DYNAMICS OF CHANGES IN THE BASIC PHYSICAL AND MECHANICAL PROPERTIES OF COTTON FIBER DURING SPINNING

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Abstract. *In this article, cotton is used in the technological transition in the production of yarn with a linear density of Nm = 54/1 (Ne = 32/1) and Nm = 27/1 (Ne = 16/1) on cotton spinning equipment used at PAPFEN LLC. the elongation property of the fiber (Elg %) and the amount of short fibers (SF%) less than 12.7mm in length and other quality parameters were determined using a measuring instrument type HVI-1000 installed in the enterprise testing laboratory. The results of the research were analyzed and measures to improve the quality of products were proposed.*

Keywords: *yarn, elongation property of yarn at break, number of short fibers in cotton fiber, yarn strength, variability of yarn properties.*

ДИНАМИКА ИЗМЕНЕНИЯ ОСНОВНЫХ ФИЗИКО-МЕХАНИЧЕСКИХ СВОЙСТВ ХЛОПКОВОГО ВОЛОКНА В ПРОЦЕССЕ ПРЯДЕНИЯ

Аннотация. *В данной статье хлопок используется при технологическом переходе при производстве пряжи линейной плотностью Nm = 54/1 (Ne = 32/1) и Nm = 27/1 (Ne = 16/1) на хлопкопрядильном оборудовании. используется в ООО «ПАПФЕН». свойство удлинения волокна (Элг %), количество коротких волокон (КВ%) длиной менее 12,7 мм и другие качественные показатели определяли с помощью измерителя типа ХВИ-1000, установленного в испытательной лаборатории предприятия. Проведен анализ результатов исследований и предложены мероприятия по повышению качества продукции.*

Ключевые слова: *пряжа, свойство удлинения пряжи при разрыве, количество коротких волокон в хлопковом волокне, прочность пряжи, изменчивость свойств пряжи.*

1. Introduction

The relative elongation (Elg %) of cotton fiber is one of the main factors for achieving high productivity in the spinning process and subsequent weaving processes, as well as in obtaining high-quality finished products. Ruvini M. et al. [1] in studying 32 types of fibers with varying degrees of elongation, argue that the elongation of the fiber affects the strength of the yarn, the number of thick and thin sections and the degree of their hairiness. It has been suggested that low elongation cotton fibers can break during the drawing process and result in an increase in the number of short fibers.

The influence of the number of short fibers in cotton fiber on the quality indicators of spinning yarn is described in detail in the following studies (Devron Tibedo et al. [2], Ibrahim A.E. Ibrahim [3]).

Researchers at Clemson University in the USA [2] used 28 fiber types with varying degrees of short fibers (less than 12.7 mm long) in cotton fiber of different breeding varieties.

Their quality indicators were determined in the HVI, AFIS and SW systems, and a regression dependence of the yarn strength, the sum of thin and thick sections (yarn with a linear density of 20 tex), depending on the number of short fibers, was established. The authors proposed a method for predicting the quality of yarn produced from fibers with different physical and mechanical properties.

According to the author [3], with an average length of cotton fiber equal to 34.37 mm and with a proportion of short fibers (less than 0.5 inches) - 4.5%, the relative strength of the yarn was 20.77 cN / tex, and with the length of the fiber 30.12 mm, and the proportion of short fibers- 6.6%, the relative strength of the yarn was 13.0 cN /tex, or the loss of strength of the yarn was- 37.4%.

Researchers at Usak University in Turkey, E. Oner et al. [4] proposed regression models of the dependence of the quality of cotton fiber on the physical and mechanical parameters (strength, elongation at break, thick and thin sections, neps and hairiness) of the finished yarn.

The quality of the produced yarn mainly depends on the properties of the raw material, its preparation for spinning, the condition of the equipment, and the preservation of the natural quality of cotton fiber during processing. The question of the number of defects in cotton fiber and their total content is a very important issue for cotton spinning. The non-standardized number of defects in the raw material reduces the quality indicators and yarn yield, which requires additional technological processes; therefore, on the part of production, the requirements for reducing the share of cotton fiber defects are constantly increasing [5].

In the textile industry it is well known that, price of raw materials is a significant part of the cost of production in spinning factories. Hence - the process of optimizing the use of raw materials is the main objective of control and requires changes in the properties of the fibers in the spinning process [6].

2. Materials and methods

As an example, cotton fiber was used from the “Andijan 35” cotton breeding variety, grown on the agricultural land of the holding enterprise, ginned at the Pop and Gulbog cotton ginning plants . These samples were used to determine the dynamics of the change in the quality parameters of the fiber both in raw materials and in semi-finished products during the production of yarn with linear densities Nm = 54/1 (Ne = 32/1) and Nm = 27/1 (Ne = 16/1) under the production conditions of the spinning factory " PAPFEN " LLC.

