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Influence of Spindle Speed on the Quality of Yarn on the Spinning Machine

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ABSTRACT

In this article, the effect of spindle speed on yarn properties were analyzed on Zinser 350 and Zinser 72 XL ring spinning machines. During the experiment, yarn samples that were at 11000 rpm, 12000 rpm, 13000 rpm, 14000 rpm, and 15000 rpm spindle speed, at 860 twists per meter and 19,6 tex linear density on Zinser 350 ring spinning machine and at 15000 rpm, 15500 rpm and 16000 rpm spindle speed, at 820 twists per meter and at 19,6 tex linear density on Zinser 72 XL ring spinning machine spun in the card spinning system. 4-I type cotton fiber used for raw material. The obtained results were compared with the requirements of Uster statistics 2018 and based on them, tables were constructed. According to the results of the analysis, the quality of the yarn samples obtained at the spinning machine of both brands at a speed of 15000 rpm gave the best results. During the research, an android application "textile calculator" was created for use in the spinning laboratory and used in the calculations.

KEYWORDS: *Spindle, twist, yarn, strength, speed, table, unevenness, linear density, Uster statistics 2018, cotton fiber, android app, textile calculator, Technolab, DGU 10161*

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INTRODUCTION

Demand for natural cotton fiber products in the textile industry has risen sharply. Of course, to make a good income, you need to produce high-quality and state-of-the-art products that are in demand. In this regard, the importance of techniques and technologies used in industry is high [1].

One of the leading branches of the textile industry is the technology of yarn production, and the use of leading company equipment in the textile industry in spinning mills is important. Of course, modern equipment, using high-quality raw materials, also has a direct impact on the production process of yarn and fabrics at the required level [2,18]. In the high-quality yarn fabric, not only will be a high level of external appearance, but also its physical and mechanical properties [3,20]. However, the fact that modern equipment is installed does not mean that it will produce a quality product. To do this, it is important to adjust all the parameters of these devices following the properties of the raw material [4].

Today, many scientists are researching to study what factors influence the change in these characteristics. Including, As Iftikhar Ahmad, Nisar Ahmad Jamil and Nadeem Haider [5] points out, the quality of the yarn is affected not only by the raw material but also by the machine parameters. During their research, they tested yarn samples on Ne=30 card yarn, at different speeds and at different twists, and concluded that the best performance in terms of yarn strength was at the lowest spinning speed and low twisting performance. During the research of Mr. Jagdish D. Patil, Mr. Prafull P. Kolte, Mr. Sujit S. Gulhane [6] used Ne = 100 and Ne = 80 cotton yarns to study the effect of yarn rotation speed on yarn quality in the ring-spinning. According to this, the strength of the yarn samples decreased with increasing yarn rotation speed. During the research of Lablu Miah, NusrathSharmin, and Jarin Yasmin [7] were spun Ne=24 yarn from cotton fiber in the card system. When comparing the properties of yarn samples according to ASTM standards, the best results were obtained when using a traveler with a

rotational speed of 12,500 rpm and a weight of 44-46 mg. Katarzyna E. Grabowska [8] conducted several studies, and one of these studies was developing a mathematical model for the strength of the yarn. In addition, a number of Uzbek researchers Q.G.Gafurov, Sh.R.Fayzullayev, J.Q.Gafurov, and X.T. Bobojanov have studied the effect of spindle speed on yarn quality. In modern spinning machines, not only the spinning speed but also all other parameters have a significant impact on the quality of the yarn [2, 16]. Therefore,the optimization of all parameters in the machine is an important factor in obtaining quality yarn.

Nowadays, many modern dynamometers, as well as strength machines manufactured by various companies,are used to measure the strength of yarn [9].

RESEARCH METHODS

In particular, during the study, samples of yarn that spun on Zinser 350 and Zinser 72 XL ring spinning machines were tested in the laboratory of the Tashkent Institute of Textile and Light Industry and in the laboratory of "Mega Tekstil" enterprise and compared with Uster

statistics 2018 [10] requirements. Technolab and Uster equipment were used in the laboratories. Ne=30 numbered yarn samples were spun on the Zinser 350 and Zinser 72XL ring spinning machines. 4-I type fine cotton fiber was used in the spinning process of yarn samples.

The HVI 900 SA equipment was used to obtain the results in Table 1. If we look at the results shown in the table, we can see that the results obtained correspond to the properties of cotton fiber, which should be present for the product planned by the enterprise.

The quality of the obtained yarn samples was tested in the enterprise laboratory on Technolab equipment. The results were obtained using techno twist device to check the number of turns, Statimat device to determine the strength of yarn samples, Techno Tester to check for unevenness, electronic yarn linear density tester to determine the linear density, and software patent number DGU 10161 created during the analysis [11]. Below is an analysis ofthe theoretical formulas in the creation of this program.

The software package is written in the Java program. Required operating system - Android 4 and higher. Technical requirement - Android mobile phones. The size of the software package was 5,6 MB.

This app creates comfort ability for the measuring of yarn quality and simplifies the calculation processes.

Except for that, in the calculation processes of quality of yarn samples, these methods are used for theassessing.

In the measuring yarn twist, we used the Techno Twist Tester instrument. And in this process, we measured the yarn samples twist as a way of untwisting.

