EFFECTS OF SOME PARAMETERS OF DREF-2 FRICTION SPINNING MACHINE ON THE PROPERTIES OF WOOL/JUTE CORE-SPUN RUG YARNS

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REZUMAT. In această lucrare a fost studiat efectul vitezei tamburelor de fricţiune şi al vitezei cilindrilor de alimentare asupra proprietăţilor firelor filate prin fricţiune DREF-2 cu miez din fir de iută şi înveliş de lână. Pe baza rezultatelor se poate trage concluzia că pe măsură ce viteza cilindrilor alimentatori creşte, densitatea de lungime, diametrul, forţa de rupere şi alungirea la rupere a firelor DREF scad. Creşterea vitezei tamburelor de fricţiune conduce la scăderea diametrului firelor DREF şi nu are un efect bine definit asupra densităţii de lungime şi a alungirii la rupere. Presupusa creştere a forţei de rupere a firelor DREF odată cu creştere vitezei tamburelor de fricţiune nu a fost întotdeauna confirmată.

Cuvinte cheie: filare prin fricţiune, fir cu miez, miez din fir de iută, înveliş din lână, fir pentru covoare.

ABSTRACT. In this research work, the effect of drum speed and inlet roller speed on the properties of wool covered/jute yarn core DREF-2 friction yarns has been studied. From the results it can be concluded that as inlet roller speed increases the linear density, diameter, breaking strength and elongation at break of DREF yarns decrease. The increase of friction drum speed leads to a decrease in DREF yarn diameter and it does not have a definite effect on linear density and breaking elongation. The expected increase in DREF yarn breaking strength with the increase in friction drum speed has not always been confirmed.

Keywords: friction spinning, core-spun yarn, jute yarn core, wool sheath, rug yarn.

1. INTRODUCTION

Over the centuries, from their initial purpose as tent floor coverings to protect the nomadic people from cold and damp, rugs have become more and more fashion products with rapid changing styles, textures, colors and designs. Nowadays, different methods of construction, as knotting, weaving, tufting, needling, braiding, fusion bonding, electrostatic flocking, can be used to produce a large variety of rugs and carpets intended either for residential or for commercial use. No matter the activity conducted in the carpeted area, the carpets and rugs are excellent thermal insulators which significantly reduce the heat loss through the floor and thus reduce the energy cost. Floor coverings provide acoustic insulation reducing the disruptive impact noise of footsteps or an object falling on the floor. In addition to their ability to lower the generated sounds, carpets and rugs reduce the duration of reflected sounds and absorb some of the outside airborne noise [2].

The impact of rugs and carpets upon the human health is considered beneficial because they can entrap the fine allergen particles until vacuumed away, thus contributing to improved indoor air quality. Rugs and carpets offer walking comfort and walking safety, reducing the risk of slips and falls, especially in the case of children and older people, and minimizing injuries when falls do happen [2].

The most common fibers used in the carpet and rug surface are wool, polyamide, polyester, and polypropylene and the common fibers used in backing structure are jute, cotton, polyester, and polypropylene. The fibers used in rug surface can be converted into yarns using woolen, semi-worsted, worsted, friction, wrap spinning and core spinning technologies. When compared to the other methods used for rug yarn spinning, friction spinning is recognized as an economical and versatile alternative [2, 5]. The advantages of friction spinning are as follows [3]:

- high production rates;
- low yarn manufacturing costs;
- elimination of rewinding;
- low end breakage rates due to less tension during yarn formation;

- good uniformity;
- soft handle and bulky appearance of yarn.

However, the friction spun yarns are weaker in comparison to similar yarns produced by other spinning systems and have a high tendency to snarl. Because of yarn low strength, the number of fibers in the yarn cross-section must be higher than in other spinning systems and this makes this technology suitable for spinning yarns in the coarse count range [1].

Due to its spinning principle, DREF-2 friction spinning machine allows the production of core-sheath composite yarns. Such yarns consist of a filament or spun yarn core and a staple fiber sheath. The sheath provides the staple fiber spun yarn appearance and surface physical properties.

In this research work, the effect of drum speed and inlet roller speed on the properties of wool covered/jute yarn core DREF-2 friction yarns has been studied. Linear density, diameter, breaking strength and breaking elongation have been evaluated.

2. MATERIALS AND METHODS

In DREF-2 friction spinning, the slivers are drafted by a specially designed inlet system, and then opened into individual fibers by a rotating carding drum. In order to reassemble the individualized fibers into a new strand (yarn), the fibers are stripped from the carding drum by air stream from the blower and transported into the nip of two perforated drums with an internal vacuum. The twisting of fiber assembly is due to the rotary movement of the two drums and is generated by the frictional contact between the drums and the fiber assembly. The yarn formed in the convergent region of the two drums is continuously withdrawn and wound onto a cross-wound package by a take up roller [3, 4].

