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Effect of Multiple Processing Variables upon Yarn Imperfection by Using Combed Sliver in Open-end Spinning Machine

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ABSTRACT

In this study effect of changing the technical settings on the rotor spinning machine to produce the counts $C_1 = 30^s$ and $C_2 = 16^s$ at different noil extraction percentage, rotor diameters and speeds was studied. It was revealed that C_2 (16^S) produced yarn of excellent quality as regards to yarn thin places under all noil extraction levels. C_2 (16^S) performed exceptionally better for yarn thick places under all rotor speeds.

Key Words: Rotor spinning; Yarn imperfection

INTRODUCTION

New field of application for rotor yarns have been established using combed slivers as the feeding material. The upgrading of more easily available and cheaper cottons by means of a combing process has the fundamental advantage, that independent of the method of harvesting and of climatic conditions; the fibre properties can be perfectly adapted to the spinning conditions. No doubt a large number of impurities from cotton are removed in blow room and carding process but as per requirement it needs further cleaning and purification. Mills have the purpose, primarily, of extracting the remaining vegetable matter, fiber neps and in particular, the seed coat fragments, which may have an extremely negative effect on the process and quality, particularly in the open end yarns.

Combing results in a reduction of ends down. Less ends down mean few spinning stops, less standing time, fewer piecing in the yarns and higher machine efficiency. The advantage of increased machine efficiency, for example two percent, is very significant and has to be considered in the profit calculation of installation with the cleaner combed sliver. It is possible to increase the rotor speed above that of carded sliver without deterioration of the spinning operation. This increased productivity, is also very important in commercial consideration. Bellis (1952) narrated that each 5% increment of comber waste extraction leads to a progressively reduced neps content. Merril (1955) reported that combing process improves the yarn imperfection. Manohar *et al.* (1983) reported that uniformity percentage imperfection and appearance of the yarn are broadly affected by rotor diameter. Barella *et al.* (1983) stated that rotor diameter affects the yarn imperfection both linearly and quadratically. Booth (1983) expressed that some neps may be removed during carding and the same time more neps created. Salhotra (1983) reported that as the opening roller speed increases, yarn imperfection decreases and increases, as the rotor speed increases. Lord and Johson (1985) observed that the examination of thick places in yarn has shown local increase in short fibre contents. Arshad (1989) expressed that the number of thick places can be reduced by combing process. Haranhalli (1990) concluded that thick and thin places might be the result of poor sliver quality, high short fibres percentage, insufficient fibre opening and dirt accumulation in rotor. Landwehrkamp (1990) concluded the combing process gives a straight improvement in thin/thick places of rotor spun yarn. Sheikh (1994) noted that yarn irregularity was a measure of cross-sectional variation in the yarn and closely associated with imperfections in yarn.

MATERIALS AND METHODS

Spinning process. MNH-93 cotton fibres were processed in blow room and carding section at normal machinery adjustments. The card sliver was fed to sliver and ribbon lap former and laps of 58 g/m were fed to comber machine and different settings were made to remove following noil percentages.

$N_1 = 5\%$, $N_2 = 10\%$, $N_3 = 15\%$

The combed sliver of three different noil extraction percentage was passed through breaker and finisher drawing and then finally processed at BD-2000 RN (rotor spinning machine) by changing the technical settings on the machine to produce the counts $C_1 = 30^s$ and $C_2 = 16^s$ at the following rotor diameters and speeds.

Rotor speed

$S_1 = 30000$ rpm, $S_2 = 40000$ rpm, $S_3 = 50000$ rpm

Rotor diameter

$D_1 = 33$ mm, $D_2 = 44$ mm, $D_3 = 57$ mm

Yarn imperfection. Yarn imperfection was measured by Uster Evenness tester-3 (UT-3) which also simultaneously measured the yarn imperfections i.e. thin, thick places per 1000 meters. The sensitivity of testing for the thin places were at –50% and for thick places as +50%.

