INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
1560–8530/2002/04–2–256–258
http://www.ijab.org

Effect of Multiple Open-End Processing Variables Upon Yarn Quality

SH. MUHAMMAD NAWAZ, NISAR AHMAD JAMIL, MUHAMMAD IFTIKHAR AND BILAL FAROOQI
Department of Fibre Technology, University of Agriculture, Faisalabad–38040, Pakistan

ABSTRACT

The effect of multiple open end processing variables upon yarn quality was studied in this research work. The results in respect of hairiness indicate that the effect of draw off navel type and yarn count were highly significant while the effect of rotor diameter was only significant. However, for yarn evenness, the results indicate that the effect of yarn count and rotor diameter was highly significant; whereas, the effect of draw-off navel was at par.

Key Words: Yarn; Processing; Quality; Yarn evenness; Yarn hairiness

INTRODUCTION

Open-end spinning concept has developed very rapidly during recent years and this is because of its higher productivity, better profitability and product quality. All these demands could no longer be satisfied adequately by conventional ring spinning system, because the conventional spinning system has almost reached its maximum utilization and there is little room for further advancement. Li and Yan (1990) suggested that there were many aspects of yarn quality but unevenness was the most important because it was significantly correlated with the fabric appearance and processing performance of the yarn.

Staple yarns have been made throughout history, first by hand, then by mechanized versions of hand spinning, then by what are now termed conventional machines i.e. ring spinning and finally by various unconventional means which definitely includes the open-end spinning system. Vila *et al.* (1982) pointed out that the hairiness of the yarn increases as the rotor diameter increases and fibre length is one of the parameter that influences yarn hairiness. However, the nature of the pre-spinning process could influence the hairiness of the resultant yarns.

MATERIALS AND METHODS

The present study on the effect of multiple open-end processing variables upon the yarn quality was initiated in Department of Fibre Technology and carried out at Shafi Spinning Mills Sheikhupura Road Faisalabad. The representative lint cotton samples of the cotton variety MNH-93 were collected from the running stock for its evaluation. These physical characteristics were estimated by high Volume Instruments (HVI)-900 SA), a fibre testing system manufactured M/s Zellweger Ltd., Switzerland. Specimen lint samples recorded span length with its mean value of 1.03 inch and CV as 0.85%, fibre uniformity ratio with its mean value 48.13% and CV as 1.35%, fibre micronaire with its mean value 4 with CV as 2.74%, fibre maturity percentage with its mean value 82.12 % and with CV as 0.76%, fibre bundle strength with its mean value 84.15000 lb/in^2 with CV as 0.53%, fibre elongation percentage with its mean value 7.3% and CV as 2.88%, cotton colour with its mean value of 67.92 and CV as .72%, trash percentage with its mean value 1.04% and CV as 10.31% and transh count with its mean value 8.2% and CV as 5.21 %. These physical characteristics were estimated by high Volume Instruments (HVI)-900 SA), a fibre testing system manufactured M/s Zellweger Ltd., Switzerland.

Raw cotton was processed at the blow room, carding and drawing section. The drawing sliver of 0.12 hanks was fed to the open-end machine (Model SE 8, Schalafhorst, Germany). Following are the coding of the variables of the open-end machine for the current study:

1. Rotor Diameter
D1 = 33 mm, D2 = 40 mm.
2. Draw-off Navel Type
N1 = Spiral grooved path with built-in four notches. (KN4R4)
N2 = Built-in four coarsely grooved notches. (KN4)
N3 = Built-in finely grooved spiral path. (Spiral)
3. Yarn count
C1 = 10^s, C2 = 16^s, C3 = 20^s

The yarn samples thus fabricated were evaluated for the following parameters.

Evenness and hairiness. Yarn evenness (U%) is determined by measuring the variation in capacity occurring as yarn passes through the condenser and recorded in terms of mean linear irregularity (U%) and the coefficient of variation in yarn mass (CV%). The hairiness module of the UT-3 consist of an electronic optical sensor which converts the scattered light reflection of the peripheral fibres into a corresponding electrons signal while the solid yarn body is eclipsed. Yarn hairiness is expressed in the form of hairiness value H, which is an indirect measure for the number of cumulative length of all fibres protruding from the yarn surface. The procedure of testing was derived from ASTM Standards (1997).

Analysis of data. The data were analysed statistically using three-factor factorial completely randomized design (CRD) for the interpretation of data. Duncan's new Multiple Range (DMR) was also applied for individual comparison of means among the various yarn characteristics as suggested by Faqir (2000) using M Stat computer package as suggested by Freed (1992).

RESULTS AND DISCUSSION

The open end is a very rapidly developing spinning technique for the production of coarse and medium count yarns. This is so because of its higher productivity, better product quality and profitability. In view of such factors the present research work was initiated to study the effect of multiple open-end processing variables i.e.; yarn count, rotor diameter and draw off navel type upon the yarn quality. The resultant data presented in these tables is discussed here character wise along with their statistical manipulation.

