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Study of the Hairiness of Polyester-Viscose Blended Yarns. Part II - Winding Section Parameters

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Abstract
The influences of winding section parameters at ring spinning frame on the hairiness of polyester-viscose blended yarns are examined. Statistical analysis of the results showed that yarn hairiness is significantly influenced by spindle speed, thread guide eccentricity (in a right, left, forward, backward direction), the balloon control ring, the diameter of the balloon control ring, the traveller weight, and relative humidity. Moreover, it was observed that separator plates and the thread guide shape do not have a significant effect on yarn hairiness.

Key words: *polyester, viscose, blended yarn, ring spinning frame, winding section parameters, yarn hairiness.*

Introduction

Yarn hairiness has a significant effect on fabric appearance, handle, thermal insulation, pilling propensity, yarn strength, yarn weaving and knitting performance. Hairiness in warp yarn can cause breakage and, as a result, the stoppage of weaving looms, thus reducing the efficiency of production. Yarn hairiness is often an undesirable property [1 - 3].

The effect of processing factors, such as drafting system parameters and yarn specifications on the hairiness of polyester-viscose blended yarns have been previously reported [4].

Yarn hairiness is also affected by other processing factors such as spindle speed, traveller weight and so on. The influence of spindle speed has been studied by many researchers [5 - 8]. It has generally been found that hairiness increases with higher spindle speed. As regards the effect of the traveller weight on hairiness at a constant spinning speed, there is good agreement between the authors that the lighter the traveller, the hairier the yarn is [6 - 8].

Some authors have found that travellers that are too light or too heavy increase yarn hairiness [5]; hairiness also increases with thread guide eccentricity [1]. Separator plates affect yarn hairiness [6, 9]; the increase in hairiness is due to the constant beating of the yarn against the separator, which causes fibre protrusion on the yarn body. The balloon control rings reduce yarn hairiness; spinning without

Table 1. *Spinning plan; [1, 2] - In these experiments, the yarns were produced with and without these devices at four spindle speeds: 10,500; 13,000; 15,500 and 18,000 r.p.m., [3] - Figure 8: Shapes of thread guides used.*

Parameters	Spindle speed, r.p.m.	Balloon control ring diameter, mm	Traveller count	
			weight, mg /piece	No.
The effect of spindle speed	5,000	43	40	3/0
	8,000			
	11,000			
	14,000			
	17,000			
	20,000			
The effect of balloon control ring diameter	13,000	43	40	3/0
		46		
		52		
The effect of separator plates[1]	10,500	43	40	3/0
	13,000			
	15,500			
	18,000			
The effect of balloon-control ring[2]	10,500	43	40	3/0
	13,000			
	15,000			
	18,000			
The effect of thread guide shape[3]	13,000	43	40	3/0
The effect of traveller weight	13,000	43	50	1/0
			45	2/0
			40	3/0
			35.5	4/0
			30	6/0
			23.6	8/0
			20	10/0
			18	12/0

Table 2. Spinning plan, constant value; B.D. - Break Draft; B.Z.S. - Back Zone Setting; D.C. - Distance Clips; D.S.A. - Drafting System Angle; F.R.P. - Front Roller Pressure; F.R.C.H. - Front Roller Covering Hardness; F.T.R.O. - Front Top Roller Overhang.

B.D.	1.3
B.Z.S., mm	56.0
D.C., colour	yellow
D.S.A., degree	49
F.R.P., daN	14
F.R.C.H., shore	70
F.T.R.O., mm	2.0

this device increases hairiness [10]. The influence of the atmospheric relative humidity on hairiness during spinning does not seem to be very important [9]. Humidity slightly influences hairiness: between 46% and 86% r.h., and hairiness increases in a dry atmosphere [9].

The present work is concerned with the effect of winding section parameters, such as spindle speed, the separator plates and the balloon control ring on yarn hairiness.