Analysis of data. The data thus obtained were subjected to statistical analysis using analysis of variance technique, while DMR test was applied for individual comparisons as suggested by Steel and Torrie (1984) using M-Stat micro computer package devised by Freed (1992).

RESULTS AND DISCUSSION

Yarn Imperfections

Thin places. The individual mean values with their statistical comparison presented in Table I showed highly significant difference at different noil extraction percentage for yarn thin places. The mean value were recorded as 42.22, 27.37 and 17.27 per km for N_1 (5%), N_2 (10%) and N_3 (15%) respectively. The above results indicate that combing process improves yarn imperfections and degree of improvement directly depends upon the percentage of noil removed. Previous reports show that combing improves the yarn imperfections, (Merril, 1955; Arshad, 1989). The amount of upgradation depends upon the quality of cotton as well as the working capacity of combing machine. Landwehrkamp (1990) concluded that combing process gives a straight improvement in thin places of rotor spun yarn, while Basit (1990) noted less number of thin places at lower amount of noils.

As the yarn becomes finer the number of fibres in the cross section decreased and the yarn imperfections increased. A similar trend of increase in imperfections (thin places) with increase in yarn number was noticed by Nawaz *et al*. (2002) who reported that thin places in open end spun yarn increases as yarn becomes finer. Farooqui (2001) concluded that by increasing yarn count thin places increase gradually. The individual means by Duncan's multiple range test indicated minimum thin places (26.50/km) at S_1 (30000 rpm) followed by S_2 (40000 rpm) and S_3 (50000 rpm) with their respective mean values 28.72 and 32.01/km. The results of S_1, S_2 and S_3 differ significantly with each other. Furthermore, as the rotor speed increases yarn thin places/km also increases. It has been claimed by previous researchers that imperfections in the yarn increases as the rotor speed increase (Simpson & Paturea, 1979). Similarly, Monohar (1983) said that yarn evenness imperfection show a significant deterioration with increase in rotor speed. Shahbaz (2000) concluded that imperfections increases as the rotor speed increases. As regards the rotor diameter, that the highest value of yarn thin places is 31.67 for D_3 (57mm) followed by 28.84 and 26.72 for D_2 and D_1 respectively (Table I). The results reveal that D_1, D_2 and D_3 differ significantly form each other. It is evident from the results that as the rotor diameter increased the yarn imperfection also increased. This implies that rotor diameter and yarn imperfection have a direct relationship. Previously, Manohar *et al.* (1983) reported that uster uniformity percentage imperfections and appearance of yarn are broadly affected by rotor diameter. Barella *et al.* (1983) concluded that rotor diameter effect yarn imperfections both linearly and quadritically. Similarly Nawaz *et al.* (2003) reported that by increasing rotor diameter the thin places increase gradually.

The CxN interaction (Table Ib) revealed that minimum thin places are record at C2xN3 (15% noil extraction and 16^s count) .The trend is evident that as the count becomes finer thin places increased, and N_3 noil extraction percentage produced less thin places as compared to N_2 and N_1, respectively. It is obvious that C_2 (16^S) produced yarn of excellent quality as regards to yarn thin places under all noil extraction levels.

Thick places per kilometer. The mean values for thick places at different noil extraction percentage were noted as 155.33, 98.47 and 50.30/km, which have significant difference among themselves. The highest value of thick places (155.33) was recorded for N_1 (5% noil extraction) followed by N_2 (10% noil extraction) and N_3 (15% noil extraction) with their respective means 98.47 and 50.30 per kilo meter. The above results indicate that combing process improves yarn imperfections and degree of improvement directly depends upon the percentage of noil removed. The reduction in thick places is probably due to the elimination of short fibres for optimum level at comber. These finding are in good agreement with those of Arshad (1989) who reported that the number of thick places can be reduced by combing process. Previous results of such work show that combing improves the yarn imperfections (Merril, 1955).