In table 1, in the form of a diagram, the tips and models of technological equipment installed at the spinning mill are presented, and in table 2 - the main indicators of the spinning plan adopted at the enterprise. In table. 3 shows the quality indicators of the mixture of cotton fiber adopted at the enterprise for the production of the above yarns. Data obtained on a Uster HVI-1000 instrument available in the factory laboratory. (data obtained are the average of 5 measurements taken from each sample)

1 Table

The system of the technological process of spinning yarn in the enterprise

Bale opener BOA - 1200 from Trützschler _ _

“ Trützschler ” _ _ EMA 1200 cleaning machine for metals and heavy impurities

Carbon monoxide feeder BO - R by Trützschler _ _ _ _

Trutzschler AFC Primary Cleaner

Trützschler fiber mixer MPM 10/1600

EE -23-800 JOSSI color fiber separation machine

Trützschler seed cleaning machine ASTA 800

Trutzschler cleaning machine CVT 4 1200

Dust cleaner model-DX from Trutzschler

Trutzschler carding machine DK-760

1- transition draw frame SH802/D company "VOUK"

2- transition draw frame TD-8 from Trützschler

Roving frame BF - 224 from Crossenhainer

Spinning machine model-2114 of " CSM " company

Winding machines model-"POLAR M" company "SAVIO"

2 Table

The spinning plan for the production of yarn adopted at the enterprise.

No.	Technological process	Incoming product		Outgoing product		Degree of drawing E
		Name _	Line density Nm	Name _	Line Density Nm	
one	Opening-trepole, carding line	Cotton blend		carding tape	0.203	
2	I- transition draw machine	carding tape	0.203	Tape 1-transition	0.203	eight
3	II- transition draw frame	Tape 1-transition	0.203	Tape 2-transition	0.203	eight
4	Roving machine	Tape 2-transition	0.203	Roving	1.49	7.33
5	Ring spinning machine (N m 27/1)	Roving	1.49	yarn on the cops	27/1	18.18
6	Ring spinning machine (N m 54/1)	roving	1.49	yarn on the cops	54/1	36.36

7	Rewinding process	yarn on the cob	27/1 54/1	yarn in bobbin	27/1 54/1	--------

3 Table

Quality indicators of cotton fiber in the mixture

No.	Cotton fiber					Qualitative indicators according to USTER HVI-1000					
	Selection	Type	Variety	Class	Share in the mixture %	Line 1 (inch)	Len 2 (inch)	Degree of uniformity Unit%	Specific breaking load gr.s/tex	Elongation Elg (%)	Short fiber index SFI(%)
one	"Andijon 35"	IV	I	"oliy"	4.19	1.033	1.214	85.1	45.09	5.1	5.4
2	-	IV	I	"yahshi"	57.19	1.026	1.218	84.2	43.84	4.9	5.3
3	-	IV	I	"o'rta"	38.62	1.028	1.235	83.2	42.39	5.3	6.1
Average value in the mixture						1.027	1.224	83.8	43.289	5.06	5.61

Sampling points taken to determine the properties of the fibers during spinning:

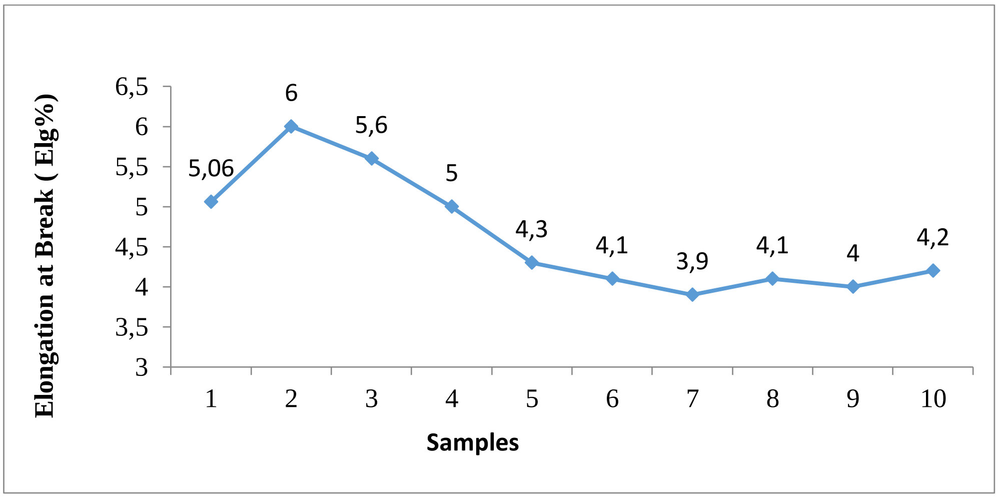
1. Fibrous mixture obtained from a bale opener ;
2. From the fiber supply hopper to the carding machine;
3. Obtained from a carding tape;
4. Obtained from the 1st transition of the draw frame;
5. Obtained from the 2nd transition of the draw frame;
6. Rovings obtained from torn.
7. "Pneumofull" in the development of yarn Nm = 27/1 (Ne = 16/1);
8. "Pneumofull" in the development of yarn Nm = 54/1 (Ne = 32/1);
9. "Ring waste" during yarn production Nm =27/1 (Ne = 16/1)/1 ;
10. "Ring waste" in the production of yarn Nm = 54/1 (Ne = 32/1)/1;

