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by

L. Hunter and D. W. F. Turpie

SOUTH AFRICAN
WOOL AND TEXTILE RESEARCH
INSTITUTE OF THE CSIR

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SOME COMMENTS ON THE SPINNING PERFORMANCE AND RESULTING YARN PROPERTIES OF WOOL AND WOOL/POLYESTER BLENDS

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ABSTRACT

The influence of polyester type in wool/polyester blends, and of different additives on the end breakage rate during spinning and on the physical properties (tensile, irregularity and frequency of faults) of the resulting yarns has been investigated. Three different polyester types, blended with a 64's quality merino wool, were covered. The effect of the type of polyester and additive and of polyester level on the end breakage rate during spinning was not large while certain of these variables had a very pronounced effect on some of the physical properties of the yarns.

KEY WORDS

Wool/polyester blends – low-pilling polyester – normal polyester – spinning performance – yarn tensile properties – yarn irregularity – frequency of faults.

INTRODUCTION

Blends of wool and staple polyester fibres have become extremely popular over the past decade or so and new fibre types, with improved performance, such as low pilling, high bulk etc. are continuously appearing on the market. Information is often lacking, however, concerning the processing performance, such as during spinning, and the resulting yarn properties of the whole range of blends of such fibres with wool. Furthermore, information about the effect of various additives on the above mentioned variables is often also sadly lacking.

Shiloh and Slinger[1], although mainly interested in the properties of the fabrics, gave some results on the physical properties of yarns consisting of blends of wool and Trevira polyester types, 220 (normal), 350 (low pilling) and 550 (high bulk) in blend ratios of 100/0, 80/20, 60/40 and 40/60 wool/polyester. They concluded that the yarn breaking strength and, except in the case of the low pilling type, also the extension increased as the polyester content increased, with the "normal" polyester superior as far as the tensile properties of the yarns were concerned. Shepherd[2] investigated the effect of variation in blend level and fibre type on spinning performance and yarn properties for wool blended with acrylic, polyester and polyamide fibres, respectively. The investigation was confined to singles hosiery yarns. He found that the acrylic blends gave the best spinning performance and the nylon blends the worst, while the low pilling polyester generally performed better during winding and spinning than the normal type. As far as the blends containing the low pilling polyester (Dacron 65 – Dupont) were concerned Shepherd[2] found that both their tensile and irregularity properties improved with an increase in the polyester content. He concluded that the winding and spinning performance generally followed the same trend with the optimum performance occurring within the range 10–40% polyester content and again at 100% polyester.

Aldrich and Grobler[3] found that the extension at break of wool/polyester (Trevira type 220 – normal) yarns was roughly independent of the blend level whereas the yarn breaking strength, expressed in terms of tenacity (i.e. gf/tex), increased consistently with an increase in polyester content. The irregularity (CV) of the yarns tended to decrease with an increase in the polyester content.

Papp and Townend[4] investigated, amongst other things, the influence of blend level on yarn strength and extension for wool/Terylene blend yarns processed on the Bradford system. They found a consistent improvement in the yarn tensile properties with an increase in Terylene content.

It is apparent that, although some work has been carried out on the processing performance and yarn properties of wool/polyester blends, no work appears to have been published on the effects of different processing additives on processing performance. Furthermore, the studies generally covered brands and types of polyester fibres which have since been modified or which are not in use in South Africa. The conclusions arrived at in those studies therefore need not apply to the present processing conditions and fibre types employed by the South African Textile Industry. It was therefore decided to investigate the spinning performance and resulting yarn properties of blends of wool and those polyester types presently used in South Africa and the effect of additives thereon. Blends of a 64's quality merino wool and three polyester types (Trevira types 220 – normal, 330 – low pilling and 340 – low pilling suitable for knitting) have been included in this study.

EXPERIMENTAL

General:

Three series of experiments were carried out.

In the first series the effect of the application of various additives on the spinning performance and physical properties of 100% wool and of a 55/45 blend of wool/polyester destined for *weaving* was studied. The fibres were originally gill blended, dyed and re-combed. The additives were applied after re-combing and immediately before drawing. The polyester selected was Trevira *type 330* (a low pilling polyester).

In the second series the effect of the application of the same additives, as were used in the first series, on the spinning performance and physical properties of 100% wool and of both 55/45 and 70/30 blends of wool/polyester destined for *knitting* was studied. The polyester selected for this series was Trevira *type 340,* (a low pilling polyester suitable for knitting). As before, the fibres were originally gill-blended, dyed and re-combed. The wool which was used was from the same lot as that used in the first series.

In the third series the effect of the blend ratio on the spinning performance and yarn properties of wool/polyester blends was studied. Two types of polyester, suitable for weaving, were selected, namely Trevira *type 330* (low pilling fibre) and Trevira *type 220* (normal). The wool and polyesters were gill blended, drawn and spun. No additives were used in this case nor were the fibres dyed.

Details for First and Second Series

Wool tops with a mean fibre length of 62,2 mm (CV 55,9%), a mean fibre diameter of 21,7 μm and containing 9,3 *per cent* of fibres shorter than 25 mm were used in both series. The polyester type 330 used in the first series and type 340 used in the second series both had a mean fibre length of 75 mm. The linear density of the type 330 was 3,6 dtex while that of the type 340 was 4,4 dtex.

