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Influence of Composition of the Mixture on the Fiber Length on Transitions of the Spinal Process

Kazakova Dilafruz Erkinovna, Djumaniyazov Khadam Djumaniyazovich

Assistant, Jizzakh Polytechnic Institute, City. Jizzak, Republic of Uzbekistan
Doctor of technical sciences, professor. Tashkent Institute of Textile and Light Industry, City. Tashkent, Republic of Uzbekistan

ABSTRACT: The research work was carried out at the joint venture SIRKECHI. For this purpose, using fiber equipment, fiber length was studied using transitions of spinning production of selected samples of fibers, ribbons, rovings and yarn from 3 options, of various mixed composition, that is, from a mixture of cotton fibers of the following ratios 4-I-30%, 5- I-70%; 4-II-60%, 5-I-40% and 4-I-60%, 4-II-40%

KEY WORDS*:* Sorting, quadratic unevenness, linear density, breaking load, relative breaking load.

I.INTRODUCTION

The geometric properties of cotton fibers include length and linear density. These indicators are considered one of the important indicators, as well as the property that determines the quality of the yarn produced, is the spinning ability of the fibers. Since the longer the cotton fiber from it produces a thin, smooth, uniform and durable yarn. From long fibers, yarn thin with normalized strength is produced, and also from short fibers yarn with a greater linear density, with a high unevenness in thickness and lower in quality. It is known that the better properties of the fiber has a length, thickness, strength and other important indicators, the yarn produced from these fibers is stronger and better.
On this basis, it is possible to get thin yarn from long fibers with durability, which corresponds to the standards regulated by the standard in terms of breaking load. To produce yarn with a small linear density consumes a smaller amount of raw materials, as a result of increasing the economic efficiency in the use of raw materials.
It is known from a number of conducted research works that increasing the length of cotton fiber by 1 mm will lead to an increase in the strength of yarn obtained from these fibers by 3-4%. Especially, fiber length is of great importance for medium cotton. Therefore, the preservation of the original length during the production process acquires great technological and economic value. Otherwise, a decrease in fiber length during preprocessing or in the spinning process by at least 1 mm leads to a decrease in the spinning ability of the fiber, as a result, it causes a decrease in the breaking elongation of the yarn over a length of 1 km.
A slight decrease in the length of cotton fiber during the spinning process negatively affects the quality indicators of the yarn obtained from them. For example, a decrease in fiber length of at least 0, 5 mm leads to a deterioration in the economic performance of spinning spinning.
Research studies were carried out to study the change in staple mass-length fibers in the spinning process. For this, in the process of yarn production, samples were taken from various sorts and certain staple mass-sheets were compared with the original version of the sample.
The results of the tests are shown in table 1.

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Table 1
The effect of different blend composition on the fiber length in spinning process

п/н	Name of the indicator	Mixing composition, %					
		4-I-30%, 5-I-70%		4-II-60%, 5-I-40%		4-I-60%, 4-II-40%	
		Extruded fiber	After spinning	Extruded fiber	After spinning	Extruded fiber	After spinning
1.	Modal mass length, mm	29,0	28,1	30,6	29,9	29,2	28,8
2.	Shtapelnaya massoflina, mm	32,6	31,4	32,5	31,8	32,5	31,9
3.	Average length, mm	23,5	22,8	26,2	25,1	24,6	23,9
4.	Quadratic uneven length,%	22,5	27,2	21,6	26,8	22,5	25,4

According to the obtained test results according to Table 1, a histogram of the dependence of the various mixed composition on the staple mass-length and quadratic unevenness along the length was built.

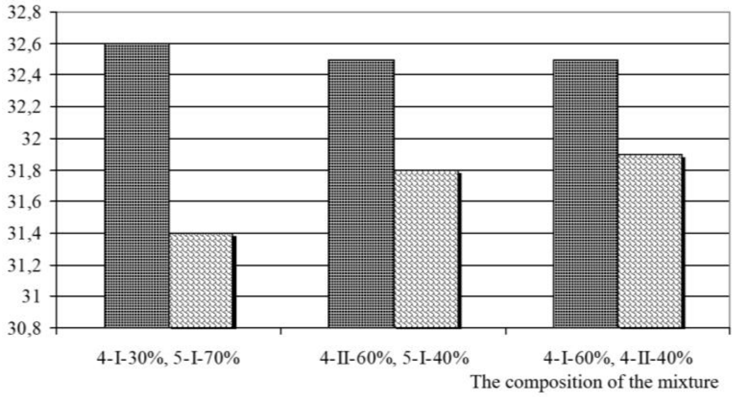

Fig.1. The effect of blending on the change in staple mass of the spinning process.