Before taking measurements, the Uster HVI-900 measuring device underwent a standard calibration in the laboratory of the enterprise.

3. RESULT AND DISCUSSION

"Ring waste" is a fiber waste that appears when it breaks when exit from the yarn extraction devices of spinning machines and sucked up by a flute and collected in special chambers.

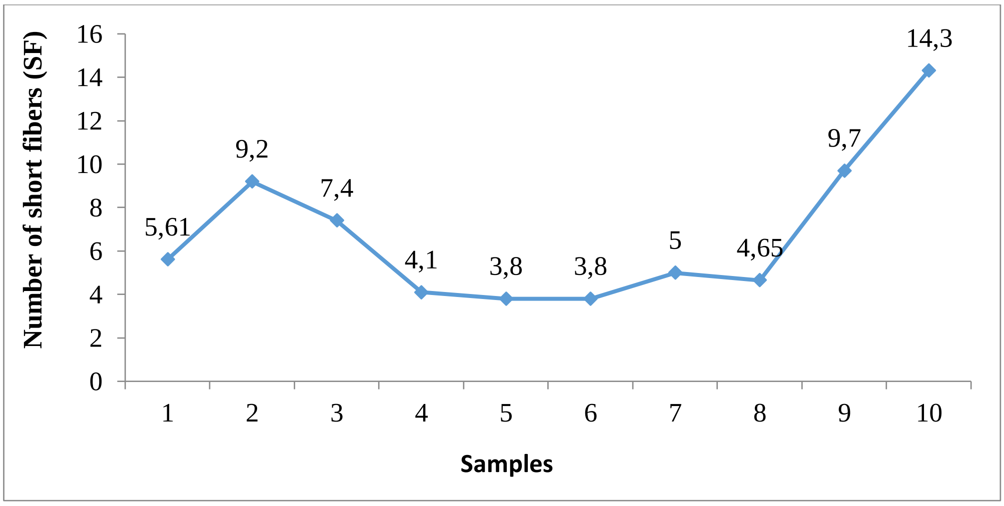
"Pneumofull waste" - fiber waste collected on the cleaning rollers of the draft devices of roving and spinning machines.



1 figure. Graph of the change in the elongation of cotton fiber in the technological process of yarn production.

Based on the data presented in Figure 1, the following conclusions can be drawn:

- It was found that the decrease in the degree of fiber elongation occurs in the main tape process (in the 1st transition by 10.7%, in the 2nd transition up to 14%). These data indicate the need to optimize the technological parameters of tape transitions.
- It has been found that the reduction in elongation from loosening aggregate to yarn formation is 30-33.3% (depending on linear density).
- It has been established that the degree of fiber elongation in the roving and spinning processes is minimal.

