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Influence Of The Improved Design Of The Twist Intensifier On The Mechanical Properties Of The Yarn

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ABSTRACT

The article conducts research on the selection of the optimal design and technological parameters of the twist, which affects the uniformity of the twist distribution in the yarn in the newly improved twisting device of the rotor spinning machine. It has also been found that many factors have influenced the optimum performance of the rotary holder mounted on the spinning tray. Experimental work evaluated the influence of the funnel type and twist intensifier on the spinning of 20 tex yarn produced on an AUTOCORO 9 rotor spinning machine of the German company Saurer Schlafhorst installed at the FT TEXTILE GROUP LLC (Uzbekistan).

Keywords: *pneumo-mechanical spinning, thread, twist, twist holder, funnel, roller, camera, scraper, wick, relative breaking force.*

INTRODUCTION

The main stage of the research work is the selection of optimal design and technological parameters of the twist, which affect the uniform distribution of twists in the yarn in the newly improved twisting device of the pneumo-mechanical spinning machine. Because ease of operation, efficiency, reliability and cost depend on it [1].

The device distributes the actual twist of the thread to the chamber, the side surface of the bushing enters the screw groove in the thread formed by twisting the fibres, and the resulting twist is transmitted to the thread-forming zone [2].

On the other hand, the determination of the optimal performance of a twist holder mounted on a yarn tray is influenced by many factors and requires a large number of experiments [3].

The application of mathematical methods in the planning of experiments, in contrast to traditional computational methods of research, makes it possible to determine the interaction of several factors that characterize the combined influences on the optimization parameters. As a result, a relatively small number of tests are divided into obtaining a mathematical model of the object under study, which serves to simultaneously make optimal solutions [4].

MATERIALS AND METHODS

Experimental work was carried out at FT TEXTILE GROUP LLC (Uzbekistan) in production conditions. The yarn was produced on an AUTOCORO 9 rotor spinning machine of the German company Saurer Schlafhorst, installed at the enterprise. The influence of the funnel type and twist intensifier on the spinning of yarns with a count of 20 tex on an AUTOCORO 9 rotor spinning machine with a spinning box of the G 628 BD series was evaluated. The quality and physical and mechanical properties of the yarn directly depend on the properties of the selected fibre. The higher the quality of the fibre, the better yarn is obtained from it [5].

Also, the properties of the spinning machine are an important factor in the production of quality yarns. For the production of yarn, cotton fibre An-Boyovut-2, type II(4), grown in Uzbekistan, was used.

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Sorting composition: II grade, superior grade - 75%, II grade, good grade - 25%. The physical and mechanical characteristics of the sorted fibres, found in the Uster HVI 1000 measuring system, are shown in Table 1.

Table 1. Physical and mechanical properties of the cotton fibre mixture

Type	Breeding varieties	Class	Sorting percentage,%	Micronair, (Mic)	Staple length 32 / inch, cod	Upper average length in inches *100, Inch*100 (Strenght)	Relative delay power, gk/tex	UI uniformity index,%	RD reflection coefficients,%
1	2		3	4	5	6	7	8	9
	An-Boyovut -2	Good	25	4,8	35	109,4	31,9	83,9	73,9
		High	75	4,7	36	111,9	31,6	83,4	75
	Average performance	-	-	4,72	35,7	111,2	31,67	83,5	74,7

+b degree of yellowing, %	Elong elongation at break, %	T trash code	SFI Short fibre index	spinning index, unit	The relative ripeness of the thread in units, cH/тех
10	11	12	13	14	15
9,0	5,6	6	7,1	-	-
9,2	7,6	3	9,1	-	-
9,15	7,1	3,75	8,6	-	-

The quality of cotton fibre meets the requirements of the standard UzDST 604-2016 [6]. The semi-finished product and yarn were produced in series according to the same spinning plan, in the same technological equipment, in the same spinning chambers. The spinning plan of the yarn spun on the basis of short technology is given in Table 2.

