Research Article

Investigation of Influence ofa New Twist Intensifier on the Properties of the Twisted Yarn

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Abstract: The article is devoted to the study of the properties of the yarn obtained by the methods of ring and rotor spinning, for twisted yarn, produced on a VTS-09 double twist machine made by Volkmann (Germany). Experiments were carried out on two typesof spinning yarns with yarn counts Ne 20/2 and 12/2 in the existing design (control) and the new design, flexible element with equal tension and twist intensifier and compared the effects of the resulting twisted yarn for quality parameters. Mathematical statistical methods (single-factor analysis of variance) were used to assess the quality of twisted yarn. Experiments have shown that the use of a new design nozzle reduces the vibration of the yarn, which leads to a uniform distribution of twists along the length of the twisted yarn, increases its tensile strength and improves the quality of the twisted yarn.

Keywords: cotton, fibre, linear density, CVm %, CV of twist, twisted yarn, single yarn, twisting machine, twist.

1. Introduction

One of the most pressing issues today is the improvement of technology for the production of twisted yarn from cotton yarn, to determine the effect of twisting of yarn from single yarns spun by ring and OE on its unevenness, strength and Twist Multiplayer[1, 2]. In spinning yarns, the fibres are not sufficiently bonded to each other, many of which are partly involved in breaking strength [3, 4]. The share of fibres in yarn strength does not exceed 45-50% [5]. Also, the ends of the fibres of the yarn come out, which makes it more hairiness and less resistant to friction [6]. The forces of friction between the fibres determine the degree of use of their destructive force in the yarn [7]. The magnitude of the friction force depends on the magnitude of the normal pressure created by the tension of the fibres when twisting the yarn [8]. On the basis of scientific research, it was determined that a single yarn is not the same in its physical and mechanical properties [9,10]. To obtain a twisted yarn with a uniform twist, the yarns must have the same tension, the same pitch of the helix where they will be located [11,12]. With an uneven tension, a weakly stretched yarn can be wound on a tightly stretched yarn, which leads to defects in the twisted yarn - corkscrew [13, 14].
With the above, a new device (nozzle) was created that gives the same tension to the yarn and helps to distribute the twists in order to obtain quality twisted yarns on the twisting machine and the effect of the new device on the quality of the twisted yarns was studied. A feature of the device is the installation of elastic elements on the inner wall of the nozzle, the spherical shape of the ball-bearing surface of the guide tube thread, as well as the uniform distribution of twists during torsion without vibration. This leads to a decrease in the unevenness of the number of twists and an increase in the quality of the twisted yarn [15,16,17].

2. Research methodology

Was studied the influence of single yarns spun by the ring and OE methods on the quality of twisted yarns using a new uniform tensioning and twisting device.
During the experiment, was used cotton fibre of type 5, I-grade, good grade, selection variety "Ak-Daryo" 5, grown in Uzbekistan.
During the research, single yarns of the count of Ne20 and Ne 12 were spun using Zinser-350 (Germany) spinning and OE BD-330 (Czech Republic) spinning machines.
The quality parameters of raw materials are given in Table 1. Also, the quality of cotton fibre meets the requirements of the standard UzDST [18].

Table.1
Indicators of the given raw material

#	Items		HVI
1	Micronaire (Mic)		4.57
2	Lineardensity, mtex		0.180
3	Length,	inches	1,28
		mm	32,6
4	Relative tensile strength, sN / tex		25,6
5	Uniformity Index (UNF)		80,3
6	Elongation,%		7,5
7	Damage and Trash count,%		2,5
8	Short fibre content,%		8,2
9	Reflectance, Rd		72,4

Rewinding of spinning yarn on an Autoconer machine, doubling processes on the cylindrical cone was carried out on a Fadismachine of the firm (Italy). From the added single yarns, yarns twisted were produced on a VTS-09 twisting machine manufactured by Volkmann (Germany).

Before the production of twisted yarns, the quality characteristics of single yarns with a count yarn Ne 20 and Ne 12 were studied [19].

The quality parameters of the obtained single yarns are shown in table 2.

Table 2
Physical and mechanical properties of individual threads

T/p	Items	Ne 20/1		Ne 12/1	
		Zinser-350 RS	BD-330 OES	Zinser-350 RS	BD-330 OES
1	Count NE	20,1	20,3	12,2	12,1
2	CVm,%	2,2	1,6	2,0	1,8
3	Breakingforce, sN	391	318	695	562
4	Relative tensile strength, sN / tex	13,2	10,9	13,9	11,2
5	CV of breaking strength, %	10,1	9,2	9,4	8,8
6	Elongation,%	5,3	6,4	6,8	7,7
7	Number of twist per meter	742	846	604	630
9	The use of fiber strength in yarn strength	0,52	0,43	0,54	0,44

3. Experimental part

As can be seen in Table 2, the yarns spun in two different methods meet the requirements of the normative technical document [20, 21]. The RKM of a yarn obtained from a ring spinning machine is 1.22-1.24 times higher than that of a yarn obtained from an OE spinning machine Twisting of Ne 20 OE yarn is 14% higher than ring-spun yarn maturing (846 vs. 742 twists/m), Ne 12 OE yarn is 4% higher (630 vs. 604 twists/m), the use of fibre strength in yarn strength in ring spinning the coefficients are 0.52 (Ne 20) and 0.54 (Ne 12), while the OE yarn is 0.43 and 0.44, respectively.

