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Imperfections and Hairiness of 24^s Cotton Yarn Affected by Air Jet Nozzle Pressures and Winding Speeds at Autocone

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Abstract

Winding process influences the yarn hairiness and the increase of hairiness during winding is verified. Yarn hairiness contributes to the formation of yarn defects during the winding process. The operation of new weaving machines such as, air jet looms, is very critically dependent on the degree of yarn hairiness. Recently, reducing of yarn hairiness during winding has become a popular approach. Muratec's hairiness reducing device (Perla) is a good example. It employs an air vortex nozzle, which removes wild fibres, wraps the long hair fibres around the body of the yarn by swirling air current. In this study, the effect of air jet pressure and winding speed at autocone on imperfection and hairiness for 24^s cotton yarn was studied. Lower speed and higher pressure were considered for best quality yarn.

Key words: Cotton, Yarn, Imperfections, Hairiness, Autocone, Winding, Pakistan

Introduction

Fifty years ago, yarn hairiness was regarded as almost a curious yarn property that some times was capable of interfering with textile processes and of creating troubles during weaving and knitting. Later on, this curious property was converted in to a measurable yarn parameter. Machine speeds were to be increased for high productivity and thus increased yarn hairiness became a very undesirable parameter, which had to be measured and controlled. Yarn hairiness measurement has now become a necessary test at the textile mills level. Barella (1983) while studying the twist effect on yarn hairiness for cotton concluded that hairiness decreased when twist increased.

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Zeltner (1990) studied on the influence of winding process on hairiness of yarns (carded, combed, cotton and polyester cotton) and concluded that it could be leaded to an increase in hairiness upto 55% in some cases. Javed (1991) expressed that imperfections (thin, thick places and neps) increased as the yarn becomes finer. Iqbal (1992) recorded a significant decrease in yarn thin places with ascending twist. Peykamian and Rust (1992) showed that winding influenced and verified that yarn hairiness increased up to 55% in some cases during winding. Barella (1993) showed that winding process was detrimental to the yarn and an increase of winding speed, increased yarn damage and hairiness. Saeed (1993) recorded a significant increase in yarn thick and thin places and decrease in yarn neps at increased winding speeds during winding at autocone. Abbasi (1994) reported that thick yarn places and yarn neps decreased with increase of twist factor and yarn hairiness decreased with ascending twist. Ahmad (1994) narrated that hairiness was inversely proportional to the twist and significant decrease in yarn thin places with ascending twist. Rehman (1994) noted a significant increase in yarn thick and thin places and slightly decrease in nep content with the increase in winding speed. Miao and Wang (1997a) reported that yarn hairiness could be reduced with an air jet attachment during winding. They also proved significant reduction in hairiness of yarn by using different air nozzles below the twist triangle on ring frame.

Recently a Muratec's hairiness reducing device (Perla) has been developed. It employs an air vortex nozzle, which removes wild fibres, wraps the long hair fibres around the body of the yarn by swirling air current. The efficiency and effectiveness of this device is yet to be tested under local conditions. It was, therefore, considered necessary to judge the performance of this device. The study in hand thus planned to observe the more suitable air jet pressures of the device and corresponding winding speeds at autocone for best hairiness and perfection of better 24^s cotton yarn.

Materials and Methods

Lint samples of Punjab American Cotton variety MNH-93 were collected from the running material at Crescent Textile Mills Ltd. Faisalabad and were processed in the blow room, carding, drawing & simplex sections at standard machinery settings and processing variables.

Processing on Edera ring spin tester

Edera spinlab tester manufactured by Edera Textile Company Italy was used on which spinning work was completed according to the instructions laid down in its operational instruction manual. The 20^s yarn count was spun on this ring frame at three different twist multipliers from 0.71 hank roving. i.e.,

Twist Multipliers

T1 = 3.5

T_1 = 3.9

T_1 = 4.3

Processing on Muratec′s Mach coner 7 V-II

Yarn samples were taken from ring frame and wound on cones with the help of Muratec′s Mach coner according to the procedure laid down in its operational instruction manual. Following changes were made at autoconer. The air-jet attachment (Perla) is positioned about two-centimeter in front of the Uster classimat sensor between the yarn tensioners on a grooved drum winder. The operated winding speeds and air-jet nozzle pressures are given below, where winding speed adjustments were made at keyboard (inverter), while air-jet nozzle pressures were changed with the help of air pressure gauge for a specific group of winding units.

i. Winding speeds

W_1 = 800 m /min

W_2 = 1200 m / min.