Table 2. Spinning plan of a pneumo-mechanical thread with a linear density of 20 tex (Ne = 30)

№	Name of equipment and brand	The linear density of the output product, teks, tex	Number of attachments	The amount of elongation	twist		The speed of the excretory organs		FVK	Theoretical productivity, kg/h
					$\alpha_т$	К, $м^{-1}$	V, m/min	N, min^{-1}		

1	Shaving machine TC-15 + IDF 2	5600	-	-	-	-	227	-	0,98	76,2
2	Pneumomechanical spinning machine, AUTOCORO 9	20	1	280	36,9	825	-	152000	0,95	0,22

The processing of raw materials at the enterprise was carried out in the following chain of modern technological equipment.
1. Bale opener Blendomat
2. Electronic metal holder SP-MF.
3. Primary cleaner CL-P
4. Multi-chamber mixer MX-I 10
5. Machine for mixing and cleaning fibres CL-C3
6. Cleaning from compounds of iodine TS - T5.
7. SP-DX fibre dusting machine.
8. Shaving machine TC 15 + IDF 2.
9. Spinning machine AUTOCORO 9.
The physicomechanical properties of the yarn were determined by standard methods, the roughness of the cross-section and the appearance defects on the Uster Tester 6.
The unevenness of the shear plate affects the roughness of the yarn since in the rotor spinning machine the effect of cyclic addition is manifested only in the unevenness of the shear along the length corresponding to the rotor circumference [7].
If the degree of elongation is 100, then 1 m of yarn is taken from a 1 cm skein taken from a razor. Consequently, the unevenness of the cutting insert on scissors of 1 m and 3 m affects the roughness of the yarn [8].
Taking into account the above, the quality characteristics of the provided saw blade were evaluated by testing on the Uster Tester 6 tool, carried out in the production laboratory of the enterprise. Several defects were found in Uster Afis Pro 2. The test results are shown in Table 3.

Table 3. Supplier sliver quality indicators

№	Name of indicators	Indicator	Uster синфи
1	Linear density, tex	5600	-
2	Metric number	0,178	-
3	sliver unevenness in cross-section Line, U Coefficient of variation, Cv	2,1 3,6	- 50% class
4	Cv/U ratio	1,714	-
5	sliver coefficient of variation by mass shear, Cv% 1m 2m	0,49 0,34	- 25% class 50% class
6	The amount of defects in one gram, pcs Knots small brushwood	55 49 6	- - -
7	The amount of short fibre,%	5,2	-

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As can be seen from Table 3, the quality of the shaving pad provided is good enough. The quadratic inequality of the sliver in cross-section is Cv = 2.1, which meets the requirements of the 50% class of Uster Statistics. The distribution of fibre mass across the cut is uniform. This is confirmed by the Cv/U ratio of 1.71 (in the normal distribution this ratio should be 1.25), i.e. the normal distribution is good enough. The number of nymphs (nodes) corresponding to 1 g of sliver is 49, which is 89% of the total number of defects. The coefficient of variation in sliver shear mass corresponds to a class of 25% for a 1-meter shear and a class of 50% for a 3-meter shear. It can be seen that the quality of the supplied sliver is suitable for the production of 20 tex yarns.
According to the experimental plan (Table 4), the yarn with a linear density of 20 tex (Ne = 30) was produced in 6 consecutive variants on the Autocoro 9 pneumatic mechanical spinning machine from the above-mentioned properties.
Two factors affecting thread quality were selected: funnel type (K4-4, KSS, SK4-A) and a new improved twist intensifier type (smooth roller (Fig. 1), grooved roller).

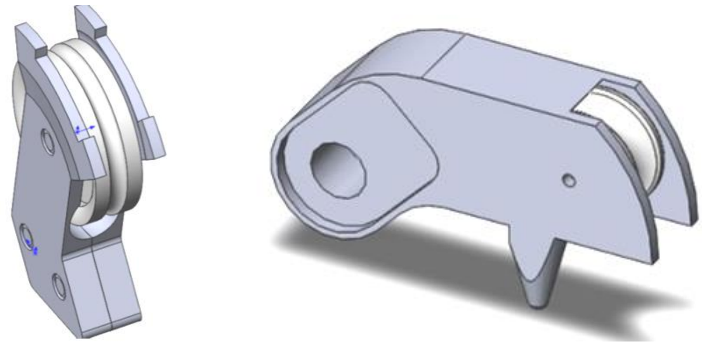

Figure 1. Newly designed smooth-surface rotating twist holders

These factors depend on the degree of fineness of the yarn, the tensile strength, the unevenness in it, the number of twists, the condition of the spinning machines. To solve the optimization problem, a method of the complete recording of combinations of factors at all levels was used [9].
The following physical and mechanical properties of yarns were determined using a combination of funnel type (K4-4, KSS, SK4-A) and twist intensifier (smooth roller, grooved roller) on a pneumo-mechanical spinning machine:

- thread fluff, cm;
- relative tensile strength, sN / tex;
- coefficient of variation of tensile strength,%;
- number of turns, twist/meter;
- coefficient of variation on twist,%.