- pressed fiber;
- after spinning process.

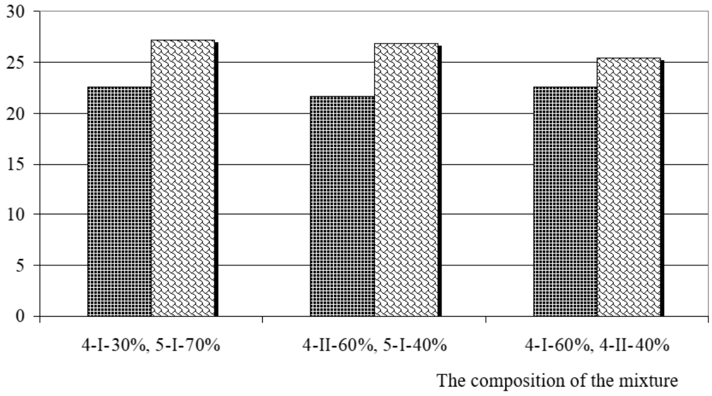

Fig. 2. The effect of blending on the change in quadratic unevenness in length during spinning.

- состав-4-I-30%, 5-I-70%
-состав-4-II-60%, 5-I-40%
-состав-4-I-60%, 4-II-40%

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Under the influence of various technological processes during primary cotton processing and fiber spinning, various types of damage are exposed, that is, mechanical damage to fibers leads to significant deterioration in the quality indicators of the products produced. As a result, the indicators of the breaking load of the fibers, the staple mass sheet are reduced, and the number of short fibers and trash are increasing. Therefore, the optimal variant of the flow of each process in the cotton ginning and spinning enterprises is chosen.

In the analysis, the change in fiber length and quadratic deviation in length with a blend of 4-I-30%, 5-I-70% staple mass length of the fibers after the spinning process by 3.7%, that is, the length is reduced by 0.8 mm, quadratic unevenness in length increases by 17.3%, with a blending composition of 4-II-60%, 5-I-40% staple mass-length of fibers decreases by 4.2% after the spinning process, that is, decreases by 1.1 mm, quadratic unevenness in length increases by 19.4%, with a blending composition of 4-I-60%, 4-II-40% staple mass-length of the fibers after the spinning process by 2.9% reducing that is, 0.7 mm decreases, the quadratic irregularity along the length increases by 11.4%. From the test results it can be seen that, with a blending composition of 4-II-60%, 5-I-40%, the fiber length is significantly reduced relative to fibers from other mixed compounds.

To produce high-quality products in spinning mills, it is necessary to choose the right sorting. In addition, the number of defects and weed impurities in the composition of cotton fibers also play a significant role. For example, a high content of the number of defects and weed impurities negatively affect the quality indicators of yarn produced from them.

The greater the breakage of the yarn in the process of its formation, the higher the index of unevenness of the yarn. As a result, an increase in yarn breakage, an increase in employment time, and a decrease in machine productivity.

Summing up, it can be said that with different blend compositions, the staple mass-length of the fibers after the spinning process decreases from 4.2% to 2.9%, quadratic unevenness in length increases from 11.4% to 19.4%.

In spinning mills, the formula of engineer A.A.Sinitsin is used to calculate the indicators of fibers in the mixture:

The staple mass length of the fibers in a mixture of 4-I-30%, 5-I-70% is 32.6 mm; linear density of 171 mtex; breaking load 4,5 sN; relative breaking load of 26.3 sN / tex.

