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A Study of The Hairiness of Polyester-Viscose Blended Yarns; Part I. Drafting System Parameters

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Abstract
The influences of drafting system parameters of a ring frame and yarn parameters on the hairiness of polyester-viscose blended yarns are examined. Samples of 80/20 polyester/viscose blended yarns were produced by a SKF Lab Spinner and the hairiness was measured by a Shirley Yarn Friction/Hairiness Meter. Statistical analysis of the results show that yarn hairiness is significantly influenced by the drafting system angle, the overhang of the top delivery roller , the covering of the top delivery roller, the back zone setting, the break draft, the yarn count and yarn twist. Moreover, it was observed that the distance clips and top roller pressure do not have a significant effect on the yarn hairiness. The origin of the improving factors and decreasing factors of hairiness are discussed.

Key words: *drafting system factors, polyester-viscose blended yarn, yarn hairiness, yarn parameters.*

Introduction

Yarn hairiness has been described by several authors. Pierce [1] accounted for the coherence of fibres in yarn by supposing that the fibres appearing on a surface have their ends tucked inside. Morton and Yen [2] pointed out that when a trailing end emerges from the nip of the front rollers, there is almost no tension in the fibre to collect it into the yarn, and therefore it is easily expelled to the surface and appears as a projecting fibre.

Barella [3] stated that yarn hairiness is formed by: (a) protruding fibre ends; (b) looped fibres arced out of the yarn core, and (c) 'wild fibres'. Usta and Canoglu [4] indicated that the fibres that cause hairiness are mainly those that appear on a yarn surface as short fibres, long fibres, fibre bridges, fibre loops, loose and vertical fibres.

Yarn hairiness is influenced by drafting system parameters, such as the drafting system angle [5], the overhangs of the top delivery roller , the back zone setting etc. There is no relation between yarn hairiness and apron slippage [6].

Yarn linear density (count) has an influence on hairiness; Pillay [7] found that yarn hairiness increases with decreasing yarn linear density (tex) when other spinning factors remained constant, and Barella [8] observed that the coarser the yarn, the higher the corresponding hairiness is. Altaş and Kadoğlu [9] stated that an increase in yarn linear density increases the hairiness.

The influence of yarn twist has been studied by many researchers; Pillay [7], Barella [8] and Goswami [10] found that yarn hairiness decreases with an increase in yarn twist.

In previous studies only a limited number of spinning parameters of a ring frame were considered, also less attention was paid to blended yarns. Therefore, when investigating the effects of processing factors on the hairiness of polyester-viscose blended ring spun yarns it is important to optimise and control the yarn hairiness.

In the present work, an attempt was made to study the effect of the drafting system parameters of a ring frame and yarn parameters, such as the back zone setting, distance clips, yarn twist etc. on the hairiness of viscose-polyester blended yarns.

Materials and methods

Fibre and roving properties

Experiments were carried out using polyester-viscose blended yarns (80:20). The characteristics of fibre and roving are given in Table1.

Preparation of yarn sample

Several yarns (20 tex Z760) with different machine settings were produced on a SKF Lab Spinner machine under standard conditions (65±2% RH and 20±2 ^{0}C). In each stage only one factor was changed and the other factors were kept constant (Table 2 see page 42).

The values of the general production conditions of the ring frame that were constant in all experiments are shown in Table 3 (see page 42).

Hairiness testing

The Shirley Yarn Friction/Hairiness Meter was used for yarn hairiness testing under specific conditions [11]. Measurement was done for 10 seconds on yarn running at a speed of 60 m/min, and 50 readings were taken to obtain the average value (number of hairs per meter), the hair length was set at 3 mm and above (S3).

The number of samples was determined according to ASTM Standard D2905-97. The results were statistically analysed by One-Way ANOVA (Analysis of Variance was at a 95% confidence limit); 95% confidence intervals of mean in all figures were also shown.

Table 1. *Properties of fibres and roving.*

Fibre	Polyester -viscose	cut length, mm	38
		Linear density (fineness), dtex	1.67
Roving		Linear density (count), ktex	0.527
		Amount of twist, t.p.m	40

Table 2. Spinning plan; S.S.: Spindle Speed; B.C.R.D.: Balloon Control Ring Diameter, T.C.: Traveller Count, 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 , Y.T.: Yarn Twist.