Materials and methods

Fibre and roving properties

The experiments were carried out using polyester-viscose blended yarns (80% : 20%). The characteristics of fibre, roving and yarn samples, and hairiness testing are given in the first part [4].

Several yarns with different machine settings were produced in a way that during each stage only one factor was changed, while the others were constant (***Tables 1*** see page 21 and ***Table 2***).

Results and discussion

The effect of spindle speed

In order to study the effect of spindle speed on yarn hairiness, yarn samples were produced by a SKF ring frame at six different speeds. The results of hairiness measurements are plotted in ***Figure 1***.

The statistical analysis and plotted averages of hairiness show that spindle speed has a significant influence on yarn hairiness [11]. When the spindle speed increases, hairiness initially decreases, but then there is an increase.

Increasing the spindle speed causes a rise in yarn tension and in the centrifugal force. The more the yarn tension increase, the more the yarn twist backs onto the roller nip; therefore it is natural to expect better binding of the fibres, and consequently, a decrease in yarn hairiness. On the other hand, an increase in the spindle speed leads to fibre protrusion on the surface of the yarn, thus yarn hairiness increases.

Generally, at low spindle speeds, the effect of yarn tension is greater than the effect of the centrifugal force, therefore hairiness is expected to decrease; but at higher spindle speeds the force involved in raising fibres from the yarn surface is greater than those which tend to incorporate them within the body of the yarn; increases in forces due to the speed of the yarn liners are proportional to the spindle speed, whereas forces due to centrifugal acceleration are not proportional (ω^2), and consequently yarn hairiness increases.

Lower hairiness values between spindle speeds of 8000 and 11000 r.p.m can be attributed to better distribution of the twist and, eventually, better control of the fibres in the spinning zone. This suggests that there is an optimum spindle speed (for a particular design of spinning frame), coupled with other spinning factors such as traveller weight.

In general, the results of the present work agree with Goswami's findings [8] but agree less with Barella et al. [5] and Pillay's [6] findings, who showed that yarn hairiness increases when the spindle speed increases; it is because of differences in the measuring method used or the range of the experiment [5, 6].

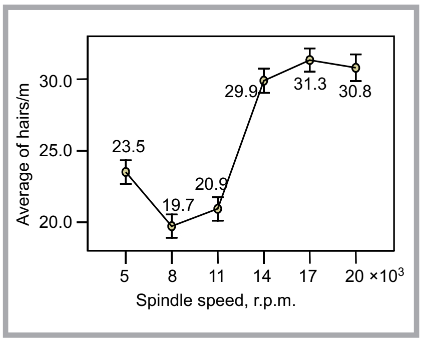

Figure 1. *Influence of spindle speed on yarn hairiness.*

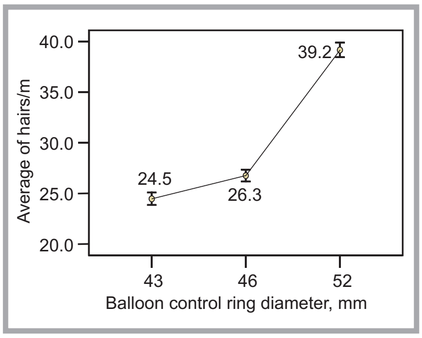

Figure 2. *Influence of balloon control ring diameter on yarn hairiness.*

The effect of balloon control ring diameter

The diameter of the balloon control ring has a significant effect on yarn hairiness. As indicated in ***Figure 2***, yarn hairiness increases with an increase in balloon control ring diameter.