1. The breaking load of the fibers in the mixture is determined by the following formula:

$$P_{ar} = \frac{P_1 \cdot \alpha_1}{100} + \frac{P_2 \cdot \alpha_2}{100} = \frac{4{,}5 \cdot 30}{100} + \frac{4{,}4 \cdot 70}{100} = 4{,}43 \text{ sN} \quad (1)$$

2. The linear density of the fibers in the mixture is determined by the following formula:

$$T_{ar} = \frac{T_1 \cdot \alpha_1}{100} + \frac{T_2 \cdot \alpha_2}{100} = \frac{171 \cdot 30}{100} + \frac{165 \cdot 70}{100} = 166{,}8 \text{ mteks} \quad (2)$$

3. The relative tensile strength of the fibers in the mixture is determined by the following formula:

$$R_{ar} = \frac{R_1 \cdot \alpha_1}{100} + \frac{R_2 \cdot \alpha_2}{100} = \frac{26{,}3 \cdot 30}{100} + \frac{26{,}7 \cdot 70}{100} = 26{,}58 \text{ sN/teks} \quad (3)$$

Where: $P_1, P_2 -$ **breaking load of the constituent components of the fibers in the mixture, sN;** $T_1, T_2 -$ **the linear density of the components of the fibers in the mixture, mteks;** $R_1, R_2 -$ **relative breaking load of the components of the fibers in the mixture, sN;**

If the mixture consists of cotton fiber only, then the relative tensile load of the yarn is calculated by the formula of prof. Solovyov:

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$$R_{ar} = 26{,}3\left(1 - 0{,}0375 \cdot 5 - \frac{2{,}65}{\sqrt{\frac{18{,}5}{0{,}171}}}\right)\left(1 - \frac{5}{32{,}6}\right)0{,}96 \cdot 1 = 11{,}99 \text{ sN/teks} \quad (4)$$

Where: R_{np} - relative breaking load of yarn, cH/текс; $P_{см}$- breaking load of fibers in the mixture, cH; $T_{см}$ - the linear density of the fibers in the mixture, tex; H_0- specific unevenness of yarn, for a combed system H_0=3,5 ÷ 4,0; card system H_0=4,5 ÷ 5,0; T_{np}- linear yarn density, tex; $L_{см}$- staple length of fibers in the mixture, mm; η - coefficient, dependent on equipment condition; (fine - η =1,1; ok - η =1,0; satisfactorily - η =0,9); κ - yarn twist correction depending on the difference between the actual and critical twist coefficients.

$$\kappa = f(\alpha_ф - \alpha_{кр})$$

$\alpha_ф$ - actual twist factor of the yarn, taken from the directory depending on the purpose, linear density and staple length of the fiber; $\alpha_{кр}$ - the critical twist coefficient is determined by the formula:

$$\alpha_{кр} = \frac{31{,}62}{100}\left[\frac{(1120 - 70 \cdot P_{см})P_{см}}{L_{см}} + \frac{57{,}2}{\sqrt{T_{пр}}}\right]$$

According to the difference $(\alpha_ф - \alpha_{кр})$ From the directory choose the value "k". It is usually less than 1. After being compared, and the following condition must be met.

$$k = f(\alpha_a - \alpha_k) = f(48{,}0 - 47{,}8) = 0{,}2 \quad (5)$$

$$\alpha_{кр} = \frac{31{,}6}{100}\left[\frac{(1120 - 70 \cdot P_a)P_a}{L_{sh}} + \frac{57{,}2}{\sqrt{T_{ip}}}\right] = 47{,}8 \quad (6)$$

Staple mass-length of fibers in a mixture 4-II-60%, 5-I-40% makes up 32,3 mm; linear density 165 mteks; breaking load of fibers 4,2 sN; relative breaking load of fibers 25,5 sN/teks.

1. Determine the breaking load of fibers in the mixture:

$$P_{ar} = \frac{P_1 \cdot \alpha_1}{100} + \frac{P_2 \cdot \alpha_2}{100} = \frac{4{,}5 \cdot 60}{100} + \frac{4{,}2 \cdot 40}{100} = 4{,}38 \text{ sN} \quad (7)$$

2. Determine the linear density of the fibers in the mixture:

$$T_{ar} = \frac{T_1 \cdot \alpha_1}{100} + \frac{T_2 \cdot \alpha_2}{100} = \frac{165 \cdot 60}{100} + \frac{167 \cdot 40}{100} = 165{,}8 \text{ mteks} \quad (8)$$

3. Determine the relative breaking load of fibers in the mixture:

$$R_{ar} = \frac{R_1 \cdot \alpha_1}{100} + \frac{R_2 \cdot \alpha_2}{100} = \frac{25{,}5 \cdot 60}{100} + \frac{25{,}1 \cdot 40}{100} = 25{,}7 \text{ sN/teks} \quad (9)$$

