STUDY ON THE PROPERTIES OF FRICTION CORE-SPUN YARNS FOR RUG APPLICATIONS

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REZUMAT. Această lucrare prezintă rezultatele cercetării privind influenţa vitezei tamburelor de fricţiune şi a vitezei cilindrilor de alimentare asupra proprietăţilor firelor filate prin fricţiune cu miez din fir acrilic răsucit şi înveliş de lână. Creşterea vitezei cilindrilor alimentatori are ca rezultat scăderea densităţii de lungime, a diametrului, a forţei de rupere şi a alungirii la rupere a firelor filate prin fricţiune. Creşterea vitezei tamburelor de fricţiune conduce la scăderea diametrului, la creşterea alungirii şi nu influenţează semnificativ densitatea de lungime a firelor DREF. În majoritatea cazurilor, forţa de rupere a firelor cu miez creşte odată cu creşterea vitezei tamburelor de fricţiune.

Cuvinte cheie: covor, filare prin fricţiune, fir cu miez, miez din fir acrilic răsucit, înveliş din lână.

ABSTRACT. This paper presents the results of research concerning the influence of drum speed and inlet roller speed on the properties of wool covered/acrylic folded yarn core friction-spun yarns. The increase in inlet roller speed results in a decrease in linear density, diameter, breaking strength and breaking elongation of friction core-spun yarns. The increase of friction drum speed leads to a decrease in DREF yarn diameter, an increase in breaking elongation and do not significantly influences the yarn linear density. In most cases, the breaking strength of core-spun yarns increases with an increase in friction drum speed.

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

1. INTRODUCTION

A rug is a textile floor covering that is used to cover a part of the floor in order to impart warmth, comfort and an attractive appearance to interiors. Rugs are smaller than carpets and they can be easily taken from one place to another because they are laid out on the floor and not fixed to the floor. Characterized by a large diversity of styles, textures and construction types, rugs and carpets bring many benefits to the space in which they are installed, such as [1, 3]:

- Improved aesthetics;
- Thermal insulation;
- Acoustic insulation;
- Walking comfort and safety;
- Control of indoor air pollution.

Rugs and carpets are essential home decor items that through their combinations of colour, pattern, texture and style have a symbolic language which can express people personality and lifestyle and can give a room its identity. Their beauty can create agreeable feelings that have a positive influence on people daily life.

Rugs and carpets are excellent thermal insulators due to the low heat conduction values of fibers and to the air trapped between the fibers at the surface pile of the carpet. Carpets provide a reduction in heat loss through the floor that can lead to a reduction of the energy costs in heating.

Floor coverings act as sound absorber and attenuate any impact noise (foot falls, dropped objects) diminishing the negative impact on human health of exposure to unwanted noise, such as loss of concentration, sleep deprivation, stress, headaches and even hearing loss.

The walking comfort of the textile floor coverings is given by their resiliency i.e. the ability to spring back after the compression of the foot so that they aid in lifting the foot in order to take the next step. When the flooring surface is hard (tiles, wood, etc), the resilience is low and may lead to the fatigue of occupants and to an increase in the incidence of lower back/leg pains. Safety is another important ergonomic characteristic of carpets and rugs due to the reduced risk of slips and falls, especially in the case of children and older people. In comparison with hard flooring, carpets provide a better support for the feet and a higher ability to soften the effect of an impact and to reduce injuries.

Textile floor coverings act as absorber of the indoor air pollutants that can easily be removed by vacuuming. The indoor air pollutants (nitrogen dioxide, sulphur dioxide, formaldehyde, allergens pollens, moulds) can affect the health of building occupants causing them irritation of the eyes, nose and throat, respiratory illness, headaches, dizziness and fatigue.

The quality of rugs and carpets is influenced in a great measure by the properties of the fibres from which they are made. In order to manufacture an ideal carpet, the fibres should have the following physical and chemical properties [5]:

- Dyeability;
- Whiteness;
- Adequate tensile strength;
- Good, long-term wear performance;
- Good resilience and resistance to compression;
- Easy care properties: soil resistance, stain resistance and easy cleaning;
- Resistance to the action of dry cleaning solvents;
- Flame resistance;
- Rapid drying when wetted;
- Good thermal insulation;
- Insect proof;
- Relatively high moisture regain to prevent static charge accumulation;
- Resistance to the action of light;
- Low relative density.

Wool is considered the traditional carpet fibre being for a long period of time the most important carpet fibre until the advent of artificial and synthetic fibres. Besides wool, in modern carpet manufacture there are used chemical fibres, such as nylon, acrylic, polypropylene and polyester. These fibres present the above characteristics to different extents.

The fibres can be converted into carpet yarns using woollen, semi-worsted, friction, wrap spinning, core spinning technologies, and even the worsted technology for finer construction of the carpet [2, 4].

In this research work, core yarns having an acrylic folded yarn as core and wool fibres as sheath have been spun on a DREF 2 friction spinning machine at different levels of drum speed and inlet roller speed. Properties of friction core-spun yarns, such as linear density, diameter, breaking strength and breaking elongation have been evaluated.