Duncan's multiple range test indicates the minimum yarn thick places (64.10/km) are recorded at C_2 (16^s) followed by C_1 (30^s). These values differ significantly from each other. The results indicated that thick places increase as yarn becomes finer. These results are in line with the findings of Haque (1998) who concluded that the main cause of imperfection in the spun yarn is substantial variation in the numbers of fibres in the yarn cross section along the length. As yarn becomes finer the number of fibres in the cross section decrease and the yarn imperfections increase. A similar trend of increase in thick places per km with increase in yarn number was observed by Farooqui (2001) who noted that thick places increase in open end spun yarn as the yarn becomes finer. Similarly Nawaz *et al.* (2002) reported that by increasing yarn count the thick places are increased gradually. Sheikh (1994) mentioned that yarn irregularity was a measure of cross-sectional variation in the yarn and closely associated with imperfections in the yarn.

The individual means by Duncan's multiple range test indicated the best value of yarn thick places/km for different rotor speeds was recorded 90.15 at S_1 (30000 rpm) followed by S_2 (40000 rpm) and S_3 (50000 rpm) with respective mean values of 1021.24 and 111.71. All values differ significantly. The results indicated that as the rotor speed increases yarn thick places also increase. These data conform to the findings of Simpson and Paturea (1979), who reported that the thick and thin places and neps in the yarn increase as the rotor speed increases. Similarly

Table I. Comparison of Individual means values for thin places

N	Means	C	Means	S rpm	Means	D	Means
N_1	42.22a	C_1	38.90b	S_1	26.50c	D_1	26.72c
N_2	27.73b	C_2	19.26a	S_2	28.72b	D_2	28.84b
N_3	17.28c			S_3	32.01a	D_3	31.67a

Mean Values Having Different Letters, Differ Significantly At 0.05 Level of Probability

Table Ia. Interaction of count and noil extraction %age (CxN)

	N_1	N_2	N_3
C_1	57.11	36.80	22.78
C_2	22.33	18.67	11.78

Table II. Comparison of individual mean values for thick places

N	Means	C	Means	S rpm	Means	D	Means
N_1	155.33a	C_1	138.64	S_1	90.16c	D_1	94.2b
.N_2	98.48b	C_2	64.10	S_2	102.24b	D_2	103.05a
N_3	50.30c			S_3	111.71a	D_3	106.78a

Mean Values Having Different Letters, Differ Significantly At 0.05 Level of Probability

Table IIa. Interaction of count and noil extraction %age (CxN)

	N_1	N_2	N_3
C_1	217.11	136.31	62.49
C_2	93.56	60.64	38.11

Table IIc. Interaction of count and speed (cxs)

	S_1	S_2	S_3
C_1	122.11	140.16	153.64
C_2	58.20	64.33	69.78

Manohar (1983) stated that yarn evenness imperfection show a significant deterioration with increase in rotor speed.

As regard to the rotor diameter, Table II show that the highest value of yarn thick places is 106.78 for D_3 (57mm) followed by 103.05 and 94.28 for D_2 (44 mm) and D_1 (33 mm) respectively. The results reveal that D_2 and D_3 differ significantly form D_1, but non-significantly with respect to each other. It is evident that as the rotor diameter increased the yarn imperfection also increased. It means that rotor diameter and yarn imperfection has a direct relationship. Manohar *et al.* (1983) reported that uster uniformity percentage, imperfections and appearance of yarn are broadly affected by rotor diameter. Barella *et al.* (1983) concluded that rotor diameter affects yarn imperfections both linearly and quadritically. Similarly Nawaz *et al.* (2003) stated that by increasing rotor diameter the imperfections increases gradually.

Table IIc shows the CxS interaction (count x rotor speed). The mean values for thick places ranges from 153.64 to 58.20, the best value is obtained under combination (C_2xS_1) i.e. coarser count and S1 (30000 rpm) which gives the best results of yarn thick places. For both counts the trend was similar i.e. S_3 (30000 rpm) generate least thick places as compared to S_2 (40000 rpm) and S_1 (50000 rpm) but definitely C_2 performed exceptionally well for yarn thick places under all rotor speed levels.

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