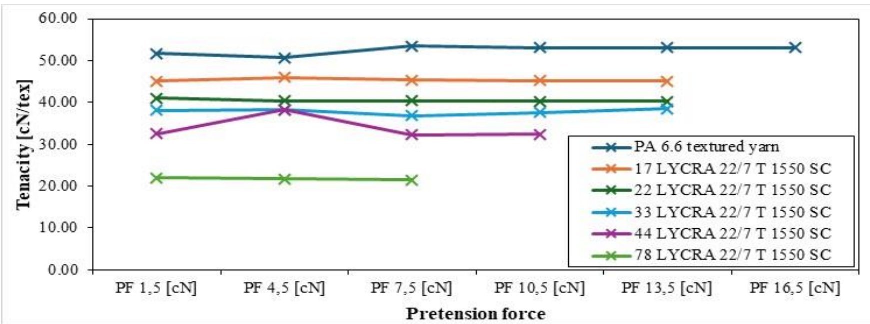

Figure 1: Yarn tenacity under different pretension forces

With an increase in pretension force, yarn elongation decreases, according to Figure 2. This effect can be related to the behavior of the spirally covered hybrid yarns under increased tension forces. With an increase in the pretension force of the elastomer yarn, the distribution of turns of polyamide filament changes on the same length of the sample. As a result, the number of turns per meter of the hybrid yarn decreases. In addition, the diameter of the elastomer core decreases with an increase in pretension force, and the diameter of the polyamide spiral is inversely proportional to the tension force. For an ideal model of the hybrid yarn, elastomer and polyamide filament are parallel under maximal possible pretension. According to this elaboration, it can be concluded that the elongation of because the total elongation of the system (hybrid yarn) appears to be much more dependent on the elongation of polyamide filament. It seems that the effect of the elastomeric core on the yarn elongation is of much less significance despite the elastomer's intrinsically extremely high extensibility. the spirally covered elastomer/polyamide hybrid yarn is lower under higher pretension forces

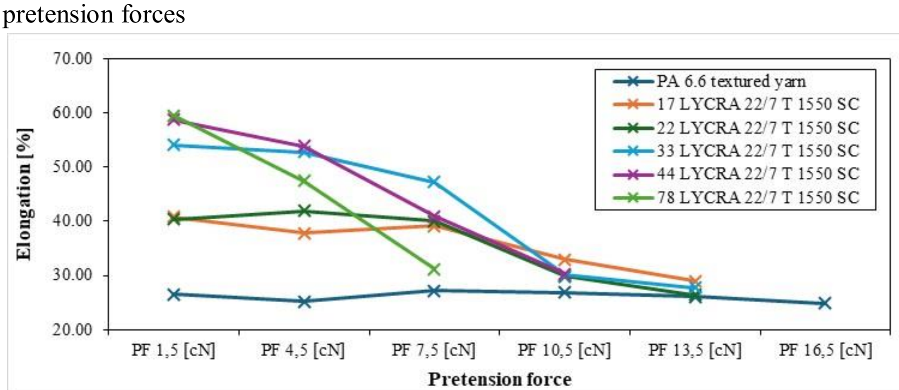

Figure 2: Yarn elongation under different pretension forces

Figures 3 – 7 show the normal distribution of the tenacity and elongation of spirally covered elastomer/polyamide hybrid yarns. As mentioned earlier, the tenacity at different pretension forces is similar for all samples. In addition, the normal distribution of tenacity is quite similar for all pretension forces for all samples. In contrast, the normal distribution for elongation results had different density values for different pretension forces. The density of the normal distribution of elongation results grows as the pretension force grows. The highest pretension forces have the highest density of normal distribution of the elongation results. These results justify the idea of this research to increase the pretension force while measuring the mechanical properties of spirally covered elastomer/polyamide hybrid yarns.

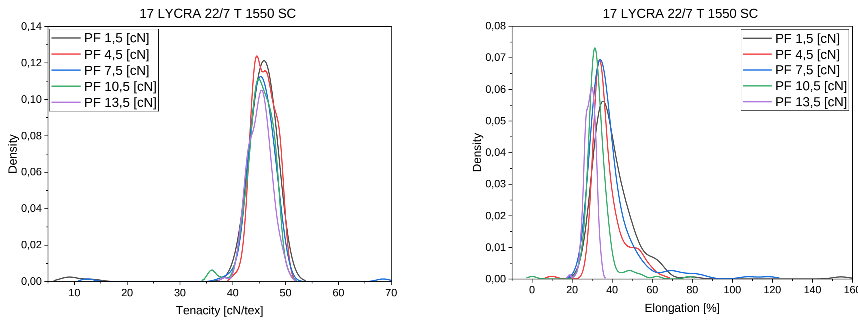

Figure 3: Normal distribution of tenacity and elongation under different pretension forces for sample17 LYCRA 22/7 1550 SC