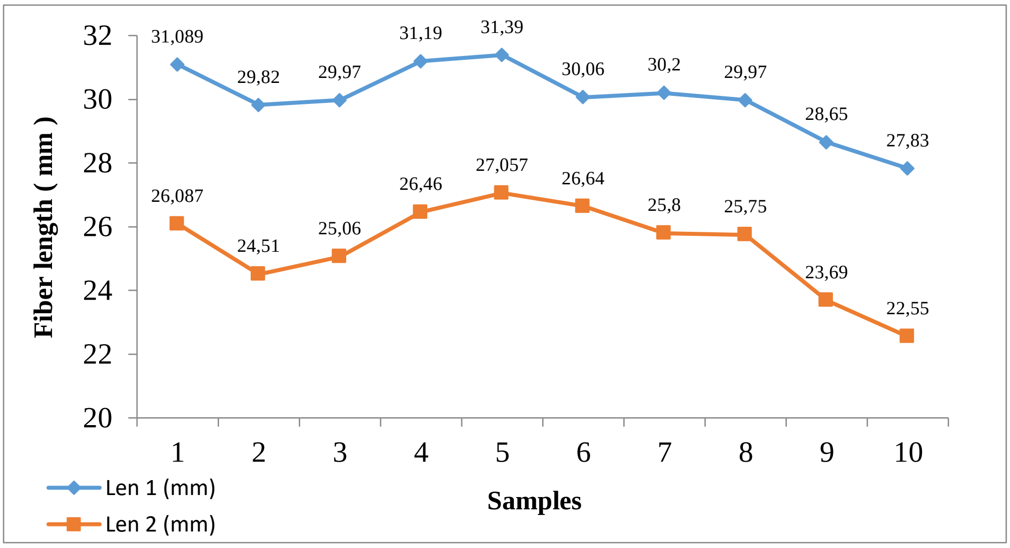


2 Figure. Indicators of change in the number of short fibers in the technological process of yarn production.

On fig. 2 presents the results of studies to determine the degree of change in the number of short fibers in the production of yarn, and based on these data, the following conclusions can be drawn:

- It was found that the proportion of short fibers less than 12.7 mm increased by 1.64 times (from 5.61% to 9.2%) in the carding machine hopper. This may be due to the breakage of the fibers in cleaning machines.

- In the process of combing, this figure decreased by 1.24 times (from 9.2% to 7.4%). This is due to the fact that on a carding machine, part of the short fibers are removed by movable and fixed caps.
- In the 1st ribbon transition, the proportion of short fibers decreased by 1.8 times (from 7.4% to 4.1%). The main reason for this is that their length changes due to the elongation of the fibers.
- A small change in the SFI value (%) of the fibers was found in the 2-junction of sliver, roving and spinning yarns
- The number of short fibers in the " sliver " coming out and accumulating in the bunker was determined. As a result, in the process of spinning yarn with a linear density of Nm = 27/1 (Ne = 16/1), the value of SFI (%) increased by 2.55 times, i.e. from 3.8% to 9.7%, in the process obtaining yarn with a linear density of Nm = 54/1 (Ne = 32/1), this figure increased by 3.76 times, i.e., from
- 3.8% to 14.3%. The first reason for this is that part of the short fibers suspended in the spinning triangle, which is formed when the fiber bundles exit the spinning machine drafting device, enters the collection chamber through the air collector and the second factor, an increase in the number of short fibers, may be the degree of stretching of the roving in spinning machine (especially for Nm = 54/1 (Ne = 32/1)).



3 figure. Dynamics of fiber length change in the technological process of yarn production.

Generally, Uster HVI uses two different methods to measure cotton fiber length:

Len 1 - The average length of all fibers in the sample is determined in inches or millimeters.

Len 2 is the average length of the longest fibers that make up half the mass of the sample, expressed in inches or mm .

On fig. Figure 3 presents the results of a study of the dynamics of changes in the length of cotton fiber in the technological process for the production of yarn of the above thickness at the enterprise.

The analysis of the obtained results is the basis for the following conclusions:

- When measuring the dynamics of changes in the lengths of the fibers in two different ways, it was found that they change almost according to the samepatterns;

- There was a decrease in the length of the fibers in the process of loosening, tripping and cleaning (Len 1 - 6.04% and Len 2 - 4.08%), and in carding, tape and roving transitions , their elongation is observed due to parallelization and fiber pulling.

-During the spinning process, a decrease in the length of the fibers in the "spinning waste" was observed, in particular in the "колечки" obtained during the production of yarn with a linear density of Nm = 54/1 (Ne = 32/1) (Len1. -13.5%; Len 2. -3.6%); and in the "spinning waste" it decreased (Len1. by -13.5% and Len2. by -10.4%) . This conclusion can be justified by increasing the degree of short fiber spinning waste.

