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Method of Obtaining Doubled Yarn from Mixed Fibers with Improved Characteristics

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Annotation
The article provides a detailed analysis of known methods for producing yarn from mixed fibers with varying densities. Based on the analysis of existing methods for obtaining composite yarn from blended cotton and viscose fibers, cotton and polyester, as well as cotton fibers and bamboo. The technology and equipment used to produce the recommended yarn for these three variants are presented. Their comparative qualitative characteristics are provided. Based on the analysis of the influence of compactors on the quality indicators of yarn, the KS compactor and the TS twist retention element were recommended.

Keywords: Yarn, composite, fibers, mixed, roving, cotton, polyacrylonitrile, polyester, viscose, polyester, bamboo, elongation, tensile strength, strength, tex, sealant, twist retainer element.

Introduction.

Globally, the textile industry plays a key role in the economy, holding a leading position in the processing of natural and synthetic fibers, as well as in providing the population and industry with necessary products. This contributes to the growth of yarn production volumes. According to the data, the global production of finished garments and knitwear reaches 120 billion units, with the main centers of production remaining the countries of East and South Asia, the USA, Europe, and the CIS. In these conditions, it is important to effectively use ring spinning machines to produce high-quality and competitive yarn necessary for the textile industry. In this regard, the use of

modern, energy-efficient equipment is becoming a key factor in the development of new types of yarn.

The development of regulatory technological parameters that positively influence the yarn production process, as well as the creation of new spinning techniques and technologies, is of particular importance. Research on the production of blended double yarn is considered a priority in this area. In the new Development Strategy of Uzbekistan for 2022-2026, important tasks have been identified: increasing the volume of industrial production by 1.4 times by continuing the industrial policy aimed at ensuring the stability of the national economy and increasing the share of industry in the gross domestic product. Within the framework of the implementation of these tasks, including in the concept for the development of the textile and knitwear industry, priority areas have been identified: improving technologies, saving raw materials and supplies, creating new high-performance equipment, and introducing automated electronic control systems into production processes. This will significantly increase the efficiency of blended fabric production. Special attention is being paid to improving the technology for obtaining blended yarn used in knitted fabrics, particularly focusing on the production of plied yarn and enhancing the competitiveness of products in the global market.

Research in this area shows that multicomponent double yarn with medium and high linear density was mainly produced from fine-fiber cotton, wool, and chemical fibers. The production of multicomponent doubled yarn with an average linear density from a mixture of medium-staple cotton fiber with a length of 35mm grown in our Republic and polyester fiber has not been sufficiently studied.

In global spinning production, methods for obtaining yarn by mixing various artificial and natural fibers are increasingly emerging [1,2,3,4,5,].

Development of a method for producing yarn from mixed fibers. To obtain composite yarn from blended fibers, ensuring a technical result that expands the range of blended yarn with improved tensile characteristics, quality, and consumer properties, while effectively using artificial and natural fibers, new fiber components are recommended.

The method involves producing composite yarn from blended fibers with average linear density of type IV 1st and 2nd grade cotton fibers mixed with chemical fibers, such as cotton-bamboo (60/40), cotton-viscose (60/40), and cotton-polyester (60/40) on a ring spinning machine, resulting in doubled yarn (29 tex) [9]. The recommended composite yarn is obtained by mixing cotton fibers and chemical fibers in the following proportions for three variants:

- ✓ cotton fiber 60%; viscose 40%;
- ✓ cotton fiber 60%; polyester 40%;

In this case, in all three variants, the fiber length is selected within the range of 35 mm (average value of cotton fibers). Obtaining composite yarn for all three variants is carried out on the Zinser 351 spinning machine. At the same time, doubled yarn of 29 tex with improved characteristics was obtained.

Analysis of the characteristics of the obtained new yarn from blended fibers.

The production of composite yarn is carried out as follows. In the first variant, a cotton fiber ratio of 60%, 38 mm and, correspondingly, 40% viscose fiber is selected. Using the card system and standard spinning production equipment, yarn production is presented in Table 1.