The increase in yarn hairiness may possibly be due to an increase in the centrifugal force at bigger diameters of the balloon control ring. Also, when the diameter of the ring is augmented, friction between the ballooning yarn and the separators

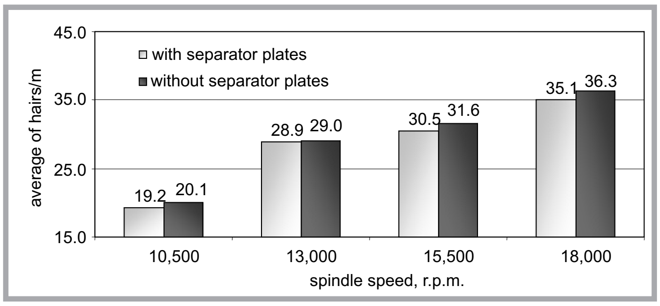

Figure 3. *Influence of separator plates on yarn hairiness.*

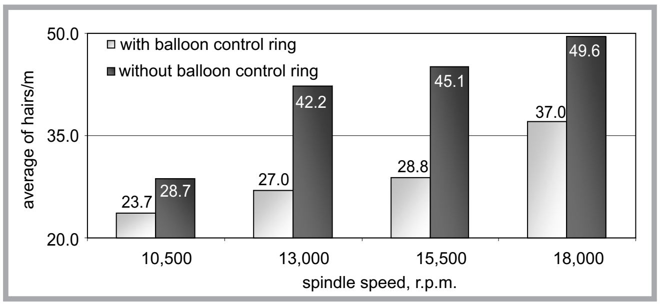

Figure 4. *Influence of the balloon control ring on yarn hairiness.*

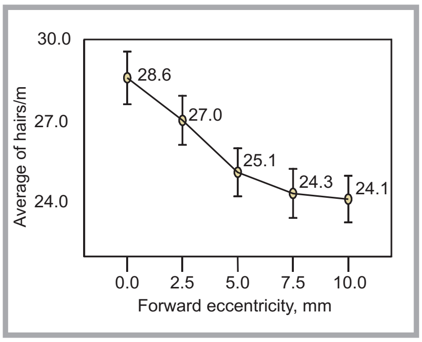

Figure 5. *Influence of forward eccentricity on yarn hairiness.*

Table 3. *Influence of rearward eccentricity on yarn hairiness.*

Backward eccentricity, mm	Average of hairs/m
0.0	28.6
2.5	32.0

increases. This effect may cause fibres to rise from the body of the yarn with a consequent increase in hairiness.

The effect of separator plates

Separator plates are often used to prevent the threads and the adjacent spindle from lashing each other and causing end breaks [6]. To study the effect of separator plates on yarn hairiness, yarns were produced with and without separator plates at four different spindle speeds.

From the trend shown in ***Figure 3***, it can be seen that separator plates have no significant effect on yarn hairiness. Pillay [6] showed that separator plates increase hairiness when yarns are spun at spindle speeds ranging from 8500 to 10500 r.p.m. The present result differs from Pillay's findings [6].

In the present study, the yarn produced was not impacted to the separator plates; therefore, it had no effect on hairiness.

The effect of the balloon-control ring

In order to review the effect of the balloon-control ring, yarns were spun at four spindle speeds (from 10500 to 18000 r.p.m.), with and without the balloon-control ring. The results obtained are presented in ***Figure 4***. It shows that the balloon-control ring has a significant effect on yarn hairiness.

Spinning without this device increases yarn hairiness because the balloon becomes bigger, therefore the friction between the yarn and the separators may cause fibres to rise from the body of the yarn with a consequent increase in hairiness. Large balloon dimensions lead to relatively high air drag on the yarn in the balloon and cause increased deformation of the balloon curve that comes out of the plane intersecting the spindle axis. This deformation can lead to balloon instability and there is an increased danger of collapse. This would be followed by an increase in the number of fibre ends and yarn hairiness as a direct result of the higher yarn tension (centrifugal force) [12]. The present finding agrees with the earlier work [10].

The effect of thread-guide eccentricity

Forward eccentricity

Forward eccentricity leads to a decrease in hairiness; the results are shown in ***Figure 5***. When the thread-guide is moved in the forward direction, yarn contact with the bottom front roller is decreased, which obviously affects the friction the yarn is subjected to, and more twist can be inserted into the yarn. Consequently, better control of fibres in the spinning zone will be expected and this could conceivably reduce yarn hairiness.