Parameters	S.S., r.p.m.	B.C.R. D,. mm	T.C.	B.D.	B.Z.S., mm	D.C., color	D.S.A., degree	F.R.P., daN	F.R.C.H, shore	F.T.R.O., mm	Y.T, t.p.m.
The effect of break draft	13,000	43	3/0	1.10; 1.18; 1.26; 1.34 1.42; 1.50	56.0	yellow	49	14	70	2.0	760
The effect of back zone setting	13,000	43	3/0	1.3	50.0; 52.5 55.0; 57.5 60.0	yellow	49	14	70	2.0	760
The effect of distance clips	13,000	43	3/0	1.3	56.0	brown blue green beige yellow red without D.C.	49	14	70	2.0	760
The effect of drafting system angle	13,000	43	3/0	1.3	56.0	yellow	35; 47; 59 71; 83	14	70	2.0	760
The effect of top roller pressure	13,000	43	3/0	1.3	56.0	yellow	49	10; 14; 18	70	2.0	760
The effect of the covering hardness of the top roller	13,000	43	3/0	1.3	56.0	yellow	49	14	70; 75 85; 90	2.0	760
The effect of the Overhang of the front top roller	13,000	43	3/0	1.3	56.0	yellow	49	14	70	0.0; 2.0 4.0; 6.0	760
The effect of yarn twist	13,000	43	3/0	1.3	56.0	yellow	49	14	70	2.0	520; 600 680; 760 850; 940 1030

Results and discussion

The effect of break draft

The results of data analysis show that the increase in break draft from 1.1 to 1.5 is not a specific trend for yarn hairiness [12] (Figure 1). At low drafts the distribution of frictional forces is such that it does not aid the removal of either leading or trailing hooks, therefore the hairiness of yarn does not undergo any appreciable change with the increase in break draft [13].

The effect of the back zone setting

In order to study this effect on yarn hairiness, five different distances between the rear and middle roller were adjusted. The results are shown in Figure 2.

Table 3. Values of general production conditions.

Pendulum Arms	PK 225
Front zone setting, mm	44
Ring diameter, mm	38

Table 4. Top roller pressure.

Color	Pressure, daN
Black	10
Green	14
Red	18

The results show that changing the distance between the rear and middle roller has a significant influence on yarn hairiness; however, these differences are not considerable. Generally, with an increase in distance from 50 mm to 60 mm, the yarn hairiness decreases at the beginning, but then there is an increase. This is probably due to the fact that when the distance increases, the straightening of fibres in the drafting zone results in the removal of hooks during drafting [13], therefore yarn hairiness is reduced. On the other hand, when the distance increases considerably, the number of floating fibres in the drafting zone increases, which causes greater yarn hairiness.

The effect of distance clips

In order to be able to guide fibres in the double apron drafting system, the upper apron must be pressed against the lower apron with controlled force. For this purpose, controlled spacing (exit opening) precisely adapted to the fibre volume is needed between the two aprons at the delivery. "Spacer" or "Distance Clips" set this spacing [14].

In order to study this effect on yarn hairiness, several distance clips were used. The result shows that the distance clips have no significant effect on yarn hairiness (Figure 3).

The effect of the drafting system angle

In order to study the effect of varying the drafting angle on yarn hairiness, five angles from 35° to 83° were used. The drafting angle has a significant influence on yarn hairiness.

The results show that the effect of the drafting angle is small at low values, but increases rapidly at higher angles (Figure 4). At higher angles of the drafting system, the overlap of the emerging yarn on the bottom front roller was much reduced; the decrease in yarn contact with the bottom front roller obviously affects the friction to which the yarn is subjected, in which case the spinning triangle became

Table 5. The influence of the type of apron on yarn hairiness and the relation between hairiness and apron slippage.

Type of apron	Hairs, 1/m	Slippage, %
A	32.1	3.24
B	33.4	3.29
C	27.3	3.49
D	27.8	3.92
E	28.0	4.81
F	30.8	5.01