Table 1. Yarn plan of the foreign enterprise "OSBORN TEXTILE"

№	Machines	Linear density of the product, tex, ktex	Number of terms, d	Elongation value, E	Twisting		Extraction working tool speed		F.V.K. .	Theoretical productivity Kg/hour
					α_T	K, м	v, m/min	n, мин$^{-1}$		
Cotton fibers										
1	Carding machine	6000	-	-	-	-	-	71,42	0,95	95
	Combing	600	1	10	8,6	53,69	-	600	0.75	120
2	Drawing «I»	6000	8	8	-	-	700	5866	0,95	210
3	Drawing «II»	6000	8	11,66	-	-	650	5447,5	0,95	186
4	Roving	600	1	10	8,6	53,69	-	1200	0,944	0,98
Polyester fiber										
1	Carding machine	4700	-	-	-	-	170	69,42	0,96	95
2	Drawing «I»	4700	8	8	-	-	450	5666	0,96	190
3	Drawing «II»	4000	8	12,5			700	5247,5	0,96	182
4	Roving	400	1	10	8,85	53,69	-	1000	0,944	0,865
5	Spinning machine	29	2	55,17	36,4	770		11000	0,954	0,0256

Table 2 presents the characteristics of composite double yarn consisting of 60% cotton fibers and 40% polyester fibers.

Table 2. Quality indicators of doubled yarn obtained from a mixture of cotton/viscose, cotton/polyester fibers

Name of Indicators	Cotton/viscose		Cotton /polyester	
	On average -X-	Coefficient of variation -CV-	On average -X-	Coefficient of variation -CV-
Elongation	4,85 %	9,69	4,65 %	9,31
Destructive power	351,55 cH	5,93	461 cH	5,65
Relative tensile strength	17,58 cH/тех	5,93	19,88 cH/тех	5,65

Table 3 shows the characteristics of the composite yarn obtained by mixing 60% cotton fibers and 40% polyester fibers.

Table-3. Table of physical and mechanical characteristics of composite double yarn with a linear density of 29 tex.

№	Indicator:	Doubled yarn (Enterprise version)	Doubled yarn (Experimental version)
1	Linear yarn density, teks	29	29
2	English number;	20	20
3	Breaking strength; cN	356,3	381,6
4	Relative breaking strength, cN/teks	12,74	13,20
5	Tensile strength coefficient of variation,%	11,3	8,92
6	Elongation,%	4,49	5,45
6	Coefficient of variation in length,%	11,7	8,86

Представленные характеристики подтверждают тот факт, что увеличивается сила разрыва, удлинение композиционной пряжи, во всех трех вариантах.

Из смешанных волокон формируется дублированной пряжи 29 текс хлопок-визкоза (60/40), хлопок-полиэстер (60/40) , хлопок/вискоза (60/40) при частоте вращения прядильных веретен 12000-18000 мин$^{-1}$

Analysis of the influence of compactors on the quality indicators of yarn

To evaluate the physical and mechanical properties of the yarn, experiments were conducted using nine different variants. The averaged results of the main physical and mechanical properties of the yarn for these variants are presented in Table 4 and illustrated as a histogram in Figure 1.

In addition to the physical and mechanical properties of the yarn, when assessing its quality, the tensile strength and the force applied to 1 g of yarn were calculated. This force was determined using the following formula [10]:

$$R_p = \eta \cdot P \cdot l \qquad (1)$$

where η -is the diagram coefficient for cotton, ranging from 0.49 to 0.51 (we assume 0.5); P is the yarn tensile strength (cN), and l is the elongation at break (cm).

To compare the properties of yarn obtained in variants [11,12], the relative breaking strength of 1 g of yarn was calculated using the formula.

$$R = \frac{\eta \cdot P \cdot l}{q} \qquad (2)$$

where: q - 0.5g is the mass of the tested yarn, determined as $q = \frac{T}{2000}$.

As can be seen from Table 4, the yarn from all variants meets the requirements of the I level technical regulatory documents [12].

The intermediate openings of the roving compactors differently affect the quality and stability of the yarn formation process in the twist triangle during the spinning-twisting method [13].

The influence of the distance between the intermediate openings of the roving compactors on the twist triangle during the production of plied yarn by the spinning-twisting method is clearly shown in Figure 1.