The roughness and fineness of the yarn in the cut are determined by a modern measuring device Uster Tester 6, and the hardness is determined by Uster Tensojet 4. On Uster devices, five coil yarn samples from each variant are tested. The hairs of the threads are evaluated on two indicators: the number of hairs of 3-10 mm in length per 100m and the hairs index. A key issue in optimization is to identify important factors that affect the performance of the rotating roller. In this case, the twist on the threading rod serves to ensure a uniform distribution of twists along the length of the thread, while achieving sufficient tension in the storage zone. The thread tension and twist distribution under conditions of the constant rotation of the cell are numerically simulated, where the influence of various dimensionless spinning parameters on the thread tension and twist distribution is evaluated [10].
In the experimental plan, all tests related to the type of funnel and intensifier (new type) were performed in three re-examinations (Table 4.4). According to the experimental plan, the optimization parameters will be as follows:

- y_1- relative tensile strength of the rope, cH/tex;
- y_2- coefficient of variation on the relative breaking strength of the thread,%;
- y_4- uneven distribution of twists in the thread,%.

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4 Table. Experimental plan.

Experiment options	Funnel type	Twist intensifier (new type) type
1	K4-4	Smooth roller
2	K4-4	Roller with slots
3	KSS	Smooth roller
4	KSS	Roller with slots
5	SK4-A	Smooth roller
6	SK4-A	Roller with slots

Multi-factor mathematical planning methods are widely used in the study of working parameters of technological equipment of the textile industry. This is because unrelated factors affect the efficiency of equipment operation to varying degrees at the same time. Based on the above studies, the factors influencing the quality of pneumo-mechanical yarn were studied. Different types of densifiers and Torque Stop devices affect the yarn formation process, the spinning alternative, and the yarn quality. Given the above, the effect of newly improved twist holders and densifiers on yarn quality was studied in 6 variants.

Table 5. Indicators of physical and mechanical properties of the thread

№	Name of indicators	Uster Statistics, 50%(5%)	By enterprise	Options (Density Type, New Type Twist Saver)					
			K4-4 Green Torque Stop	K4-4 Smooth roller	K4-4 Roller with slots	KSS smooth roller	KSS Roller with slots	SK4-A силлик ролик	SK4-A Roller with slots
1	The linear density of yarn, tex	-	19,7	19,72	19,81	19,36	20,04	19,42	20,01
2	Coefficient of variation in linear density,%	-	12,08	10,96	11,05	11,13	11,23	11,08	11,97
3	Breaking force, cH	206,8	221	242	239	234	228	233	229
4	Relative tensile strength, cH / tex	10,5	11.24	12,27	12,07	12,14	11,39	11,98	11,45
5	Coefficient of variation in relative tensile strength,%	8,8	8,4	7,08	7,12	7,56	7,92	7,32	7,68
6	Elongation,%	-	2,6	2,72	2,37	3,05	2,74	2,59	2,37
7	Number of turns, m^{-1}	-	825	826	790	819	811	824	807
8	Coefficient of variation by the number of turns,%	-	3,8	2,85	3,6	3,2	3,4	3,05	3,5

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9	The number of thread breaks per 1000 cameras per hour	-	76	52	56	53	58	55	60

The physical and mechanical properties of the yarn obtained from the experiments in each variant were re-examined 3 times, the results of which are given in Table 5. Based on the results obtained, histograms were constructed depending on the type of densifier and torsion intensifier. The physical and mechanical properties of the yarn were determined on the Uster Tester using a type of compactor with a new improved rotary roller screw distributor. Experimental work Under the production conditions of FT TEXTILE GROUP LLC, 20 tex yarns with linear density were produced. The yarns of all options were found to meet the requirements of Uster Statistic 2018.

However, the use of different types of densifiers and new types of twist holders resulted in a yarn forming process, optimal spinning and yarn quality, as well as a 20-tex yarn with a linear density under production conditions using a new improved device, which was compared with a 20-tex yarn. The results obtained are presented in Table 4.5.