In this study, DREF-2 friction spinning machine has been used to produce core-sheath composite yarns aimed for weft in rug applications. The core consisting in a single jute yarn was fed axially along the DREF yarn direction while the sheath fibers resulted from drafting and opening of a wool sliver were fed vertically. Due to the rotating action of the drums, the wool fibers were wrapped around the jute yarn core to form a sheath. The 15 ktex wool sliver fed to the DREF-2 friction spinning machine has been obtained by subjecting wool fibers to blending, opening and carding.

The drum speed and inlet roller speed have been modified in order to assess their effect on the properties of wool covered/jute yarn core DREF-2 friction yarns. Five values of the inlet roller speed have been used in the experiments: 150, 250, 350, 450, and 600 rpm. At each inlet roller speed, the drum speed has been varied to 2800, 3200, and 3600 rpm. Totally, 15 variants of DREF-2 core-spun yarns have been obtained.

The physical and mechanical properties of the single jute yarn used as core are presented in Table 1.

Table 1. **Jute yarn properties**

Characteristics	Value
Linear density (ktex)	0.76
CV of linear density (%)	8.3
Diameter (mm)	1.03
Twist (tpm)	100
Tenacity (cN/tex)	16.27
CV of breaking strength (%)	13.64
Breaking elongation (%)	1.68

The main characteristics of the wool fibers used as sheath are presented in Table 2.

Table 2. **Wool fibre characteristics**

Characteristics	Value
Diameter (μm)	28.2
CV of diameter (%)	26.5
Average length (mm)	40.7
CV of fibre length	32.9
Tenacity (cN/tex)	14.1
CV of breaking strength (%)	15.23

For all variants of DREF-2 core-spun yarns, yarn linear density, diameter, and tensile characteristics have been evaluated.

Because the counts of DREF-2 core-spun yarns were in the coarse range, yarn linear density has been determined by weighing a length of 1m of yarn and yarn diameter has been measured using a ruler and a magnifying glass.

Tinius Olsen H5 KT tensile tester has been used to evaluate the tensile properties. The distance between clamps has been chosen at 250 mm and the speed of superior clamp at 12 mm/min.

3. DISCUSSIONS AND RESULTS

The rotation movement of the friction drums twists the fiber assembly and strengthens it. Therefore, the friction drum speed directly influences the yarn twist. When the speed of friction drums increases the twist is expected to be greater.

The inlet roller speed influences the draft of the inlet system.

Figure 1 presents the linear density of DREF-2 wool/jute core-spun yarns. Regardless the friction drum speed, as inlet roller speed increases, the linear density of DREF-2 core-spun yarns decreases because the number of fibers in the cross-section of the sheath is reduced. The reduction of sheath linear density modifies the sheath/core ratio from 87/13 at an inlet roller speed of 150 rpm to 58/42 at an inlet roller speed of 600 rpm. It seems that there is not a specific trend of yarn linear density variation with the increase in friction drum speed.

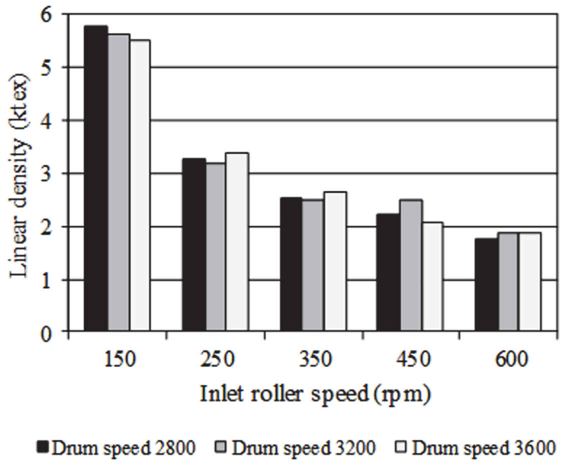

Fig. 1. The linear density of DREF-2 wool/jute core-spun yarns

As inlet roller speed increases, the DREF-2 wool/jute core-spun yarns become finer and the diameter of yarns decreases (Figure 2). Also, the increase of friction drum speed leads to a decrease of DREF-2 core-spun yarn diameter because the increasing radial forces generated by the increasing twist exert a higher compressibility effect on fiber assembly.

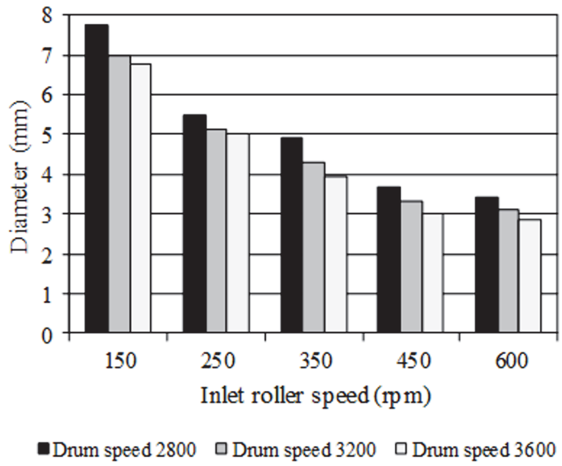

Fig. 2. The diameter of DREF-2 wool/jute core-spun yarns

The stress-strain curve of DREF-2 wool/jute core-spun yarns (Figure 3) shows a sharp fall in the load corresponding to the breakage of jute core yarn. This is followed by stepwise rise and fall of load due to the breaks of wool fibers and the stick-slip frictional effects.