Таблица-1. Physical and mechanical indicators of doubled yarn obtained from a mixture of cotton/polyester fibers

№	Наименование показателей		Options for spacing between intermediate holes of roving seals		
			8 мм	10 мм	12 мм
1	Linear yarn density, teks		29	29	29
2	Coefficient of variation for linear density, %		0,96	1,27	1,55
3	Breaking strength; cN		418	461	484
4	Relative breaking strength, cN/teks		18,95	19,88	20,81
5	Coefficient of variation for relative breaking load, %		7,04	5,65	4,25
6	Elongation	%	9,14	9,33	9,35
		См	4,57	4,65	4,68
7	Breaking strength, (kg/cm)		0,5	0,53	0,55
8	Relative breaking work per 1 g of yarn		34,5	35,7	36,6

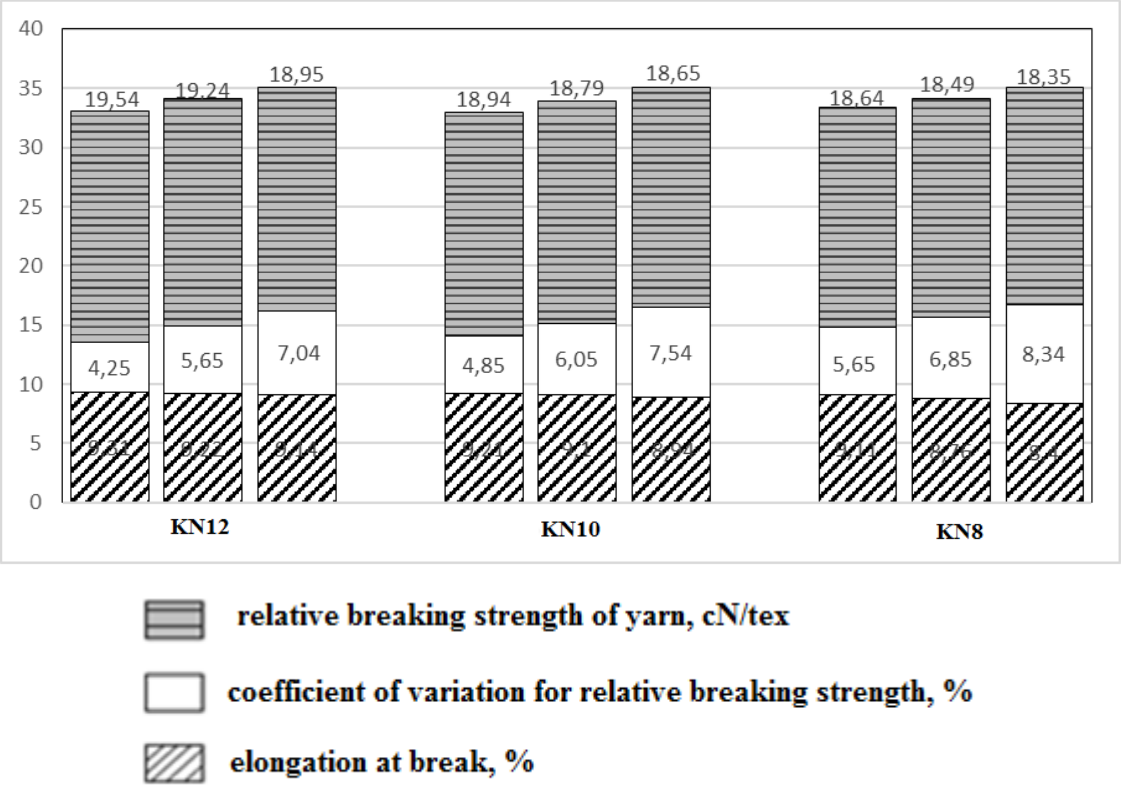

Figure 1 - Indicators of the physical and mechanical properties of yarn

- ✓ relative breaking strength of yarn, cN/tex
- ✓ coefficient of variation for relative breaking strength, %
- ✓ elongation at break, %

In Figure 1, the relative breaking load of yarn passing through the KS seal is 18.95-19.54 cN/tex. In the comparative variants, when using KN8 seals, the tensile strength is 18.65-18.94 cN/tex, and when using KN4 seals, the tensile strength is within the range of 18.35-18.64. cN/tex.

When using KS compactors, the yarn elongation at break was KN12 9.14-9.35%, when using KN8 compactor - 8.94-9.25%, and when using KN10 compactor - 8.84-9.15%, i.e., the highest indicators of yarn elongation at break were observed in variants 1,2,3 when using KS compactors.

