CORE-SPUN YARNS FOR RUG APPLICATIONS

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REZUMAT. Această lucrare prezintă rezultatele cercetării privind câteva proprietăţi ale firelor cu destinaţia covoare, filate printr-o metodă de filare cu miez. Fire cu miez cu densitatea de lungime de 20 ktex au fost obţinute utilizând fire dublate de iută ca miez, fiber de lână ca înveliş şi două valori ale torsiunii. Au fost determinate neuniformitatea densităţii de lungime, diametrul firelor şi forţa de adeziune dintre miez şi înveliş. Valorile coeficientului de variaţie a densităţii de lungime sunt mari, cuprinse între 5% şi 10%. Creşterea torsiunii şi a procentului de miez conduce la scăderea diametrului firelor şi la creşterea forţei de adeziune dintre miez şi înveliş.

Cuvinte cheie: covor, fir cu miez, miez din iută, înveliş din lână, forţă de adeziune.

ABSTRACT. This paper presents the results of research concerning some properties of rug yarns spun by a core spinning technique. Core-spun yarns of 20 ktex linear density have been obtained using doubled jute yarns as core, 100 % wool fibers as sheath, and two values of twist Yarn linear density variation, yarn diameter, and the adhesion force between core and sheath have been evaluated. The values of CV of linear density are high, ranging between 5% and 10%. As twist and core percentage increase, the diameter of core-spun yarns decreases and the adhesion force between core and sheath increases.

Keywords: rug, core-spun yarn, jute core, wool sheath, adhesion force.

1. INTRODUCTION

The origin of art of carpet making can be traced back to the Neolithic age (7000 BC), but it is difficult to identify with great precision where and when carpets have been produced for the first time. It is quite possible that different people in different regions, with no contact with each other, started to weave carpets at about the same time. However, it is thought that the art of carpet making may have originated in Persia (Iran), Turkmenistan, Central Asia, Mongolia and China. What can surely be asserted is that by the fifth century BC the technique of carpet making had reached a high artistic level as can be proven by the oldest known existing carpet in the world, the Pazyryk carpet, discovered in a frozen tomb in the Altai Mountains, Siberia. The Pazyryk carpet is a knotted rug of fine construction (3600 tufts/dm^2) and elaborate pictorial design consisting in a field with repeated patterns, framed by a main border and several secondary borders. Its dense pile and beautiful design hint at a long history of evolution and experience in weaving at the time of its production [1].

The terms carpet and rug are often used interchangeably, but some sources differentiate them based on size, use or way of placing on the floor. Carpets are defined as textile floor coverings permanently fixed in place, while rugs are defined as textile coverings laid out on the floor, most often for decorative purposes. Carpets are considered of larger size than rugs being used mainly on floors, while rugs are used mainly on beds. Also, some experts differentiate between carpet and carpeting, the latter being laid on the floor from wall to wall.

Traditionally, carpets and rugs were produced using natural fibers, mainly wool. Even if synthetic fibers duplicate some of wool characteristics, wool still remains the choicest fiber in woven carpet production being associated with high-quality products. In contrast to the synthetic fibers, wool as a natural protein fiber has several sustainable attributes: it is renewable, fully biodegradable under the action of oxygen, warm temperatures and humidity, recyclable, and can be produced organically [2, 3].

Wool unique structure and outstanding properties make it an excellent raw material in carpet and rug production. Due to its three-dimensional spiraling crimp, wool has natural elasticity that enables carpets to quickly recover to the original thickness after compression caused by footsteps or furniture. Wool has a self-cleaning property, being soil and stain-resistant. Waxed exterior surface of wool fiber is made up of overlapping scales that inhibit the penetration of soil particles and water-based spills into the fiber. The soil is held at the surface of the pile where it can be easily removed by vacuuming. Wool releases soil up to 25 % more readily than synthetic fibers [1].

Wool is a hygroscopic fiber; it exchanges moisture in vapor form with the surrounding air. When air humidity is high, wool absorbs moisture and then releases it when the atmosphere is dry, acting as an atmospheric buffer. This gives wool carpets the ability to control the indoor environment by regulating the humidity fluctuations in the room. Under saturated atmospheric conditions, wool can absorb up to 30% of its weight in moisture vapor without feeling damp. In addition, wool has anti-static properties due to the retention of moisture within the fiber which prevents static charge accumulation. Using wool carpets, the risk of electrical shock generation when a person touches a grounded object is reduced.

Due to its protein constituents, wool is naturally flame retardant. Wool has a higher ignition temperature than most synthetic fibers used in carpets, so that it is more difficult to ignite. The levels of heat, toxic gases and smoke released during wool burning are low. Wool fiber does not support combustion (it is self-extinguishable). Because wool carpets provide fire safety, they are recommended for environments with fire precautions, such as trains and aircraft.

The chemical composition of wool gives it a high affinity for dyestuff, enabling it to be dyed in a large variety of colors.