Yarn evenness (U%). Table Ia and Ib indicate that the effect of yarn count (C) and rotor diameter (D) was highly significant, while the effect of draw-off navel type (N) was non-significant. In case of their interactions, all the first and second order interactions revealed non-significant. DMR test (Table Ib) for the comparison of draw-off navel type revealed that highest yarn irregularity (10.84%) was recorded for N2 (KN4) followed by 10.71% and 10.55% for N1 (KN4R4) and N3 (spiral), respectively. These values were non-significant with respect to each other. However, in a previous study (Simpson & Patureau, 1979) reported that yarn spun with a coarsely grooved draw-off navel have more imperfections and unevenness than those spun with finely grooved take off navel.

Table Ia. Analysis of variance for yarn evenness

Source of variance	Degrees of freedom	Sum of squares	Mean square	F Value	Prob
D	1	8.507	8.507	33.2087	0.0000 **
N	2	1.282	0.641	2.5020	0.0890 N.S.
C	2	25.362	12.681	49.5034	0.0000 **
DN	2	0.629	0.314	1.2275	0.299 N.S.
DC	2	8.836	0.418	1.6321	0.2027 N.S.
NC	4	1.808	0.452	1.7648	0.1453 N.S.
DNC	4	0.652	0.140	0.5480	N.S.
Error	72	18.444	0.256		
Total =	89	57.430			

** = Highly Significant;* = Significant; N.S. = Non-significant

Table Ib. Comparison of individual means for yarn evenness

Navel Type	Evenness	Count	Evenness	Rotor Dia	Evenness
N1	10.71	C1	9.97 A	D1	10.39 B
N2	10.84	C2	10.92 B	D2	11.01 A
N3	10.55	C3	11.22 C		

Any two means not sharing a letter in common differ significantly at $\propto$ =0.05

As regards to the yarn count, the result revealed that the highest value of yarn irregularity was 11.22% for C3 (20^s) followed by 10.92% and 9.97% for C2 (16^s) and C1 (10^s), respectively. The result showed that C1, C2 and C3 were significantly different from each other. It was evident from these results that as the yarn became finer it became more irregular. Similar results were reported by Hamid (1981) who concluded that the evenness of rotor spun yarns decrease as the yarn becomes finer. Likewise, Khalid (1987) tabulated the evenness of 10^s and 16^s as 12.51 and 13.59%, respectively for rotor spun yarn. Haque (1998) endorsed that the main cause of unevenness in the spun yarn is substantial variation in the number of fibres in the yarn cross section along the length. Similarly, Douglas (1989) reported that irregularity also depends upon yarn count. However, Haranhalli (1990) pointed out that rotor spun cotton yarns were superior in short-term regularity to carded ring spun cotton yarns.

As regards to the rotor diameter, the result shows that the highest value of yarn evenness was 11.01% recorded at D2 followed by 10.39% for D1. The result showed that D1 and D2 were highly significant with respect to each other. It means that as the rotor diameter is increased the unevenness (U%) of yarn also increases. Previous findings of Barella *et al.* (1983) reported that yarn irregularity, tenacity and elongation percentage are effected by rotor speed in a liner manner but the rotor diameter effects these parameter both linearly and quadratically. Whereas, Oxtoby (1987) mentioned that the accumulation of impurities in rotors deteriorate the evenness of the yarn.

Yarn hairiness. The statistical analysis of variance and comparison of individual means of yarn hairiness shown in table 2a and 2b respectively, indicated that the effect of draw-off navel type (N) and yarn count (C) were highly significant, while the effect of rotor diameter was only significant. In case of interactions, DxN and NxC were highly significant while interactions DxC and DxNxC were non-significant.

Table IIa. Analysis of variance for yarn hairiness

Source of variance	Degrees of freedom	Sum of squares	Mean square	F Value	Prob
D	1	0.747	0.747	5.5956	0.0207 *
N	2	59.835	29.917	224.0728	0.0000 **
C	2	5.87	2.935	21.9825	0.0000 **
DN	2	5.468	2.734	20.4752	0.0000 **
DC	2	0.126	0.063	0.4721	N.S.
NC	4	2.255	0.564	1.2232	0.0040 **
DNC	4	0.762	0.190	1.4264	0.2340 N.S.
Error	72	9.613	0.134		
Total =	89	84.676			

** = Highly Significant; * = Significant; N.S. = Non-significant

DMR test (Table IIb) for the comparison of draw-off navel type revealed that highest yarn hairiness (7.07) was recorded for N1 (KN4 R4) followed by 6.03 and 5.08 for N2 (KN4) and N3 (spiral) respectively. The result showed that all the draw-off navel (N1, N2 and N3) differs significantly from each other. The result showed that a coarsely grooved draw-off navel produce a yarn with higher level of hairiness as compared to yarn produce by the finely grooved draw-off navel. Similar result was concluded by Simpson and Patureau (1979) who reported that coarsely grooved navel have a high value of roughing up the yarn as compared to finely grooved navel type.