2. MATERIALS AND METHODS

The wool fibres used as sheath in the core-spun yarns were received in scoured and dyed state and were first processed on a blending and opening line that consisted in a weighing hopper, a conveyor belt, an opener, a condenser and a bale press (Figure 1). Wool fibres were spread in alternate layer on the floor. Each layer of fibres has been sprayed with lubricant in order to minimize fibre breakage and to reduce fly during carding. Vertical slices have been taken from the wool pile and fed to the weighing hopper. The weighing hopper delivered constant mass of fibres to a transverse conveyor belt at regular time intervals.

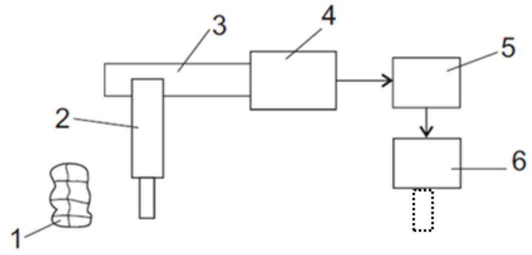

Fig. 1. Blending and opening line of wool fibres
1-“sandwich” layers of wool fibres; 2-weighing hopper; 3-conveyor belt; 4-opener; 5-condenser; 6-bale press.

From the conveyor the material passed to the feeding cylinders of the opener. Due to the action of the opening drum teeth and the large difference between the peripheral speed of the opening drum and that of the feeder cylinders the wool fibres were opened. The perforated drum of the condenser separated the transport air from fibres that have been pressed in bales.

After blending and opening, the wool from bales was fed into the carding machine, where the interaction of a series of rollers covered with fine teeth opened and totally separated the fibres. The sliver has been coiled in cans for storage and transport.

Two carded slivers, each of 12 ktex linear density, have been fed to a spinning head of a DREF-2 friction spinning machine. After drafting and opening into individual fibres, the wool sheath fibres were deposited on the false twisted acrylic folded yarn core and were wrapped helically over the core. The core-wrapped yarn was withdrawn and wound onto a cross-wound package.

The friction drum speed that influences the yarn twist has been varied at three levels: 2800, 3200, and 3600 rpm, while the inlet roller speed have been modified at five levels: 150, 250, 350, 450, and 600 rpm. The inlet roller speed influences the draft of the inlet system.

Totally, the properties (linear density, diameter, breaking strength and elongation) of 15 variants of DREF-2 core-spun yarns have been assessed.

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

Table 1. **Acrylic folded yarn properties**

Characteristics	Value
Linear density (ktex)	0.42 x 2
CV of linear density (%)	4.8
Diameter (mm)	1.91
Twist (tpm)	128
Breaking strength (N)	33.71
CV of breaking strength (%)	7.15
Breaking elongation (%)	18.62

The main characteristics of the wool fibres 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

In order to determine yarn linear density, 1m of yarn has been weighed on a Sartorius 2354 weighing balance. The yarn diameter has been measured using a ruler and a magnifying glass.

The tensile properties of core-wrapped yarns have been tested on a Tinius Olsen H5 KT tensile tester using a distance between clamps of 250 mm and a speed of the superior clamp of 170 mm/min.

3. DISCUSSIONS AND RESULTS

The obtained friction core-wrapped yarns are used as weft yarns in rug weaving.

In Figure 2, the linear density of DREF-2 wool covered/acrylic yarn core spun yarns is presented. An increase in inlet roller speed from 150 rpm to 600 rpm leads to a decrease in linear density of DREF-2 core-spun yarns, no matter the friction drum speed. As friction core-wrapped yarns become finer, the linear density of the wool sheath reduces and modifies the sheath/core ratio that varies from 85/15 at an inlet roller speed of 150 rpm to 54/46 at an inlet roller speed of 600 rpm. The increase in friction drum speed do not influences significantly the linear density of yarns.

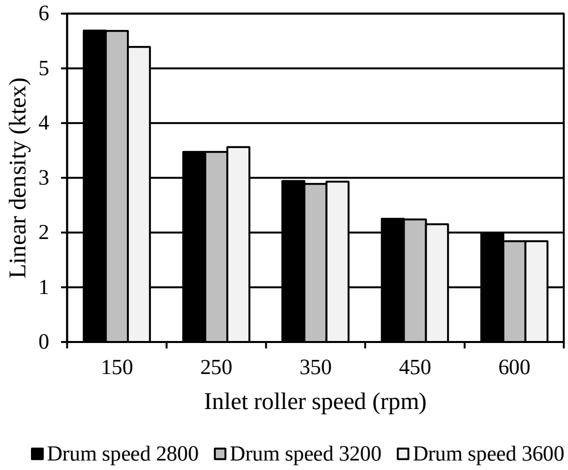

Fig.2. The linear density of DREF-2 wool/acrylic core-spun yarns

As inlet roller speed increases, the friction wool covered/acrylic core-spun yarns become finer and the diameter of yarns decreases (Figure 3). The diameter of DREF-2 core-spun yarns also decreases with an increase in friction drum speed from 2800 rpm to 3600 rpm due to the increasing radial forces generated by the increasing twist.