W_3 = 1600 m / min.

ii. Pressures at Perla.

P_0 = 0 M Pa.

P_1 = 0.15 M Pa.

P_2 = 0.20 M Pa.

P_3 = 0.25 M Pa.

Yarn quality characteristics

The spun yarn samples were evaluated (before and after the application on the air jet nozzle at autoconer) for yarn imperfections and hairiness.

Yarn imperfections and hairiness

Yarn imperfections and hairiness were determined by Equipment Uster tester UT-3, which measures the imperfections viz. thin, thick places and neps per 1000 meters of yarn. The sensitivity setting for the determination of imperfections were –50% for thin places, + 50% for thick places and + 200% for neps.

The hairiness modules of the UT-3 consists of an electronic optical sensor which convert the scattered light reflections of the peripheral fibres into a corresponding electrons signal while the solid yarn body is collapsed. Yarn hairiness was expressed in the form of hairiness value H, which is an indirect measure for the number cumulative length of all fibres protruding from the yarn surface. The procedure of testing was derived from ASTM Standards (1997)

Statistical analysis

The data thus obtained was analysed statistically using Completely Randomized Design (CRD). Duncan’s Multiple Range test was also applied for individual comparison of means among various quality characteristics as suggested by Faqir (2000), on applying M-Stat micro computer statistical program devised by Freed (1992).

Results and Discussion

Yarn imperfections

Yarn thick places

The analysis of variance of the data regarding the yarn thick places and individual comparison of the mean values are presented in the Table-1, which shows that the effects of all treatments and their interactions were observed highly significant.

The mean values for different twist multipliers i.e. T_1, T_2 and T_3 were 229.2 220.1 and 180.1 /Km. respectively. All mean values were significantly different from one another. The twist multiplier T_3 produced the lowest value as 180.1 thick places/Km.

Treatment means for different winding speeds were 180.1, 213.0 and 236.3 /Km. for W_1, W_2 and W_3 respectively. The lowest value of yarn thick places was noted at winding speed W_1 and all means differed significantly among each other.

Different pressures at Perla produced mean value of yarn thick places as 198.9, 195.1, 207.0 and 238.1 / Km. for P_0, P_1, P_2 and P_3 respectively. The mean values were significantly different from each other and lowest value as 195.1 /Km. was noted against pressure P_1.

Considering the above results, yarn thick places decreased with ascending twist, which confirmed the findings of Abbasi (1994), who reported a significant decrease in yarn thick places with increase in twist factor. In the present study it was observed that yarn thick places increased at high winding speeds and at high air pressure at Perla. Previously a research worker Rehman (1994) also recorded that yarn thick places increased significantly at high winding speeds.

Yarn thin places

The analysis of variance of the data and individual comparison of the mean values with respect to yarn thin places are shown in the Table-2. The variance Table shows that the effects of the twist multipliers, windings speeds, air pressures at Perla and the interaction T x W were found highly significant, while all other interactions were observed non-significant.

The twist multiplier i.e. T_1, T_2 and T_3 gave the respective mean values as 17.14, 13.61 and 13.06 /Km. for yarn thin places. Individual mean values showed the twist multiplier T_3 gave the lowest value of yarn thin places as 13.06 /Km. length of yarn. The means of thin places due to T_2 and T_3 were found non-significant with one another but both means were significantly different with T_1.

The mean values of yarn thin places for different winding speeds were 10.25, 14.58 and 18.97 /Km. for W_1, W_2 and W_3 respectively. The winding speed W_1 gave the lowest value of yarn thin places. All the three mean values were significantly different from each other.

The different air pressures at Perla i.e. P_0, P_1, P_2 and P_3 produced the respective mean values of thin places as 14.04, 12.11, 13.96 and 18.30 /Km. of yarn length, Pressure P_1 produced the lowest thin value as 12.11 /Km. P_0 was non-significantly different with P_2 and both P_0 and P_2 differed significantly with P_1 and P_3.

Present results indicated that yarn thin places decreased with ascending twist. These results confirmed the findings of Iqbal (1992) and Ahmad (1994), they reported the decrease in thin places with the increase of twist. The present results show that the yarn thin places increased with the increase of winding speed and pressure at Perla. Previously Saeed (1993) and Rehman (1994) declared the similar observation for winding speed.