Where: P_1, P_2, .., P_n - fiber breaking load 1, 2,…,n- blend components, cH; L_1, L_2, .., L_n - fiber length 1-го, 2-го,…, n-го blend components, мм; T_1, T_2, .., T_n - fiber linear density of individual components of the mixture, мтекс; R_1, R_2, .., R_n - relative breaking load of fiber 1-го, 2-го,…, n-го blend components, cH/текс; α_1, α_2, .., α_n – the proportion of the individual components of the mixture, %.

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$$R_{ar} = \frac{4{,}2}{165}\left(1 - 0{,}0375 \cdot 5 - \frac{2{,}65}{\sqrt{\frac{20{,}0}{0{,}165}}}\right)\left(1 - \frac{5}{32{,}3}\right)0{,}96 \cdot 1 = 11{,}86 \text{ sN/teks} \quad (10)$$

$$k = f(\alpha_a - \alpha_k) = f(38{,}0 - 37{,}95) = 0{,}05 \quad (11)$$

$$\alpha_{кр} = \frac{31{,}6}{100}\left[\frac{(1120 - 70 \cdot 4{,}2)4{,}2}{32{,}3} + \frac{57{,}2}{\sqrt{20}}\right] = 37{,}95 \quad (12)$$

Staple mass-length of fibers in a mixture 4-I-60%, 4-II-40% makes up 33,1 mm; linear density 170 mteks; breaking load of fibers 4,5 sN; relative breaking load of fibers 26,5 sN/teks.

1. Determine the breaking load of fibers in the mixture:

$$P_{ar} = \frac{P_1 \cdot \alpha_1}{100} + \frac{P_2 \cdot \alpha_2}{100} = \frac{4{,}5 \cdot 60}{100} + \frac{4{,}1 \cdot 40}{100} = 4{,}34 \text{ sN} \quad \textbf{(13)}$$

2. Determine the linear density of the fibers in the mixture:

$$T_{ar} = \frac{T_1 \cdot \alpha_1}{100} + \frac{T_2 \cdot \alpha_2}{100} = \frac{170 \cdot 60}{100} + \frac{165 \cdot 40}{100} = 168 \text{ mteks} \quad \textbf{(14)}$$

3. Determine the relative breaking load of fibers in the mixture:

$$R_{ar} = \frac{R_1 \cdot \alpha_1}{100} + \frac{R_2 \cdot \alpha_2}{100} = \frac{26{,}5 \cdot 60}{100} + \frac{24{,}8 \cdot 40}{100} = 25{,}82 \text{ sN/teks} \quad \textbf{(15)}$$

According to the formula of Prof. A.N. Solovyov, we define the relative breaking load of yarn:

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$$R_{ar} = 26{,}5\left(1 - 0{,}0375\cdot 5 - \frac{2{,}65}{\sqrt{\frac{20{,}0}{0{,}170}}}\right)\left(1-\frac{5}{33{,}1}\right)0{,}96\cdot 1 = 15{,}12 \text{ sN/teks} \quad (16)$$

κ - yarn twist correction depending on the difference between actual and critical twist coefficients, т.е.

$$\kappa = \mathrm{f}\left(\alpha_{ф} - \alpha_{кр}\right)$$

$$k = f(\alpha_a - \alpha_k) = f(39{,}0 - 38{,}6) = 0{,}4 \quad (17)$$

$\alpha_{ф}$ - actual twist factor of the yarn, taken from the directory depending on the purpose, linear density and staple length

$$\alpha_{кр} = \frac{31{,}6}{100}\left[\frac{(1120 - 70\cdot 4{,}5)4{,}5}{33{,}1} + \frac{57{,}2}{\sqrt{20}}\right] = 38{,}6 \quad (18)$$

For the implementation of theoretical calculations for the design of indicators of fibers in the mixture and yarn, the results of tests of indicators of fibers in various mixed compositions and the relative breaking loads of yarns are given in the table 2.