In both series gill blending was carried out on a Schlumberger intersecting gill box type GNP. The fibres were gilled three times in each case using fallers of pin density 6,5 p.p.cm. The gilled tops were then dyed.

In the case of the first series the 100% wool lot was dyed blue – black and the 55/45 wool/polyester type 330 blend was dyed charcoal to distinguish between the various blends. In the case of the second series the 100% wool lot and also the 70/30 and 55/45 wool/polyester type 340 blends were all dyed light blue.

After dyeing, all lots were re-combed on a Schlumberger rectilinear comb type PB26 and then finished on an auto-leveller gill box. Each dyed lot was then divided into five sub-lots. One sub-lot was sprayed with water, the other four were each sprayed with a different additive dissolved, suspended or emulsified in water. Spraying took place during the first of two gilling operations prior to drawing.

The following types of additives, commonly used in wool worsted processing, were selected (see Table I for levels of application):

(i) A fumed alumina (A) applied at a level which gave rather high withdrawal forces and which could explain the relatively poor performance of this additive in some cases.

(ii) A non-oxidising water soluble synthetic lubricant (D).

(iii) A water soluble synthetic processing aid of high lubricity (O). This additive is a polyoxyalkylene derivative (100% active).

(iv) A neutral emulsion having a vegetable oil base (E).

(v) A control (W) which consisted of water (3%) only.

In cases (i) to (iv) three *per cent* of water was applied together with the additive.

After two drawing operations on Schlumberger intersecting gill boxes, types GNP and GN4, respectively, the slivers were converted into a roving on a Schlumberger double apron high draft drawframe type FM1.

All sub-lots of the first series were spun into 21 tex yarns having 680 t.p.m and were later folded for weaving. All sub-lots of the second series were spun into 29,5 tex knitting yarns having 480 t.p.m. In the case of the first series, the yarns were spun on a Rieter spinning frame type H6 using 48 spindles at a spindle speed of 8 000 r/min. In the case of the second series the yarn was spun on a Rieter spinning frame type H2 using 36 spindles at 8 000 r/min.

Details for Third Series:

Wool tops with a mean fibre length of 61,9 mm (CV 57,1%), a mean fibre diameter of 20,0 μm and containing 10,3 *per cent* of fibres shorter than 25 mm were used for the third series. The polyester types (Trevira types 330 and 220) which were blended with these wool tops had mean fibre lengths and fibre linear densities of 75 mm and 3,6 dtex, respectively. The blends selected varied in composition from zero to 100% polyester in steps of 20 *per cent*, in the case of both the polyester types.

Gill blending was carried out on a Schlumberger intersecting auto-leveller gill box. The fibres were gilled three times in the case of each blend, using fallers with a pin density 6,5 pins per centimetre. After two drawing operations on Schlumberger intersecting gill boxes types GNP and GN4, respectively, the slivers were converted into roving on a Schlumberger double apron high draft draw frame type FM1.

All blends of the third series were spun into 21 tex yarns having 650 t.p.m. These yarns were spun on a Rieter spinning frame type H2 using 36 spindles. The spindle speed used was 10 500 r/min.

GENERAL

All gillings, re-combing, drawing and spinning operations were carried out at room conditions of 70% R.H. and 21°C.

Each spinning trial was commenced on an empty tube and, after allowing the yarn to build up to approximately the same extent on the tube in each case, end breakages were recorded over a period of four hours. All yarns were autoclave steamed at 100°C for 10 minutes under a vacuum of 660 mm Hg and then conditioned and subjected to the various physical tests described below.

YARN TESTS

All tests were carried out under standard (20 ±2°C and 65 ±2% R.H.) atmospheric conditions.

Tensile Tests

The yarn breaking strength and extension at break (hereafter referred to simply as extension) were measured on an Uster automatic breaking strength tester with the mean time to break adjusted to fall within the range 20 ± 3 s. Two hundred tests were carried out on each yarn sample.

Yarn Irregularity

The yarn irregularity (CV in %) and the frequency of imperfections were measured on the Uster series of evenness testing equipment testing 2 000 metres in each case.

Yarn Fault Analysis

The frequency of thick places present in the various yarns was determined, during the cone winding process, by means of an Uster Classimat fault classifying instrument. This instrument measures and counts the thick places occurring in a yarn electronically and classifies them into 16 classes according to their cross-section and length[5].

Yarn Linear Density (Count)

The yarn linear density (in tex) and variation in linear density (CV in %) were calculated from the masses of 100 metre lengths of yarn taken from different spinning tubes (bobbins).

Yarn Twist

The yarn twist was determined, manually in the case of the plying (folding) twist, and automatically in the case of the singles twist, on a Zweigle automatic twist tester employing a gauge length of 50 cm in both cases.