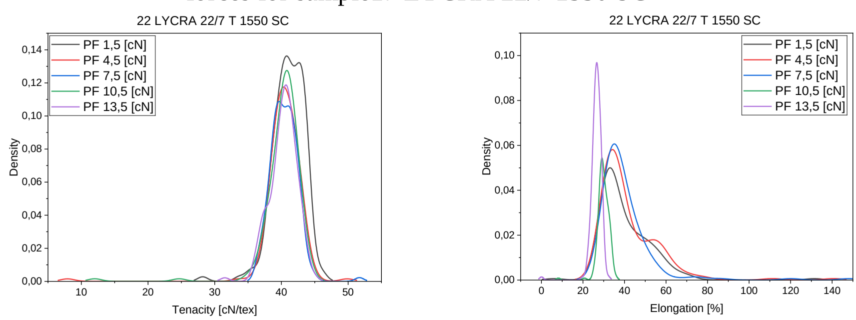

Figure 4: Normal distribution of tenacity and elongation under different pretension forces for sample 22 LYCRA 22/7 1550 SC

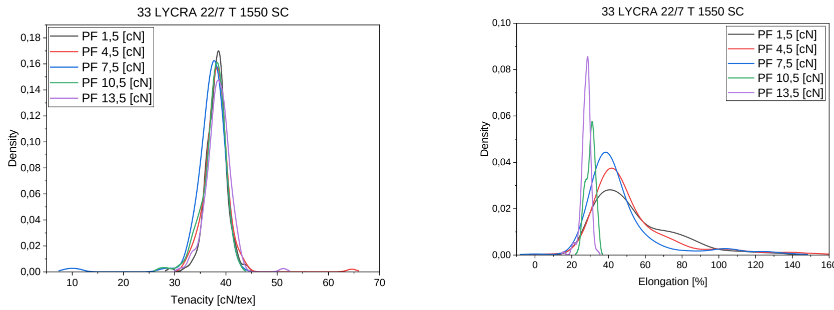

Figure 5: Normal distribution of tenacity and elongation under different pretension forces for sample 33 LYCRA 22/7 1550 SC

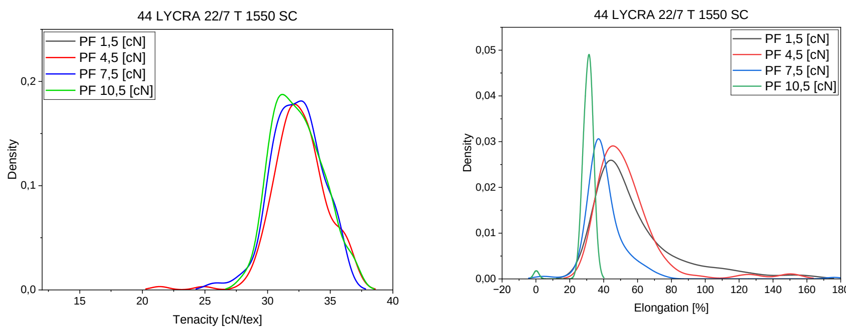

Figure 6: Normal distribution of tenacity and elongation under different pretension forces for sample 44 LYCRA 22/7 1550 SC

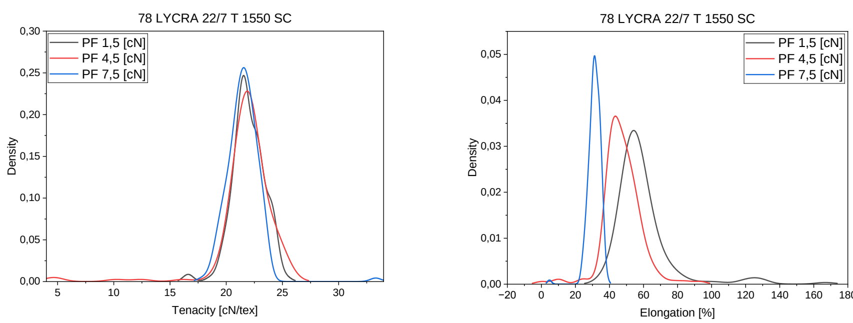

Figure 7: Normal distribution of tenacity and elongation under different pretension forces for sample 78 LYCRA 22/7 1550 SC

3. CONCLUSION

The present research investigated the effect of pretension forces while measuring the mechanical properties of spirally covered Lycra/polyamide hybrid yarns. The results show that:

- Pretension force influences the elongation values of spirally covered elastomeric/polyamide hybrid yarns.
- Pretension forces have little effect on the tenacity of investigated samples.
- Higher pretension forces have a higher density of normal distribution of elongation of measured samples.
- To get a clearer correlation between the pretension force and linear density of the polyamide/elastomer hybrid yarn, the proposed measurement method must be further developed.

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