Yarn neps

The analysis of variance and individual comparison of mean values are given in Table-3, which shows that the effects of twist multiplier, winding speeds, air pressures at Perla and all interactions except T x W x P were noted highly significant and the interaction T x W x P was observed significant.

Mean values against different twist multipliers were 247, 238.9 and 203.4 /Km. for T_1, T_2 and T_3 respectively. There was a significant difference between all the three twist multipliers. The lowest value as 203.4 neps/Km. was noted for twist multiplier T_3.

The different winding speeds i.e. W_1, W_2 and W_3 produced the mean values of yarn neps as 255.4, 231.8 and 202.1 /Km. respectively. Lowest value as 202.1 neps/Km. was noted for winding speed W_3. All the mean values of yarn neps were different significantly from each other.

The mean values of yarn neps against the air pressures at Perla i.e. P_0, P_1, P_2 and P_3 were 219.1, 212.3, 228.0 and 259.7 /Km. respectively. Lowest value of yarn neps as 212.3 /Km. was noted at pressure P_1. There was a significant difference between all the mean values of yarn neps.

Present results indicated that yarn neps per thousand meters decreased with the increase of twist factor. Similar results were mentioned by Abbasi (1994), who reported a significant decrease in neps with the increase of twist. Previously Rehman (1994) and Saeed (1993) recorded that nep content decreased with the increase in winding speed, which was confirmed by the present results.

Yarn hairiness

The analysis of variance of the data and individual comparison of the mean values are tabulated in the Table-4, which shows that the effects of twist multipliers, winding speeds, air pressures at Perla and the interaction T x P were observed highly significant, interaction T x W x P was found significant, while the interaction W x P was noted non significant.

The individual mean values of hairiness for different twist multipliers i.e. T_1, T_2 and T_3 were 8.51, 7.76 and 7.01 respectively. The lowest hairiness value as 7.01 was noted at T_3 and mean values due to T_1, T_2 and T_3 were found significantly different from each other.

The three different winding speeds i.e. W_1, W_2 and W_3 produced the yarn hairiness value as 7.65, 7.77 and 7.88 respectively. Winding speed W_1 produced the lowest value of yarn hairiness as 7.65. All the three mean values were significantly different from one another.

Mean values of hairiness for different air pressures at Perla i.e. P_0, P_1, P_2 and P_3 were 8.01, 7.87, 7.66 and 7.53 respectively. These four mean values were different significantly from one another. P_3 produced the lowest value of hairiness as 7.53.

In the light of above results, it was concluded that yarn hairiness decreased significantly with the increase of twist multiplier, which was similar to the findings of Abbasi (1994) and Ahmad (1994), who recorded a significant decrease in yarn hairiness due to increase in twist factor. Likewise, Barella (1983) concluded that yarn hairiness decreased when twist was increased.

A considerable increase in hairiness was noted at high winding speeds as mentioned by Zeltner (1990), who studied the influence of winding process on hairiness of yarns (carded, combed, cotton and polyester cotton) and concluded that it could lead to an increase in hairiness up to 55% in some cases. Similarly, Peykamian and Rust (1992) showed that winding influenced the yarn hairiness and verified increase in hairiness after winding. Likewise, Barella (1993) showed that winding process was detrimental to the yarn and an increase of winding speed, increased yarn damage and hairiness.

Present results indicated that increase in air pressure at Perla decreased the yarn hairiness. Similar findings were reported by Miao and Wang (1997a), who mentioned that yarn hairiness could be reduced with an air jet attachment during winding. In another study, Miao and Wang (1997b) used different air nozzles below the twist triangle on ring frame and proved significant reduction in hairiness of yarn.

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Table 1: Analysis of variance for 24^s yarn thick places.

S.O.V.	D.F.	S.S	M.S.	F. Value	Prob.
T	2	49100.167	24550.083	2646.1168	0.0000**
W	2	57345.167	28672.583	3090.4581	0.0000**
P	4	15964.333	3991.083	430.1766	0.0000**
TXW	3	30892.667	10297.556	1109.9162	0.0000**
TXP	6	1715.833	285.972	30.8234	0.0000**
WXP	6	1388.833	231.472	24.9491	0.0000**
T XWXP	12	331.667	27.639	2.9790	0.0020**
Error	72	668.000	9.278		
Total	107	157406.667			

Coefficient of Variation = 1.45 % **Highly Significant = ****

Table 1A: Comparison of individual means for 24^s yarn thick places.