Backward eccentricity

Backward eccentricity leads to an increase in hairiness; the result is shown in ***Table 3***. When the thread-guide is moved rearwards, the yarn comes into contact with the front bottom roller at a longer distance, but this does not allow the twist to bind the fibres issuing from nip more effectively; therefore yarn hairiness is increased.

Right eccentricity

The eccentricity in the right direction has a significant influence on the yarn hairiness. ***Figure 6*** shows that as the right eccentricity increases, yarn hairiness increases.

When the thread-guide is moved in the right direction, the sides of the triangle become unequal and the left hand side elongates. As a result, the right eccentricity may actually increase yarn hairiness because of further reduced control of fibres on the left hand side of the twist triangle. Furthermore, it is possible that the twist blockage at the pigtail guide will be more severe than the conventional set-up (eccentricity is zero), which could lead to increased yarn hairiness.

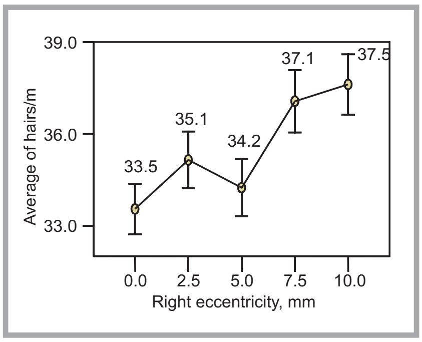

Figure 6. *Influence of right eccentricity on yarn hairiness*

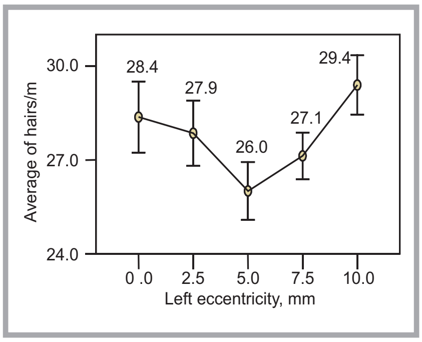

Figure 7. *Influence of left eccentricity on yarn hairiness*

Left eccentricity

The eccentricity in the left direction has a significant influence on yarn hairiness (***Figure 7***). When the thread-guide is moved to the left direction (from 0.0 mm to 5.0 mm), the left hand side decreases; also, the left eccentricity should give better control of the fibres on the left hand side of the triangle (due to the reduced distance, the less controlled fibres on the left hand side have to travel to reach the convergence point) than with the conventional arrangement (eccentricity is zero), while the fibres on the right hand side of the triangle are still controlled by the pre-twisting process; therefore, with this arrangement yarn hairiness is reduced [13].

On the other hand, when the eccentricity of the thread-guide in the left direction increases excessively, the twist blockage at the pigtail guide increases and the yarn balloon becomes unbalanced, which may cause fibres to rise from the body of the yarn, with a consequent increase in hairiness.

The effect of the shape of the thread guide

Five different thread guides were used for the experiments (***Figure 8*** see page 24). The results show that the shape of the

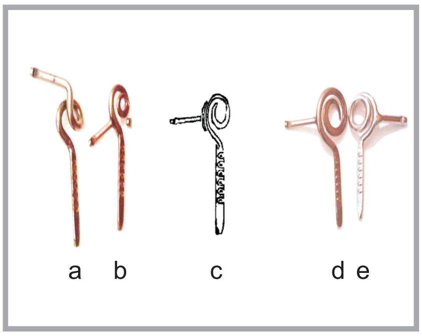

Figure 8. Shapes of thread guides used.