The results of tensile tests showed that for all variants the breaking strength of DREF-2 wool/jute core-spun yarns was lower than the breaking strength of jute yarn used as core. This can be explained by the fact that during yarn formation the core is false twisted so that the core yarn loses twist and can remain trapped in this state in the DREF yarn. In this case the core contributes to the DREF yarn strength only with the adhesion forces between fibers. Moreover, the contribution of sheath wool fibers to the DREF yarn strength is low because the sheath fibers are characterized by low orientation and loose packing in the cross-section. Figure 4 presents the breaking strength of DREF-2 wool/jute core-spun yarns. The expected increase in DREF yarn breaking strength with the increase in friction drum speed has not always been confirmed. In friction spinning, because of the slippage between the yarn and the drum surfaces, the twist efficiency can be as low as 40 %.

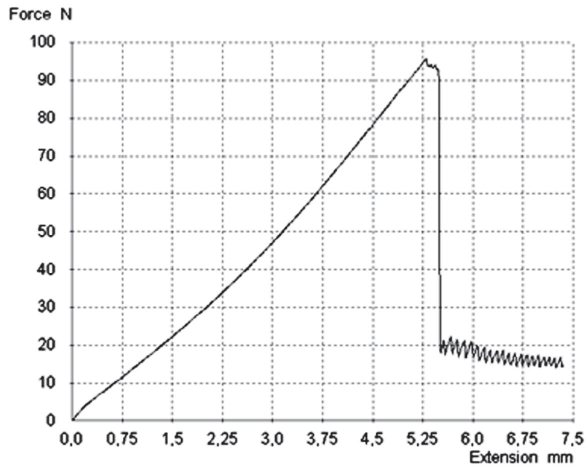

Fig. 3. The stress-strain curve of DREF-2 wool/jute c ore-spun yarns.

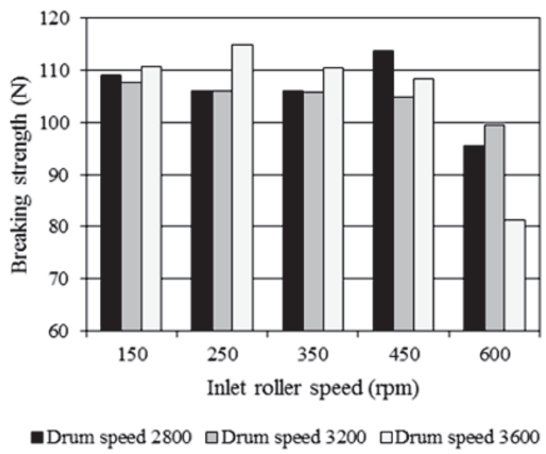

Fig. 4. The breaking strength of DREF-2 wool/jute core-spun yarns.

The elongation at break of DREF-2 wool/jute core-spun yarns is higher than the elongation at break of jute core yarn and has a tendency to decrease with the increase in inlet roller speed as a result of the reduction of wool fiber number in the yarn sheath (Figure 5). As can be seen in figure below, the experimental yarns do not present the same evolution of elongation at break with the increase of friction drum speed.

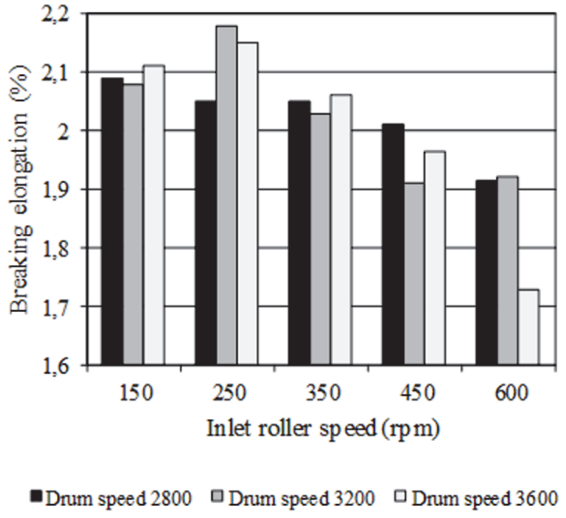

Fig. 5. The breaking elongation of DREF-2 wool/jute core-spun yarns.

4. CONCLUSIONS

Due to its spinning principle and low spinning tension, DREF II friction spinning machine allows the production of core-sheath composite yarns at high speeds up to 250 metres per minute.

In this research work, the effect of drum speed and inlet roller speed on the properties of wool covered/jute yarn core DREF-2 friction yarns has been studied. From the results it can be concluded that as inlet roller speed increases the linear density, diameter, breaking strength and elongation at break of DREF yarns decrease. The increase of friction drum speed leads to a decrease in DREF yarn diameter and it does not have a definite effect on linear density and breaking elongation. Because of the slippage between the yarn and the drum surfaces, the expected increase in DREF yarn breaking strength with the increase in friction drum speed have not been confirmed in all variants of inlet roller speed.

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