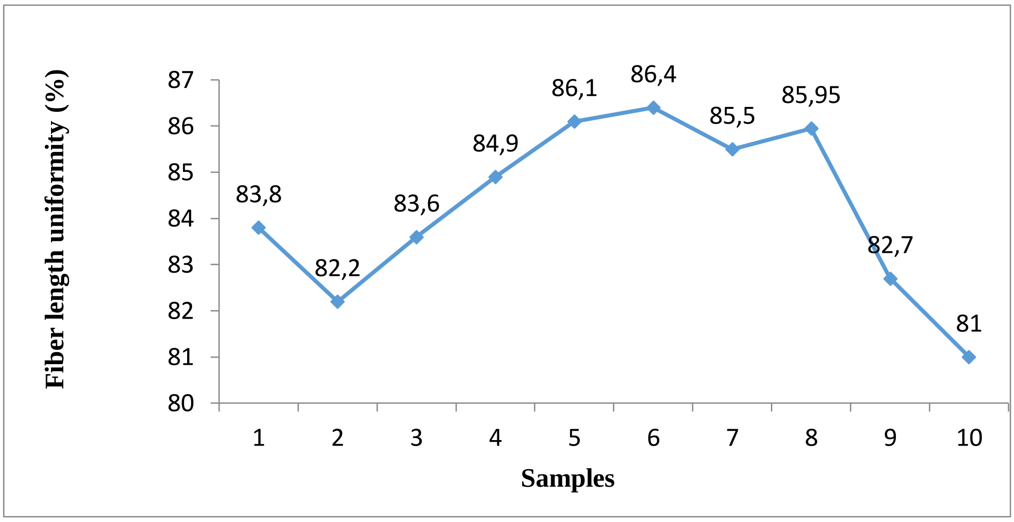


Figure.4 Dynamics of changes in the uniformity of fiber lengths in the technological process of yarn production

Based on the results obtained, the following conclusions can be drawn:

-In the process of defibration and cleaning of fibers from impurities in loosening and scutching aggregates, the uniformity of fiber lengths is partially reduced compared to the mixture (-1.9%) . and in subsequent processes it was found that this figure increased and reached its peak in the roving, and decreased in the "spinning waste" and “Pneumofull waste" due to the increase in short fibers.

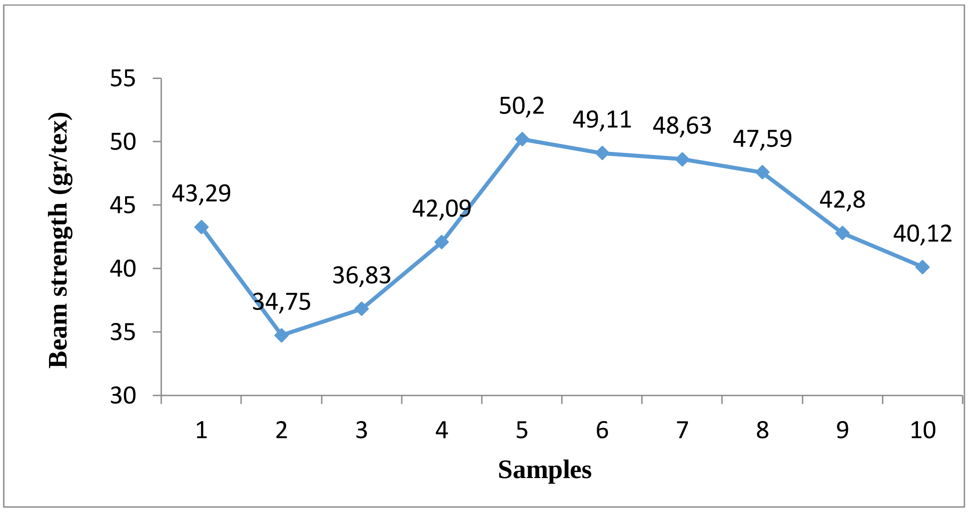


Figure.5 Dynamics of changes in the strength of a bundle of fibers of a certain mass in the process of yarn production

Relative tensile strength of cotton fiber, i.e. its relative strength is determined by measuring the tensile strength of a strand of 1/8 inch (3.175 mm) fiber on the measuring block of a Uster HVI type instrument. In the experiments, the relative strength of the fiber decreased compared to the mixture in the loosening-carding process (from 19.72 to 14.92%), increased in the tape and roving processes (up to 15.96%), and as a result, a decrease in the strength of the fibers in the " sliver " was observed. " (from 1.13% to 7.32%). The main reasons for this may be a change in the degree of short fibers in semi-finished products at technological transitions.

4. Conclusion

Based on the study, the following main conclusions can be drawn:

In the carded system, due to the low elongation of the fibers in the "spinning waste" formed during the spinning of cotton fiber, and the high content of short fibers, it is not advisable to use them in their blends when producing yarn of high linear density (Nm40/1 ÷ 65/1).

They are recommended to be included in blends for yarns of low linear densities (Nm 40/1 and below), produced by the Open End (OE) spinning method.

- It is recommended to optimize the linear densities of semi-finished products (sliver, roving) in spinning plans, especially for the production of fine yarn.

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6. DECLARATION OF CONFLICTING INTERESTS

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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