RESULTS AND DISCUSSION

Table 5 shows that the tensile strength of the yarn was in the range of 12.07–12.27 cH/tex when applied on the K4-4 density, 11.39–12.14 cH/tex on the KSS density, and 11 on the SK4-A density compared to the other option. 45–11.98 cH/tex, in addition, the use of a new type of twisting device with high measuring elements increased the tensile strength of the yarn and, conversely, decreased the coefficient of variation in tensile strength. The coefficient of variation in relative tensile strength when using K4-4 compactor with smooth and grooved roller bearing devices is 7.08-7.12% if used with KSS compactor 7.56-7.92%, when used with SK4-A comparator 7.32 -7.68%. Also, if K4-4 compactor and twist storage devices were used, the number of twists was found to be 790-826 twist/meter, 811-819 twist/meter in KSS densifier, and 807-824 twist/meter in SK4-A densifier.

Large elongation is important in yarn processing technology because the yarn is first stretched to a certain extent and then stresses occur under its influence. Also, with the increase of the elements holding the twist, the force required to break the thread increases when using any type of compactors. Good results were obtained in terms of the quality of the yarn produced when the smooth roller twist guard and compactor K4-4 were installed, and the number of thread breaks in the machine was less than in the groove roller twist holder. When the number of strip breaks was determined for each option, the best results came out on the first option, with an average of 52 breaks per 1,000 cameras.

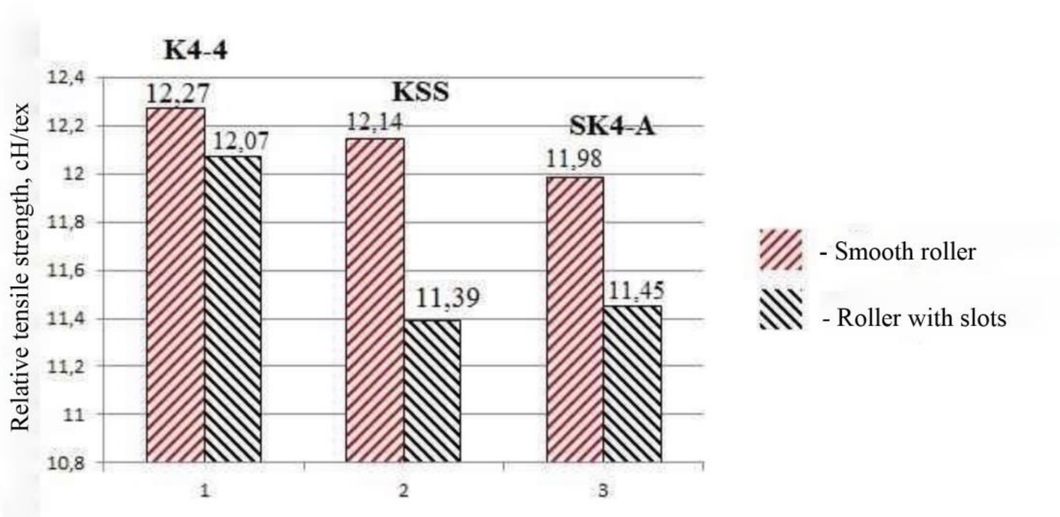

Figure 2. Histogram of the change in the relative tensile strength of the rope depending on the type of densifier and twist intensifier (new type)

The changes in the relative tensile strength of the rope depending on the types of compactors used and the new improved twisting devices are shown in the histogram (Figure 2). In this graph, a result of

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12.27 cH/tex was obtained when a newly improved smooth-surface rotary twist saver with the highest relative tensile strength K4-4 densifier was used. The smallest result was 11.39 cH/tex when using a new improved grooved surface torsion bar with KSS compactor.