The above is explained by the peculiarity of the method of OE spinning (OES), ie its dependence on the structure of the yarn [22]. During the experiments, the quality characteristics of the twisted yarns in the existing design (control variant) and in the new device (experimental variant) with the addition of two single yarns were compared.

All tests were performed three times in repetition. Physico-mechanical performance of the rope was determined on the STATIMAT-C tester, the coefficient of variation on the twist on the AUTOTWIST COUNTER twist gauge.

4. Theoretical part

The comparison of the parameters was performed mainly on the basis of one-factor variance analysis [23]. Experiments were carried out on 3 repetitions of the RKM and of the CV of RKM of the twisted yarns.
The results of measuring the RKM of Ne 20/2 (RS, OES) yarns are given in Table 3.

Table 3.
Parameters of Rkm value of the Count Ne 20/2
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Repetitions	Construction of the spindle (factor A)			
	RS		OES	
	Normal	New	Normal	New
1	14,6	14,82	11,68	11,8
2	14,6	14,83	11,60	11,9
3	14,36	14,80	11,63	12,0
Mean	14,52	14,81	11,67	11,9

Table 4.
The square root value of the Rkm indices

Repetition	Construction of the spindle (factor A)			
	RS		OES	
	Normal	New	Normal	New
1	3,821	3,850	3,418	3,435
2	3,821	3,851	3,421	3,450
3	3,789	3,847	3,410	3,464
A_i	11.431	11.548	10.249	10.349
$\sum_y^2$	43.5565	44.4521	35.014	35.7009
A	22.979		20.598	
$\sum\sum_y^2$	88.0086		70.7149	

The sum of the squares was calculated from the following formulas

$$SS_{total} = \sum_{i=1}^{p} \sum_{j=1}^{m} y_{ij}^2 - \frac{A^2}{mp} \quad (1)$$

$$SS_a = \sum_{i=1}^{p} A_0^2 - \frac{A^2}{mp} \quad (2)$$

$$SS_A = SS_{total} - SS_a \quad (3)$$

Table 5.

Source of dispersion	The sum of the squares	Number of degrees of freedom-f	Average square	Fisher-F criteria
RS				
Factor A Error Sum	0,0023 0,0006 0,0029	1 4 5	0,0023 0,00015	15,3>7,71 $F_{табл}$=7,71
OES				
Factor A Error Sum	0,0017 0,0003 0,0020	1 4 5	0,0017 0,000075	22,6>7,71 $F_{табл}$=7,71

Since 15.3> 7.71 for spun yarn and 22.6> 7.71 for OE yarn, a significant difference in RKM is observed for the two constructions of the double-twisting device when spinning in both methods for Ne 20/2 twisted yarn. The advantage of the new design has been proven.The effect of the factor on the CV% on the breaking force is analyzed in Tables 6-8.

Table 6.
Values of the CV% on the RKM of the count Ne 20/2 yarn

Repetition	Construction of the spindle (factor A)			
	RS		OES	
	Normal	New	Normal	New
1 2 3	9,3 8,9 8,8	8,2 8,7 8,3	8,7 8,5 8,9	8,3 7,9 8,1
Mean	9,0	8,4	8,7	8,1

Table 7.
The square root values of the CV% on the breaking strength of 20/2 twisted yarn

Repetition	Construction of the spindle (factor A)			
	RS		OES	
	Normal	New	Normal	New
1	3,049	2,863	2,949	2,881
2	2,983	2,949	2,915	2,811
3	2,966	2,881	2,983	2,846
A_i	8,998	8,693	8,847	8,538
$\sum y^2$	26,9917	25,1934	26,092	24,3015
A	17,691		17,385	
$\sum_i \sum_j y_{ij}^2$	52,1851		50,3935	

Table 8.
Analysis of the variance of CV% of the yarn count 20/2 (Ring Spun and OE)

Sourceofdispersion	The sum of the squares	Number of degrees of freedom-f	Averagesquare	Fisher-F criteria
Ring Spinning				
Factor A Error Sum	0,0155 0,0077 0,0232	1 4 5	0,0155 0,0019	8,16 F_T=7,71
OE spinning				
Factor A Error Sum	0,0159 0,0046 0,0205	1 4 5	0,0159 0,0011	14,45 F_T=7,71

Since the ring-spun yarn is 8.16> 7.71 and the OES yarn is 14.45> 7.71, the decrease in yarn unevenness when using a new structural yarn in terms of tensile strength has been proven to be not accidental.
The values of the RKM of 20/2 (for RS and OES) yarns developed in different devices are given in Table 9, and the square root values of the tensile strength parameters are given in Table 10.