Table IIb. Comparison of individual means for yarn hairiness

Navel Type	Hairiness	Count	Hairiness	Rotor Dia	Hairiness
N1	7.07 C	C1	6.4 B	D1	5.97 A
N2	6.03 B	C2	5.83 A	D2	6.15 B
N3	5.08 A	C3	5.9 A		

Any two means not sharing a letter in common differ significantly at $\propto = 0.05$

As regards to the yarn count the highest value of yarn hairiness was recorded 6.4 for C1 (10^s) followed by 5.9 for C3 (20^s) and 5.83 for C2 (16^s). These results showed that C1 differ significantly from C2 and C3. However C2 and C3 were non-significant with respect to each other. The result showed that as the yarn became finer hairiness reduced. Similar result was reported by Douglas (1991), who concluded that as finer yarns had fewer fibres in their cross section so there were fewer protruding fibres. Thus having less yarn hairiness as compared to coarse counts with larger number of fibres in their cross section. Datye and Bose (1982) expressed that hairiness depends upon spinning shed humidity, fibre content and abrasion for yarn.

As regards to the rotor diameter, Table IIb indicates that highest yarn hairiness (6.15) was recorded for D2 (40 mm) followed by 5.97 for D1 (33 mm). The result showed that both values differs significantly from each other. It was evident from the result that as the rotor diameter increased yarn hairiness increased. Similar result was reported by Manich (1980) who reported that the factors that chiefly effects is the degree of friction between the yarn and the parts of the rotor as the yarn leaves the collecting groove to come out of the nozzle. This means larger the rotor diameter, higher will be the friction and greater will be the hairiness. Likewise Vila *et al.* (1982) reported that yarn hairiness is directly proportional to the rotor diameter i.e. as the rotor diameter increases, yarn hairiness also increases. Oxtoby (1987) reported that accumulation of impurities in the rotor made the yarn more hairy. Haranhalli (1990) noted that the open-end yarns are less hairy as compared to ring spun yarns.

REFERENCES

ASTM Committee, 1997. Standard test method for measurement of cotton fibre by High Volume Instruments (HVI) Spin lab System of Zellweger, Uster, Inc. ASTM Designation D 4605-86. *ASTM Standards on Textile Materials Amer. Soc. For Testing and Materials*, Philadelphia, U. S. A.

Barella, A., A.M. Manich, N. Patricia, Marino and J. Garofalo, 1983. Factorial studies in rotor spinning part 1: cotton yarns. *J. Text. Inst.*, 6: 329–39.

Datye, K.V. and C. Bose, 1982. Minimizing hairiness. *World Text. Asst.*, 2: 120–23.

Douglas, K., 1989. *Uster News Bulletin No. 36*, pp: 66–8. Zellweger Ltd. 8610-Uster, Switzerland.

Douglas, K., 1991. Relation between fibre and the yarn. *Uster News Bulletin, No. 38*, pp: 26–7. Zellweger Ltd. 8610-Uster (Switzerland).

Faqir, M., 2000. *Statistical Methods and Data Analysis.* Kitab Markaz, Bhawana Bazar, Faisalabad–Pakistan

Fareed, R.D., 1992. *M. Stat Microcomputer Statistical Programme.* Michigan State, University of Agriculture, Norwey. 3248. Agriculture Hall, East Lausing, Michigan Lausing, U.S.A.

Hamid, A., 1981. Studies for optimum twist multiplier on open-end for cotton. *M.Sc. Thesis*, Deptt. of Fibre Tech., University of Agriculture, Faisalabad.

Haque, A., 1998. *Weaver's Perspective of Pakistani Yarn*, pp: 35–6. Golden jubilee Issue, Textech. Nat. Col. Text. Engg., Faisalabad.

Haranhalli, A.S., 1990. *Practical open-end Spinning*, pp: 14-41. Mahajan Book Distributors. Ahmedabad, India.

Khalid, A.S., 1987. Studies for optimum rotor speed on open-end for Pakistan cotton. *M.Sc. Thesis*, Deptt. of Fibrte Technology, University of Agriculture, Faisalabad.

Li, Y. and H. Yan, 1990. Measuring unevenness and blend ratio of yarn with microwave resonaters. *Text. Res. J.*, 60: 54–9.

Manich, A.M., 1980. *Doctoral Thesis.* University of Politecnica, Barcelona.

Oxtoby, E., 1987. *Spun Yarn Technology*, pp: 138–57. Butterworths and Co. Ltd.,U.K.

Simpson, J. and M.A. Patureau, 1979. Effect of rotor speed on open- end spinning and yarn properties. *J. Text. Inst.*, 79: 468–573.

Vila, F., A. Pey and A. Barella, 1982. The influence of the rotor speed and twist multiplier on yarn hairiness in relation to pre-spinning processing. *J. Text. Inst.*, 73: 55–63.

(Received 03 March 2002; Accepted 18 March 2002)