Table 2

The change in the relative breaking load of yarn depending on the performance of fibers of various mixed compounds

п/н	The name of indicators	The composition of the mixture, %		
		4-I-30%, 5-I-70%	4-II-60%, 5-I-40%	4-I-60%, 4-II-40%
1.	Fiber breaking load, sN	4,43	4,38	4,34
2.	Linear fiber density, mteks	166,8	165,8	168,0
3.	Relative breaking load of fibers, sN/teks	26,58	25,7	25,82
4.	Relative breaking load of yarn, sN/teks	11,99	11,86	14,12

According to the results of table 2 shows the graphs of 3-5 changes in the relative tensile strength of the yarn, depending on the performance of fibers in various mixed compositions.

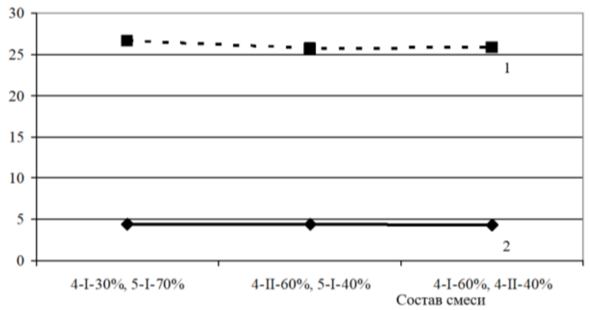

Fig. 3. The change in the breaking load of fibers and the relative breaking load of yarn of various mixed compounds.
1 is the relative breaking load;
2-breaking load.

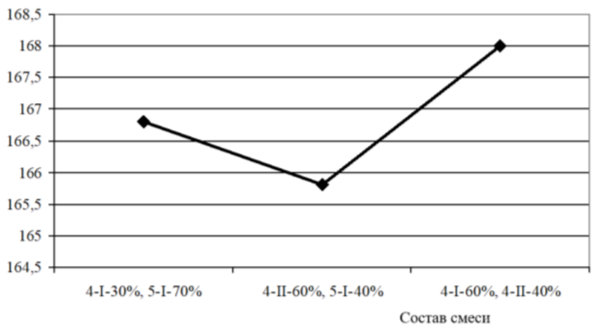

Fig. 4. Changes in the linear density of fibers of various blended compositions

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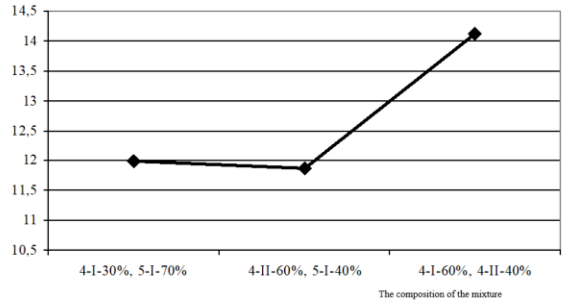

Fig.5. Change in the relative breaking load of yarn of various mixed compounds.

In a theoretical analysis of the results obtained, it can be seen that with mixed composition 4-I-30%, 5-I-70% breaking load of fibers is 4,43 sN, linear density 166,8 mteks, relative breaking load 26,58 sN/teks, and the

II. CONCLUSION AND FUTURE WORK

In a theoretical analysis of the results obtained, it can be seen that with mixed composition 4-I-30%, 5-I-70% breaking load of fibers is 4,43 sN, linear density 166,8 mteks, relative breaking load 26,58 sN/teks, and the relative breaking load of the yarn from this mixture is 11,99 sN/teks, when mixed 4-II-60%, 5-I-40% breaking load of fibers is 4,38 sN, linear density 165,8 mteks, relative breaking load 25,7 sN/teks, and the relative breaking load of the yarn from this mixture is 11,86 sN/teks, when mixed 4-I-60%, 4-II-40% breaking load of fibers is 4,34 sN, linear density 168 mteks, relative breaking load 25,82 sN/teks, and the relative breaking load of the yarn from this mixture is 14,12 sN/teks. From theoretical analyzes it can be seen that when mixed 4-I-60%, 4-II-40% quality indicators of fibers and yarn produced from it are much higher than those of fibers and yarn of other mixed compounds.

Summing up, it can be said that the breaking load of fibers of various blend compositions varies with 4,38 before 4,43 sN gacha, relative breaking load with 25,7 before 26,58 sN/teks, as well as the relative breaking load of the yarn produced increased from 11,86 before 14,12 sN/teks.

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