The wool fibers can be converted into carpet yarns by woolen, semi-worsted, friction, and wrap spinning systems. Even worsted yarns may be applied in the finer constructions [4]. Exceptionally coarse yarns consisting of a jute or cotton core wrapped by wool fibers can be obtained by a core spinning technique. Core-spun yarns are often used for manufacturing of hand-crafted rugs.

In this research work, core-spun yarns of 20 ktex linear density have been spun by a core spinning technique using two values for twist. Doubled jute yarns (obtained by twisting of 3, 4 or 5 single yarns) have been used as core and 100 % wool fibers have been used as sheath. Yarn linear density variation, yarn diameter and the adhesion force between core and sheath have been evaluated.

2. MATERIALS AND METHODS

The technological process used to obtain core-spun yarns for rug applications consists of:

– stack blending of fibers and oil applying to successive layers,

– fiber opening on a bale opener and a blending opener,

– fiber condensing and pressing into bales,

– core-yarn spinning.

There is no carding used in this spinning system.

The core spinning machine consists of five sections, as can be seen in Figure 1.

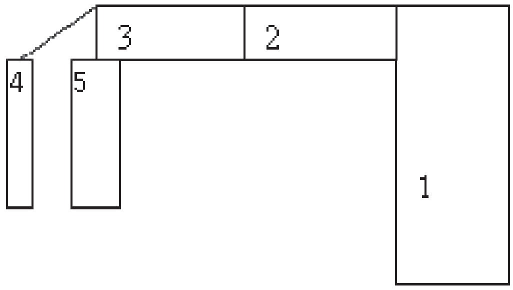

Fig. 1. The principle scheme of core spinning machine: *1* – weighing hopper; *2* – conveyor belt; *3* – opening device; *4* – core yarn feeding device; *5* – core – spun yarn twisting and winding devices.

The weighing hopper delivers fiber portions of constant mass at regular time intervals to a transverse conveyor belt. The conveyor belt feeds the fibers to the opening device composed of a pair of feed roller, a main cylinder and a doffer provided with metallic clothing. The fibers delivered by the doffer wrap around the core yarn which is fed along the doffer generating line direction. The twisting of fiber sheath is done by rotating abrasive rollers. The core-spun yarn is cross wound on the package by means of rotational motion of the package and traverse motion of the yarn guide.

Core-spun yarns of 20 ktex linear density have been spun using doubled jute yarns as core and 100 % wool fibers as sheath. The ratio between core and sheath has been changed by changing the number of single yarns doubled together and the portion mass into weigh pan, so that the linear density of the core-spun yarns to be kept constant. Two values of twist have been used: 32 and 20 tpm, as can be seen in Table 1.

Table 1. **Core-spun yarn variants**

Sheath fiber type	**100 % Wool**					
Linear density of jute core yarn (ktex)	3 x 2.2		4 x 2.2		5 x 2.2	
Core/sheath ratio	33/67		44/56		55/45	
Twist (tpm)	32	20	32	20	32	20

The wool fibers used as sheath have had a mean diameter of 33 μm, a CV of diameter of 27.7 %, an average length of 41 mm, and a CV of fiber length of 25.5 %. The characteristics of the jute single yarn used to obtain the core doubled yarn were as follows: 2.2. ktex linear density, 3.6 % CV of linear density, 164 tpm twist, 180.3 N breaking strength, 13.4 % CV of breaking strength, 1.72 % elongation at break, 8.1 % CV of elongation at break.

The core-spun yarns obtained on this technology are used as weft yarns in rug weaving. For all variants of core-spun yarns, yarn diameter, yarn linear density variation and the adhesion force between core and sheath have been evaluated.

Because the core-spun yarns were exceptionally heavy, in order to determine the linear density a length of 1m of yarns has been weighed.

The yarn diameter has been measured using a ruler and a magnifying glass.

Tinius Olsen H5 KT tensile tester has been used to evaluate the adhesion force between core and sheath. The jute core yarn has been gripped in the superior clamp, while the fiber sheath has been gripped in the inferior clamp. When subjected to traction, the sheath glides on core and the pulling force needed to uncover the core can be measured. The distance between clamps has been chosen at 50 mm.

3. DISCUSSIONS AND RESULTS

The average values of the linear density of core-spun yarns lies between the tolerance limits, from 19.5 ktex to 20.5 ktex.

The values of the coefficient of variation of core-spun yarn linear density are quite high ranging between 5% and 10% (Figure 2). This unevenness of the yarn mass may be explained by the insufficient individualization of the sheath fibers taking into account that there is no carding in the fiber preparation for spinning.