Yarn unevenness expressed the coefficient of variation (CV in %) and was measured in the Techno Testerinstrument.

$$CV\% = \frac{S}{\dot{x}} \times 100 \quad (1)$$

where: S= standard deviation, ẋ= average.

$$CV = 1{,}25U \quad (2)$$

where: U= linear irregularity.

$$CV_{lim}\% = \frac{186}{\sqrt{n}} \quad (7)$$

Irregularity index I, can be calculated as follows:

$$I = \frac{CV_{actual}}{CV_{lim}} \quad (8)$$

CV_{actual} being the actual irregularity [12].

RESULTS

The results of the study are presented in the form of tables and diagrams below. The yarn samples tested on Technolab and Uster equipment were compared with the requirements of Uster statistics 2018 95% and 50% (Table 2). Zinser ring spinning machines of 2 different brands (Zinser 350 and Zinser 72 XL) were used in the analysis [13].

From the Table 1 below it can be seen that the strength of the yarn reaches a maximum at R=13,9 sN/tex atspindle speed 11000 rpm and a minimum at R=13,0 sN/tex at spindle speed 14000 rpm. If we compare the results with the requirements of Uster statistics 2018 (95%),we can see that the strength of the yarn is 11,2% higher at thespeed of the rotation of the spindle =11000 rpm.

TABLE 1 Yarn samples tested on Technolab and Uster equipment compared with the requirements of Uster statistics 2018 95% and 50%

№	Indicators Name	On Zinser 72 XLMachine			Uster Statistics 2018, 50%	On Zinser 350 Machine			Uster Statistics 2018, 95%
1	Spindle Speed, X1000Rpm	15	15,5	16	-	11	13	15	-
2	Twist Count		820		-		875		-
3	Practical Twist,	849	828	760	-	840	821	805	-
4	Linear Density, Tex	19,6	19,6	19,6	19,6	20,4	20,4	20,0	19,6
5	Coefficient Of Variation In Linear	14,71	14,69	15,77	15,28		-		17,86
6	Strength, (Sn/Teks)	15,1	14,2	14,3	15,6	13,9	13,2	13,3	13,7
7	Coefficient Of Variation In Strength,	6,28	7,76	5,69	8,2	5,3	6,6	5,8	10,7
8	Elongation, %	5,35	5,54	5,25	5,4		-		-
9	Thin Places (Thin/Km-50%)	8	4	7	12	34	38	31	51
10	Thick Places (Thick/Km+50%)	153	156	289	160	268	364	286	462
11	Neps(Nep/Km+200%)	157	168	193	307	489	489	513	769
12	Hairiness, H	5,25	5,57	5,48	5,6	6,7	7,1	7,4	6,9

If we analyze the table 2 above, we can see that the linear density of yarn samples was 3,5 % higher than Uster statistics 2018 (95%) requirements when the spindle rotates at the speed of 11000 rpm, 12000 rpm, and 13000 rpm, 2% higher at the speed of 14000 rpm and also 1,5% higher at the speed of 15000 rpm on Zinser 350 machine.So, the more we increase the spinning speed on the Zinser 350 ring spinning machine, the more it can be seen that the linear density of the yarn decreases and remains at the level of demand. We know that the more we reduce the linear density of the yarn, the greater its length, and we can get a fabric that is thinner and lighter from a thin yarn [17].

If we take into account that the standard deviation of the physical and mechanical properties of the yarn is 2.5% [14], A yarn of 20,4 tex and yarn of 20.0 tex are assumed to have the same linear density. So, this means that yarn with a low linear density will have less mass due to the small amount of fiber in the cross-section [19]. If we compare the lengths of yarns of the same mass of 20,4 tex and 20,0 tex and the fabric obtained from them, respectively, we can see that the length of the yarn with 20,0 tex and the length of the fabric obtained from it will be longer. As a result, more fabric is produced and more revenue is generated [15].

In order to increase the accuracy of the results obtained during the study, to study the advantages of another new brand of ring spinning machine Zinser, and to compare the quality of yarn samples from two different brands of machines studied during the study, another study was conducted at the enterprise of "Mega Textile" LLC. Zinser 72 XL ring spinning machine, Technolab laboratory equipment, Ne = 30 yarn samples were taken as the object of research in this process. Type 4-I fine cotton fiber was used in the spinning process.

When the spindle speed 15000 rpm, the strength of the yarn was 15,1 sN/tex and was 3,3% less than Uster statistics 2018 50% requirements, when the spindle speed 15500 rpm, the strength of the yarn is 14,2 sN/tex, which is 9% less than the Uster requirements, and at a spindle speed of 16000 rpm, the strength of the yarn is 14,3 sN/tex on Zinser 72 XL machine. We can see that it is 8,3% lower than the Uster statistics 2018 50% requirements.

So, we can see the analysis of the results in this diagram shows that when the spindle speed on the ring spinning machine is 15000 rpm, the strength of the yarn samples is the highest and is 3,3% lower than the Uster statistics 50% requirements. From these results, we can see that the increase in the spindle speed of the spinning machine has an inversely proportional effect on the strength of the yarn samples spun.

CONCLUSIONS

Therefore, when spinning cotton yarns with Zinser 350 and Zinser 72 XL ring spinning machines using 4-I grade cotton fiber as raw material, the spindle speed at 15000 rpm was analyzed by analyzing the yarn quality parameters, two studies have confirmed that it was the optimal option.

The results on the Zinser 72 XL ring spinning machine were in line with Uster statistics 2018 at

50%, while the results on the Zinser 350 were in line with Uster statistics 2018 at 95%.

It turned out that one parameter in the spinning machine had a significant impact on several of its quality indicators. Given that the spinning machine has more than one parameter, the optimization of all parameters ensures that the quality of the yarn is high.

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