Table 9.
Rkm value of the Ne 12/2 twisted yarn

Repetition	Construction of the spindle (factor A)			
	RS		OES	
	Normal	New	Normal	New
1 2 3	14,66 14,60 14,60	14,88 14,92 15,2	11,6 11,7 11,62	11,96 11,98 12,0
Mean	14,62	15,0	11,64	11,98

Table 10.
Square root values of tensile strength parameters

Repetition	Construction of the spindle (factor A)			
	RS		OES	
	Normal	New	Normal	New
1	3,829	3,857	3,406	3,458
2	3,821	3,863	3,421	3,461
3	3,821	3,899	3,409	3,464
A_i	11,471	11,619	10,236	10,383
$\sum_y^2$	43,8612	45,0013	34,9252	35,9354
A	23,09		20,619	
$\sum_i \sum_j y_{ij}^2$	88,8625		70,8606	

The analysis of the variance of the coefficient of variation of the 12/2 twisted yarn is given in Table 11.

Table 11.
Dispersion analysis of the CV% of 12/2 (RS and OES) yarn

Sourceofdispersion	The sum of the squares	Number of degrees of freedom-f	Averagesquare	Fisher-F criteria
RS				
Factor A Error Sum	0,0036 0,0009 0,0045	1 4 5	0,0036 0,000225	16,0>7,71 F_T=7,71
OES				
Factor A Error Sum	0,0025 0,0010 0,0035	1 4 5	0,0025 0,00025	10>7,71 F_T=7,71

Since the ring-spun yarn is 16.0> 7.71 and the OE spinning yarn is 10> 7.71, the difference in the relative tensile strength values of the yarns in both methods is not accidental when comparing the yarns in the two designs.

Table 12.
Values of the coefficient of variation on the breaking strength of Count Ne 12/2 yarn

Repetition	Construction of the spindle (factor A)			
	RS		OES	
	Normal	New	Normal	New
1 2 3	7,6 7,9 7,9	7,4 7,0 7,2	8,3 8,0 8,3	7,9 7,8 7,7
Means	7,8	7,2	8,2	7,8

Table 13.
The square root values of the coefficient of variation on the tensile strength of count Ne12/2 yarn

Repetition	Construction of the spindle (factor A)			
	RS		OES	
	Normal	New	Normal	New
1	2,757	2,720	2,881	2,811
2	2,811	2,646	2,828	2,793
3	2,811	2,683	2,881	2,775
$\sum_y^2$	8,379	8,049	8,59	8,379
A	23,4044	21,5981	24,5977	23,4031
$\sum_i \sum_j y_{ij}^2$	16,428		16,696	
$\sum_y^2$	45,0025		48,0008	

Table 14.
Dispersion analysis of the coefficient of variation of 12/2 (RingSpun and OESpinning) yarn

Sourceofdispersion	The sum of the squares	Number of degrees of freedom-f	Averagesquare	Fisher-F criteria
RS				
A factor	0,0182	1	0,0182	16,25>7,71
Error	0,0045	4	0,00112	
Sum	0,0227	5		$F_{\text{т}}$=7,71
OES				
A factor	0,0074	1	0,0074	13,2>7,71
Error	0,0023	4	0,00056	
Sum	0,0097	5		$F_{\text{т}}$=7,71

Due to 16.25> 7.71 for RS yarn and 13.2> 7.71 for OES yarn, it is important to reduce the unevenness of the yarn in terms of tensile strength when using new structural yarn.
The analysis of variance shows that regardless of the method of spinning and count the Ne of a single yarn, the specific tensile strength of the twisted yarn increases and the unevenness decreases when using a new tensile element in a twisting machine, indicating that the design effect is not random.

5. Conclusion

When yarns spun in a different spinning system are twisted, the strength of the yarns increases. It can be seen that the strength of OE spun yarns is relatively lower than the strength obtained by ring spun yarns.
When using the same tensioning and twisting device that twists the elastic element twice in the spinning tube, the vibration of the yarn tension is small, which allows the twists to be evenly distributed along the length of the twisted yarn and improves the quality of the twisted yarn. The CV% of the strength of Ne 20/2 twisted yarn in the production of a new uniform tensioning and twisting device increases from 1.1 to 1,122 (in Ring Spun) and from 1,071 to 1,092 (in OE spinning); Production of Ne 12/2 yarn increases from 1,052 to 1,079 (in RS) and from 1.04 to 1.07 (in OES). The decrease in the CV% of unevenness in breaking strength (Sk / S0) is reduced by 6.6-7.7% (in RS) and by 5-7% (in OES).

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Conflict of interest
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