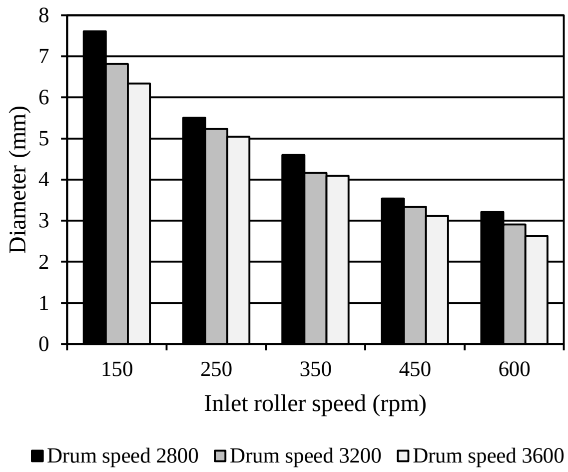

Fig.3. The diameter of DREF-2 wool/acrylic core-spun yarns

Figure 4 presents the breaking strength of DREF-2 wool/acrylic core-spun yarns. As can be seen in Figure 4 and Table 1, the breaking strength of all variants of DREF-2 wool/acrylic core-spun yarns is by 28.2% to 73.8% higher than the breaking strength of acrylic folded yarn used as core. This increase is due to wool fibre strength contribution to strength of wool covered/acrylic core-spun yarns. In friction spinning, the slippage that occurs during twisting between the yarn and the drum surfaces reduces the twist efficiency that can be as low as 40 %. This might be a possible explanation for the fact that not always an increase in friction drum speed leads to an increase in breaking strength of DREF yarns.

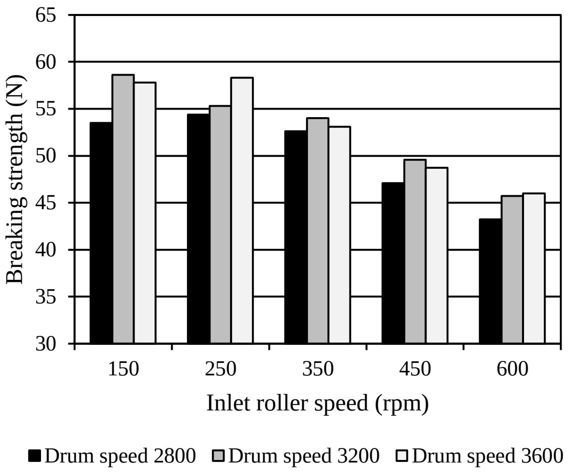

Fig.4. The breaking strength of DREF-2 wool/acrylic core-spun yarns

As can be seen in Figure 5 and Table 1, the elongation at break of DREF-2 wool/acrylic core-spun yarns is higher than the elongation at break of acrylic folded yarn core and has a tendency to decrease with the increase in inlet roller speed as a result of the reduction of wool fibre number in the yarn sheath. At constant inlet roller speed, an increase in friction drum speed leads to an increase in the elongation at break of wool covered/acrylic yarn core spun yarns.

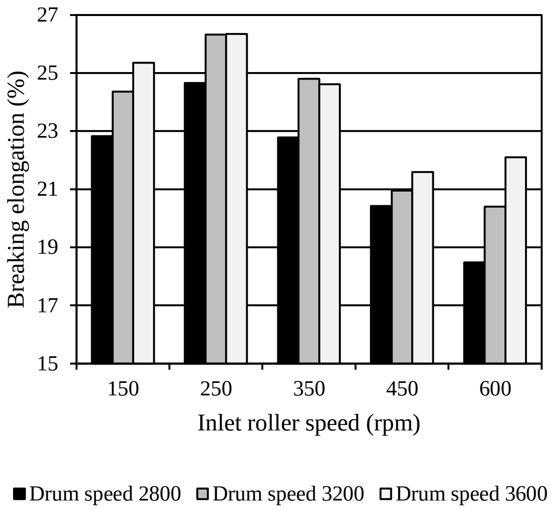

Fig.5. The breaking elongation of DREF-2 wool/acrylic core-spun yarns

4. CONCLUSIONS

The obtained friction core-spun yarns consisting of an acrylic folded yarn as core and wool fibres as sheath have the feel, warmth and look of wool, but are cheaper than 100 % wool yarns of similar linear density.

In this research work, the influence of drum speed and inlet roller speed on the properties of wool covered/acrylic folded yarn core friction-spun yarns has been studied. Based on the results, the following conclusions can be drawn:

- The increase in inlet roller speed results in a decrease of linear density, diameter, breaking strength and breaking elongation of friction core-spun yarns.
- When friction drum speed increases, the yarn diameter decreases, the breaking elongation increases and yarn linear density is not significantly influenced.
- In most cases, the breaking strength of friction yarns increases with an increase in friction drum speed, but this variation has not been confirmed in every experimental variant.

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