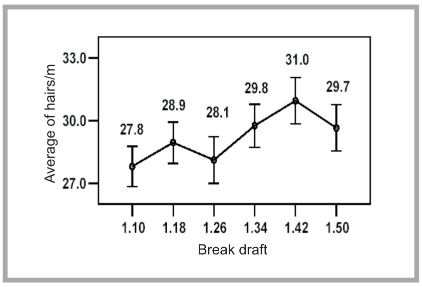

***Figure 1.** Influence of the break draft on yarn hairiness.*

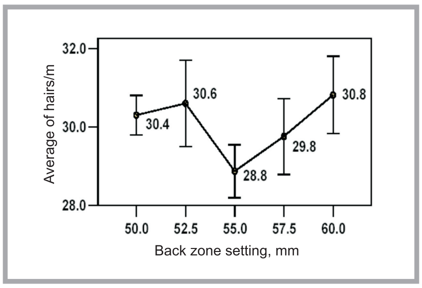

***Figure 2.** Influence of the back zone setting on yarn hairiness.*

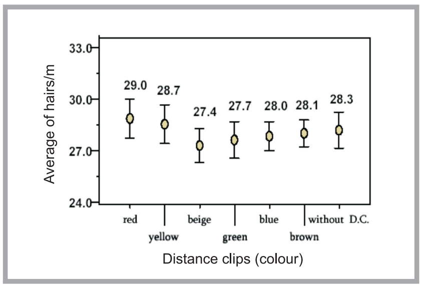

***Figure 3.** Influence of distance clips on yarn hairiness.*

very small. If the spinning triangle is too short, then the fibres on the edge must be strongly defected to bind them in, this is not possible with all fibres. Some edge fibres escape the twist effect and are lost as fly. Others may be bound in, but at one end only and one fibre end projects from the body of the yarn, which is therefore hairy [5]. On the other hand, at higher angles yarn contact with the top front roller increased and caused that the effect of the friction field increased in this zone; this does not allow the twist to bind the fibres issuing from the nip, then the fibres appear on the surface of the yarn body, and therefore increases yarn hairiness.

The effect of top roller pressure

In the SKF arm, weighting pressure can be simply adjusted in three steps with the aid of a key [5] (Table 4).

The effect of top roller pressure on yarn hairiness is shown in Figure 5, where it can be seen that a change in roller pressure from its lowest to highest (10-18 daN) value has no significant effect on yarn hairiness.

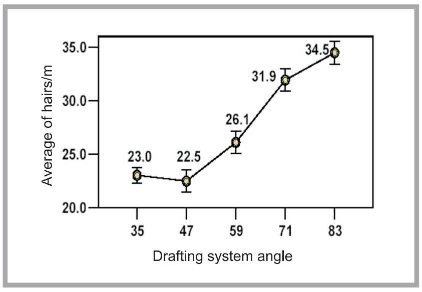

***Figure 4.** Influence of the drafting angle on yarn hairiness.*

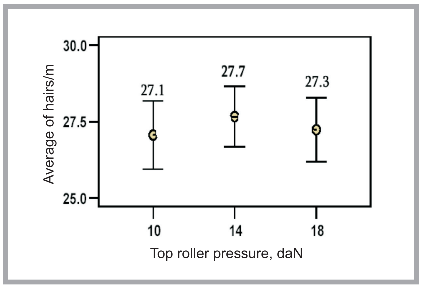

***Figure 5.** Influence of the top roller pressure on yarn hairiness.*

The effect of the covering hardness of the top roller

The covering hardness has a significant influence on hairiness. When the hardness increases, the yarn hairiness decreases (Figure 6). Soft coverings have a greater area of contact, enclose fibre strand more completely [5] and cause the friction field to become bigger than that of hard coverings.

In a big friction field the twist can not penetrate into the spinning triangle effectively, and therefore the fibre strand is less bound together at this point and hence less compact. A result of this is that hairiness increases. On the order hand, hard coverings cause the spinning triangle to become a bit smaller than that of soft coverings, which implies more turns of twist in the spinning triangle and leads a decrease in yarn hairiness.

The effect of the overhang of the front top roller

The overhang of the front top roller has a significant influence on yarn hairiness. As the roller overhang increases, yarn hairiness initially decreases and then increases (Figure 7).

The top front roller almost never lies vertically above the associated bottom roller. Usually, the top roller is shifted 2 mm forward. This gives a rather smoother running, because the weighting force acts as a stabilizing component in the running direction so that swinging of the top roller is avoided. Furthermore, the angle of warp is reduced, and the spinning triangle is made shorter; consequently, yarn hairiness is decreased. On the other hand, the overhang must not be made too large, otherwise the distance from the exit opening of the aprons to the roller nip line becomes too long, resulting in poorer fibre guidance and increased yarn hairiness [5].

The effect of the type of apron on hairiness and the relation between hairiness and apron slippage

A detailed study on apron-to-apron slippage of a ring frame has already been carried out [6]. The slippage between the top and bottom apron was measured by the method described earlier [6].

The apron-to-apron slippage was calculated using the following equation:

$$A\% = \frac{B - T}{B} * 100$$

A - Apron-to-apron slippage
B - Bottom apron surface speed
T - Top apron surface speed

To measure the slippage between the bottom and top roller, their surface speed

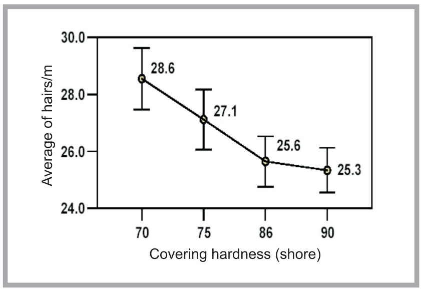

***Figure 6.** Influence of the covering hardness on yarn hairiness.*

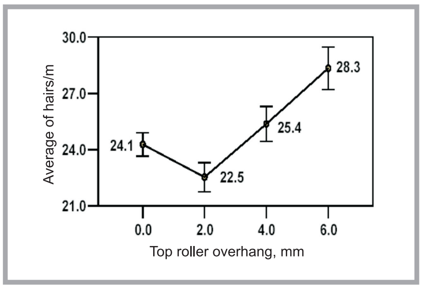

***Figure 7.** Influence of the overhang of the front top roller on yarn hairiness.*

was calculated. The process was repeated seven times to get the average.