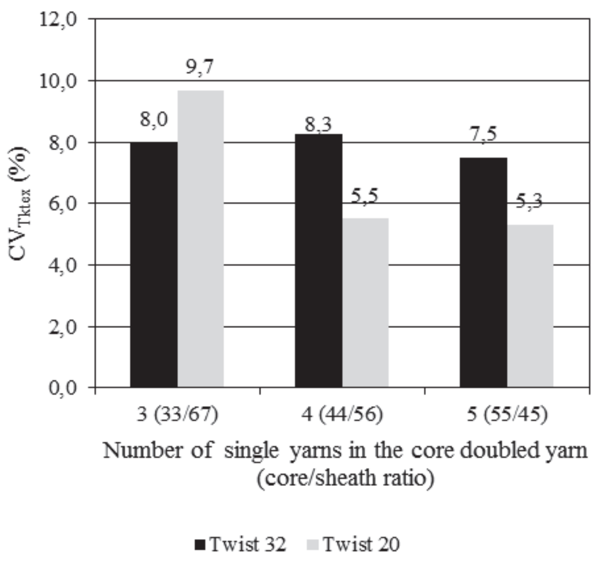

Fig. 2. The CV of linear density of wool/jute core-spun yarns

As plotted in Figure 3, the diameter of wool/jute core-spun yarns decreases when twist increases. As sheath percentage in the core-spun yarns decreases the yarn diameter decreases because wool fibers have a higher bulkiness than jute yarn.

Figure 4 presents the adhesion force between core and sheath. The higher the yarn twist, the higher the adhesion force between core and sheath is. Regardless the twist value, as the number of the single jute yarns in the core doubled yarn increases from 3 to 5, the adhesion force between core and sheath increases because there is a higher probability of the sheath fibers to be gripped between the single jute yarns during twisting.

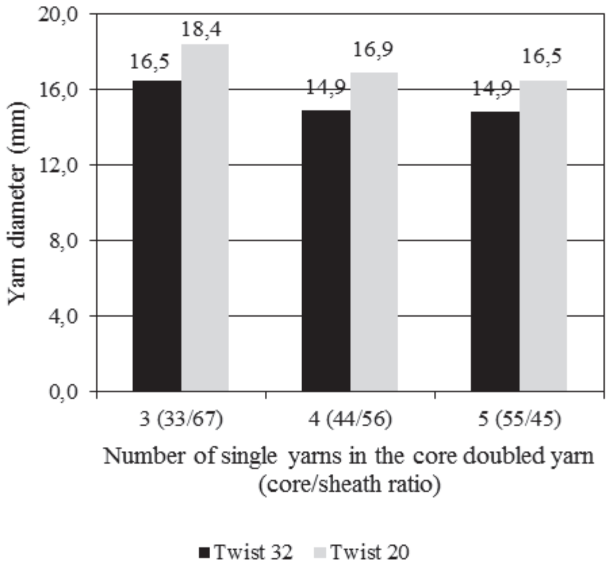

Fig. 3. The diameter of wool/jute core-spun yarns

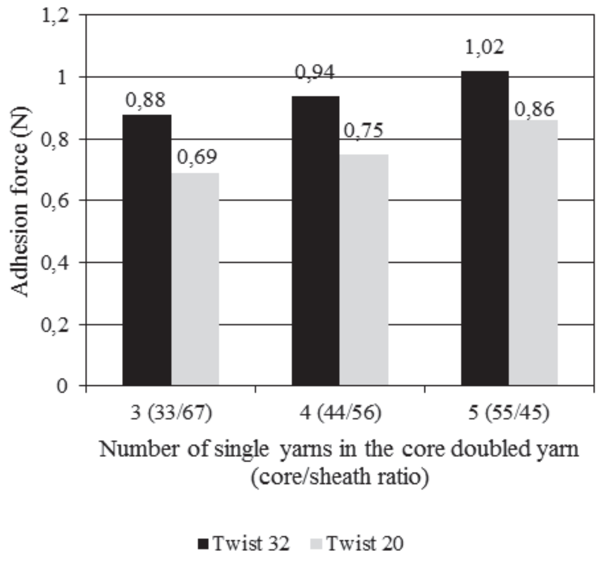

Fig. 4. The adhesion force between core and sheath

4. CONCLUSIONS

In rug construction, wool remains a traditional favorite fiber, but it is very expensive in comparison with chemical fibers. In order to be competitive, rug producers are looking for solutions to reduce the product price without affecting its quality. The core spinning technique presented in this paper allows the obtaining of wool/jute core-spun yarns which have the feel, warmth and look of wool, but are much cheaper than 100 % wool yarns. The savings over 100 % wool yarns are due to the fact that some wool fibers are replaced by a jute yarn and the carding is absent from the technological process of fiber conversion to yarn.

In this research work, core-spun yarns of 20 ktex linear density have been spun by a core spinning technique using two values for twist. Doubled jute yarns (obtained by twisting of 3, 4 or 5 single yarns) have been used as core and 100 % wool fibers have been used as sheath.

Based on the results of this research, the following conclusions can be drawn:

− The values of CV of linear density of wool/jute core-spun yarns are high, ranging between 5% and 10%, probably due to the insufficient individualization of the sheath fibers.

− As twist increases, the diameter of core-spun yarns decreases and because the sheath becomes tighter wrapped over the core the adhesion force between core and sheath increases.

− An increase in the number of single jute in the doubled core yarns reduces the core-spun yarn diameter and increases the adhesion force between core and sheath.

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