Variable	Twist Multiplier			Winding Speed			Pressure at Perla			
Level	T_1	T_2	T_3	W_1	W_2	W_3	P_0	P_1	P_2	P_3
Mean	229.2a	220.1b	180.1c	180.1c	213b	236.3a	198.9c	195.1d	207b	238.1a

Any two means sharing a letter do not differ significantly at 5% level of probability

Table 2: Analysis of variance for 24^s yarn thin places.

S.O.V.	D.F.	S.S	M.S.	F. Value	Prob.
T	2	353.130	176.565	30.3646	0.0000**
W	2	1369.407	684.704	117.7516	0.0000**
P	3	555.657	185.219	31.8530	0.0000**
TXW	4	92.593	23.141	3.9809	0.0057**
TXP	6	17.537	2.923	0.5027	N..S.
WXP	6	55.037	9.173	1.5775	0.1661 N..S.
T XWXP	12	13.852	1.154	0.1985	N..S.
Error	72	418.667	5.815		
Total	107	2875.880			

Coefficient of Variation = 16.51 % Highly Significant = ** Non-Significant = N.S.

Table 2A: Comparison of individual means for 24^s yarn thin places.

Variable	Twist Multiplier			Winding Speed			Pressure at Perla			
Level	T_1	T_2	T_3	W_1	W_2	W_3	P_0	P_1	P_2	P_3
Mean	17.14a	13.61b	13.06b	10.25c	14.58b	18.97a	14.04b	12.11c	13.96b	18.3a

Any two means sharing a letter do not differ significantly at 5% level of probability

Table 3: Analysis of variance for 24^s yarn neps.

S.O.V.	D.F.	S.S	M.S.	F. Value	Prob.
T	2	38701.167	19350.5583	556.8513	0.0000**
W	2	51428.167	25714.083	739.9736	0.0000**
P	3	35494.000	11831.333	340.4700	0.0000**
TXW	4	9027.333	2256.833	64.9441	0.0000**
TXP	6	1255.500	209.250	6.0216	0.0000**
WXP	6	826.500	137.750	3.9640	0.0018**
T XWXP	12	974.000	81.167	2.3357	0.0137*
Error	72	2502.000	34.750		
Total	107	140208.667			

Coefficient of Variation = 2.57 % Highly Significant = ** Significant = *

Table 3A: Comparison of individual means for 24^s yarn neps.

Variable	Twist Multiplier			Winding Speed			Pressure at Perla			
Level	T_1	T_2	T_3	W_1	W_2	W_3	P_0	P_1	P_2	P_3
Mean	247a	238.9b	203.4c	255.4a	231.8b	202.1c	219.1c	212.3d	228b	259.7a

Any two means sharing a letter do not differ significantly at 5% level of probability

Table 4: Analysis of variance for 24^s yarn hairiness.

S.O.V.	D.F.	S.S	M.S.	F. Value	Prob.
T	2	42.465	21.233	5967.0006	0.0000**
W	2	0.879	0.440	123.5575	0.0000**
P	3	3.741	1.247	350.4671	0.0000**
TXW	4	0.010	0.002	0.6909	N..S.
TXP	6	0.729	0.122	34.1460	0.0000**
WXP	6	0.035	0.006	1.6401	0.1486 N..S.
T XWXP	12	0.090	0.007	2.1038	0.0270*
Error	72	0.256	0.004		
Total	107	41.206			

Coefficient of Variation = 0.77 % Highly Significant = **Non-Significant = N.S. Significant = *

Table 4A: Comparison of individual means for 24^s yarn hairiness.

Variable	Twist Multiplier			Winding Speed			Pressure at Perla			
Level	T_1	T_2	T_3	W_1	W_2	W_3	P_0	P_1	P_2	P_3
Mean	8.54a	7.76b	7.01c	7.65c	7.77b	7.88a	8.01a	7.87b	7.66c	7.53d

Any two means sharing a letter do not differ significantly at 5% level of probability

Conclusion

The analysis of this study for 24^s yarn reflects the following findings:

- The yarn imperfections (thin, thick places and neps) and hairiness decreased with the increase twist multiplier
- The lower level of winding speed resulted the best values for yarn thin, thick places and hairiness while the yarn neps have the adverse effect at low level winding speed.
- The highest pressure at Perla produced the least value of yarn hairiness, whereas, highest values of yarn thick, thin places and neps were observed at this pressure.

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