To study this effect, six different top aprons were used as follows:
A. SUPERTEX SMP 37*32*1.0 0704
B. SUPERTEX SMT 37*32*1.0 0403
C. PRECITEX WB 6640 37*28*1 1*BS1
D. SUPERTEX LGG-4080 37*28*1.0*V 0403
E. SUPERTEX LGG-4080 37*28*1.0 0704
F. SUPERTEX JSHK 37*30*1.2 AS-V40

The results show that the type of apron has a significant influence on hairiness and apron slippage. The differences in material and type of these aprons change the hairiness of yarn and apron slippage, but no clear trend is observed for the relation between hairiness and apron slippage (Table 5). It is similar to the findings of Das et al. [6].

The effect of yarn count

Yarn count has a significant influence on yarn hairiness. Generally, as shown in Figure 8, as yarn count (Tex) decreases, hairiness also decreases; i.e., this parameter becomes greater as the number of fibres in the cross section of the yarn increases. This fact has already been demonstrated by some researchers [8, 9] who investigated hairiness.

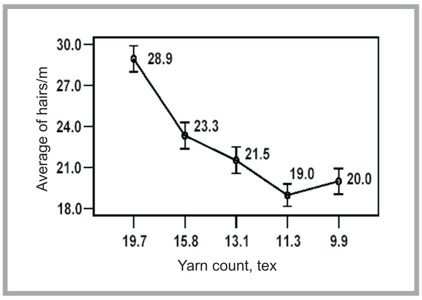

Figure 8. *Influence of yarn count on yarn hairiness.*

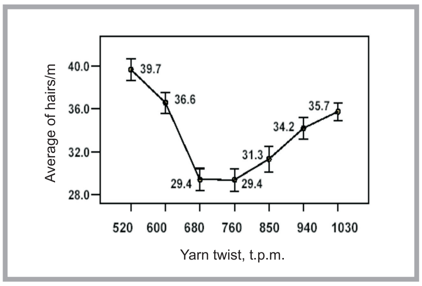

Figure 9. *Influence of yarn twist on yarn hairiness.*

The effect of yarn twist

The yarn twist has a significant influence on yarn hairiness. The results obtained are shown in Figure 9. It can be seen in the figure that as the yarn twist increases, hairiness first decreases, but then there is an increase. The primary decrease in hairiness due to the increasing twist in the yarn can be explained by assuming that the twist in the yarn will run closer to the nip of the front rollers in the case of higher twist than that of low twist, resulting in improved control over the emerging fibres. Thus, longer lengths of fibres will have a greater chance of being bound up into the body of the yarn, and shorter lengths will be more apt to protrude outside.

But, at a certain twist value, the yarn hairiness increases, which can be explained following. When the twist of the yarn is considerably increases, the spinning triangle becomes very small and consequently hairiness increases. Furthermore this increase may possible be due to the following phenomenon. The increased twist angle causes that the "packing" forces on the fibres become greater than the strength of the fibres in the yarn body, which causes the fibres to break and appear on the surface of the yarn, and consequently hairiness increases.

Conclusions

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

1 The results show that the increase in break draft from 1.1 to 1.5 has not a specific trend for yarn hairiness.
2 Generally, with increasing distance between the rear roller and middle roller, from 50 mm to 60 mm, yarn hairiness decreases at first, but then there is an increase; however, this difference is not considerable.
3 The results show that the effect of the drafting system angle is small at low values, but increases rapidly at higher angles.
4 The covering hardness has a significant influence on hairiness. When the hardness increases, yarn hairiness decreases.
5 As the roller overhang increases, yarn hairiness initially decreases and then increases.
6 The results show that the type of apron has a significant influence on hairiness and apron slippage, but no clear trend is observed for the relation between hairiness and apron slippage.
7 Yarn linear density (count) has a significant influence on yarn hairiness. Generally, as yarn linear density (tex) decreases, hairiness decreases.
8 When the yarn twist increases, hairiness first decreases, but then there is an increase.
9 Distance clips and top roller pressure have no significant effect on yarn hairiness.
10 Spinning factors have a considerable effect on all yarn characteristics, which, in addition to hairiness, should be considered for the production of yarn with suitable properties.

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