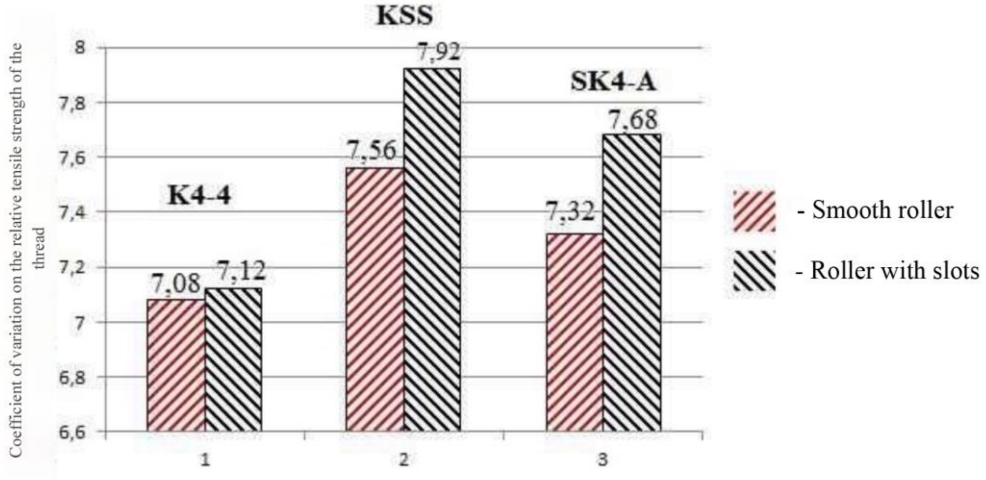

Figure 3. Histogram of the coefficient of variation of the relative breaking strength of the thread depending on the type of funnel and intensifier (new type)

The coefficient of variation in the relative tensile strength of the yarn, depending on the types of densifiers used and the newly improved twisting devices, is shown in the histogram (Figure 3). In this histogram, the coefficient of variation at the highest relative tensile strength was 7.92% when using a newly improved groove surface rotating torsion bar with a KSS compactor. The best result was obtained with the use of a newly improved rotary groove surface torsion bar with K4-4 compactor with a result of 7.08%.

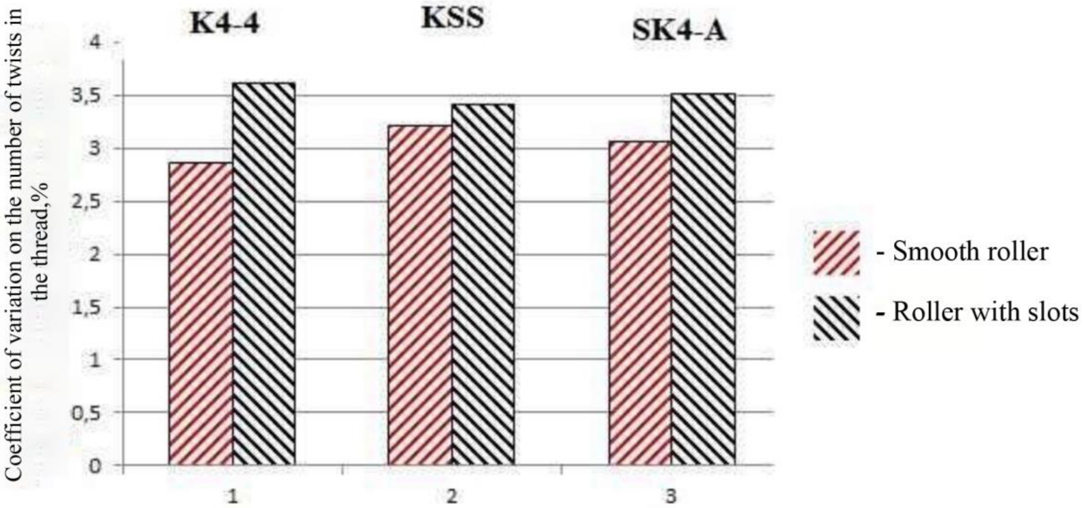

Figure 4. The coefficient of variation in the number of turns in the thread varies depending on the type of funnel and intensifier (new type).

The coefficient of variation in the number of twists in the yarn is shown in the histogram (Figure 4) depending on the types of densifiers used and the new improved twist storage devices. After the introduction of new improved twist storage devices, the coefficient of variation in the number of twists in the yarn increased.

CONCLUSION

In summary, the unevenness in the number of twists in the yarn was improved when a new improved smooth-surface rotary twist guard was used with K4-4, SK4-A compactors. It can also be seen from the histogram obtained that it gives good results when used in combination with option 1 K4-4 compactor and the newly improved smooth surface rotary twist saver. Sliver squared unevenness by cut meets the requirements of 50% class of Uster Statistics, the coefficient of variation in sheer mass corresponds to 25% class on 1-meter shear, 50% class on 3-meter shear, and the quality of supplied sliver is suitable for 20 tex yarn production. As a result of the experiments, the number of thread breaks was reduced by 32% compared to the current situation at the enterprise, when the production of 20 tex yarns with a linear density with the installation of a new design smooth roller twist saver and a sealant type K4-4, relative tensile strength increased by 8%, rope roughness decreased by 9%, the unevenness of the distribution of twists across the yarn was reduced by 25%. This theoretical research has shown that it has been proven in practice.

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