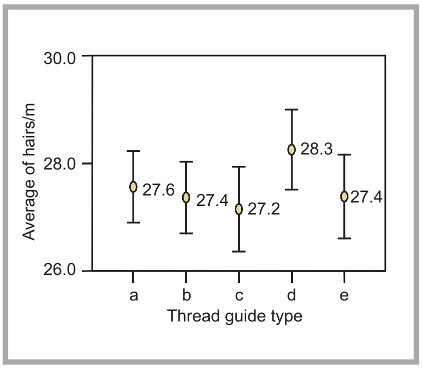

Figure 9. *Influence of the thread guide shape on yarn hairiness.*

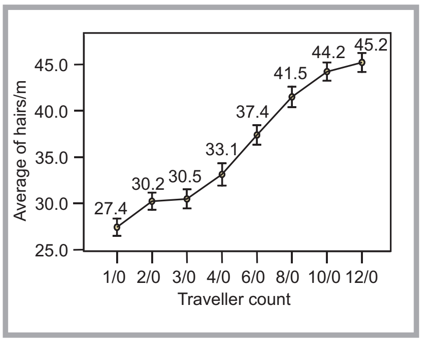

Figure 10. *Influence of traveller weight on yarn hairiness.*

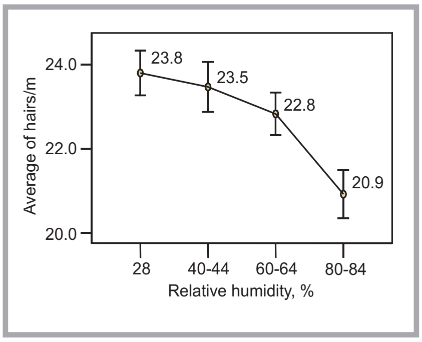

Figure 11. *Influence of the atmospheric relative humidity on yarn hairiness.*

thread guide has no significant influence on yarn hairiness. ***Figure 9*** shows that the difference between the hairiness of the yarns is not considerable.

The effect of the traveller weight

The traveller weight has a significant influence on yarn hairiness. The effect of increasing the traveller weight on yarn hairiness was examined while the spindle speed was kept constant. A traveller weight ranging from 18 to 50 (mg/piece) was used. ***Figure 10*** shows the change in value of the hairiness, which indicates that when the traveller weight increases, yarn hairiness decreases.

The reduced hairiness of yarns at higher traveller weights can be explained by the combined effects of tension and twist distribution in the yarn at the time of spinning.

Tension in the yarn increases with increasing the traveller weight, and as a result a better binding of the fibres would be expected. Greenwood [14] showed that as the traveller weight is increased, the tension increases, with a consequent greater build-up of twist in the balloon so as to increase the torque in the yarn to overcome the friction between the yarn and traveller. He also pointed out that the twist close to the front rollers increases when heavier travellers are used [14]. For the range (18-50 mg/piece, Table1) a similar trend was found by another researcher [6, 8].

The effect of atmospheric relative humidity

Relative humidity has a significant influence on yarn hairiness. ***Figure 11*** shows that higher relative humidity decreases hairiness. The yarns produced were of 20 percent viscose fiber and 80 percent polyester fibre. Considering the fact that polyester fibres are hydrophobic, and the properties of fibres, such as bending rigidity, are less affected by humidity at a higher level of relative humidity, we can state that, at lower levels of relative humidity, the variation of hairiness is not considerable. In general, the influence of humidity during spinning does not seem very significant. This effect is according to other research [9].

Summary and conclusions

The results of these experiments are summarised below, and some practical implications are suggested.

- Spindle speed has a significant influence on yarn hairiness. When the speed is increased, hairiness initially decreases, but then there is an increase.
- Spinning without a balloon-control ring increases yarn hairiness.
- Yarn hairiness increases with an increase in balloon control ring diameter.
- Thread-guide eccentricity in the forward direction leads to a decrease in hairiness, right and backward eccentricity increases hairiness, and as the left eccentricity increases, yarn hairiness initially decreases, and then it increases.
- Yarn hairiness decreases when the traveller weight increases.
- Relative humidity has a significant influence on yarn hairiness. Higher relative humidity decreases hairiness.
- Separator plates and the shape of thread guide have no significant effect on yarn hairiness.

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