In yarn production technology, high elongation is of great importance, as the yarn first stretches to a certain degree, after which stress occurs under its influence.

The mechanical properties of the yarn can be assessed by the specific breaking load of the yarn (Fig. 2).

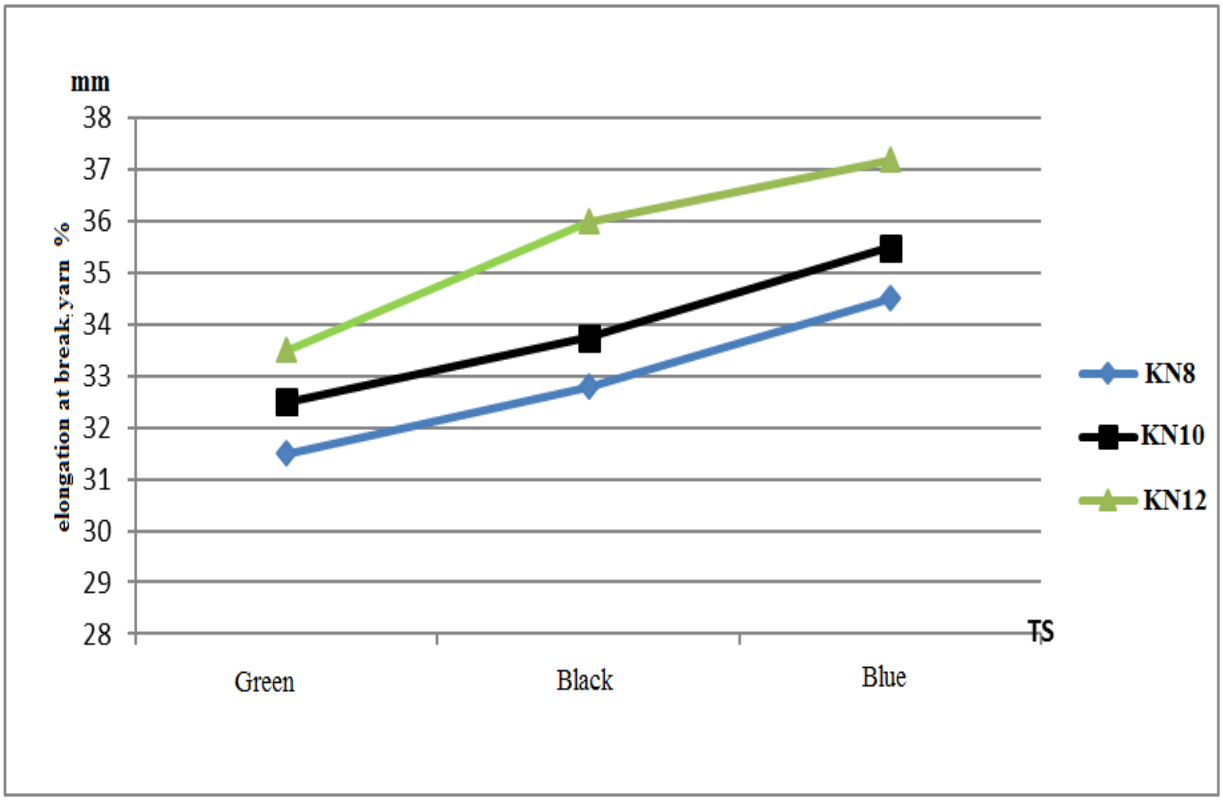

Figure 2. Dependence of the change in yarn elongation during yarn break on the type of funnel

The importance of tensile strength is determined by its tension and successful processing in technological processes. As can be seen from Figure 2, when using the KS funnel, the relative breaking load of the yarn is high. When using KS, as a result of the increase, the relative breaking load of the yarn in various funnels increases sufficiently. The best results were obtained when producing yarn with a linear density of doubled yarn of 29 tex.

Conclusions. Based on the analysis of existing methods for obtaining yarn from blended fibers, a method for obtaining yarn with improved characteristics was recommended: a) cotton fiber - 60% and viscose - 40%; b) cotton fiber - 60% and polyester - 40%. Based on the analysis of the influence of the seals on the quality indicators of the yarn, the KS sealer was recommended.

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