RESULTS AND DISCUSSION

SPINNING END-BREAKS

From the results of the end-breaks during spinning (see Tables I and II) it appears as if the polyester content did not have a consistent effect on this parameter although the type 330 might have been slightly superior to the type 220 in this respect (see Table II). It also appears as if the control (W), and the additive (A) gave slightly more ends down during spinning than the other additives (see Table I), particularly in the case of the blends. No other conclusions can be drawn from the end-breakage results. The fact that the stronger polyester fibres did not effect a significant improvement in the end-breakage rate could perhaps be due to the very good performance of the 100% wool.

YARN TENSILE PROPERTIES

Series 1 (Weaving yarns – Trevira Type 330)

If the results of the 100% wool yarns are compared with those of the 55/45 wool/polyester yarns (both two-ply and single) (see Table III), it is apparent that the latter were with one exception, more than twice as strong as the former regardless of what additive had been applied. The wool/polyester yarns generally

TABLE I

END-BREAKS PER 100 SPINDLE HOURS RECORDED DURING THE SPINNING OF YARNS OF SERIES 1 AND 2

Code	Amount of Additive Applied * (% on mass of fibre)	Blends with polyester T330 spun into weaving yarn (1st series)		Blends with polyester T340 spun into knitting yarn (2nd series)		
		100% Wool (Blue-Black)	55/45 Wool/polyester (Charcoal)	100% Wool (Blue)	70/30 Wool/polyester (Blue)	55/45 Wool/Polyester (Blue)
W	Control	1	2	3	7	16
A	0,25	9	5	6	2	6
D	0,5	1	1	2	6	7
O	0,5	2	2	2	3	5
E	1,5	2	1	2	1	1

* In each case 3 *per cent* of water was applied as well

TABLE IV

LINEAR DENSITY, TWIST AND TENSILE PROPERTIES OF YARNS FROM SERIES 3

Blend Wool/Polyester	Linear Density (tex)	Twist		Breaking Strength		Extension	
		Mean (t.p.m)	CV (%)	Mean (gf)	CV (%)	Mean (%)	CV (%)
SINGLES YARN							
100/0	20,2	663	5,3	120	15,1	8,9	29,4
Trevira Type 220							
80/20	21,0	659	7,4	188	16,1	17,8	21,8
60/40	20,8	669	6,0	283	14,7	20,4	10,2
40/60	22,3	665	5,0	413	13,8	21,1	8,2
20/80	21,1	663	5,1	523	15,3	22,1	9,2
0/100	19,8	666	3,1	564	14,2	21,6	7,2
Trevira Type 330							
80/20	20,4	671	5,4	178	14,4	14,4	23,9
60/40	21,3	659	5,8	250	13,9	16,5	14,3
40/60	22,0	660	4,4	351	12,3	16,8	11,4
20/80	21,5	674	6,0	427	13,6	17,8	9,9
0/100	21,5	653	4,4	519	12,9	17,4	10,3
TWO-PLY YARN							
100/0	40,3	384	4,9	259	8,4	13,3	23,8
Trevira Type 220							
80/20	41,8	393	3,6	446	9,2	20,7	10,7
60/40	40,7	398	6,8	642	10,9	22,4	8,0
40/60	43,8	391	6,1	938	8,8	23,0	7,3
20/80	42,1	380	3,3	1185	9,8	23,7	7,1
0/100	39,5	393	6,3	1348	9,8	23,8	7,7
Trevira Type 330							
80/20	40,5	377	4,0	404	10,4	16,8	14,8
60/40	41,6	390	4,9	602	9,3	18,4	9,4
40/60	43,5	404	5,7	799	9,0	18,9	9,1
20/80	42,4	373	3,7	963	8,7	19,7	7,7
0/100	42,4	382	5,7	1092	13,9	18,5	11,0

type) having considerably higher breaking strength values than the others. This is consistent with the generally accepted characteristics of a low-pilling (type 330) polyester fibre type.

Except for the initial jump in yarn extension from 100% wool to 80/20 wool/polyester the changes in this parameter, with a change in polyester content, were not very great although the tendency was still for the extension to increase as the polyester content increased until a polyester content of 80 *per cent* was reached. Thereafter (i.e. in the case of 100% polyester) the extension dropped slightly again. It is apparent that the extension of the yarns containing the Trevira Type 220 was quite a lot higher than that of the yarns containing the Trevira Type 330. It is noticeable, too, that the coefficient of variation of yarn extension decreased very sharply as the polyester content increased to about 40% whereafter the decrease was less rapid and the CV of extension tended to level off.

IRREGULARITY, FREQUENCY OF IMPERFECTIONS AND FAULTS

Series 1 (Weaving yarns – Trevira Type 330)

In the majority of cases the yarn irregularity (CV in %) and frequencies of thin and thick places decreased when going from the 100% wool to 55/45 wool/polyester yarns whereas the frequency of neps tended to increase (see Table V). The effect of additives on irregularity was not very large and was also not consistent although there was a tendency for the additive A to produce the most neps.

The Classimat results (see Table VI) do not show consistent trends except that the use of additive A, particularly in the case of the 55/45 wool/polyester blend, increased the number of faults (i.e. infrequent thick places) considerably. The results of the pure wool and 55/45 wool/polyester yarns do not show the same trend as far as the effect of additives was concerned.

This suggests that in practice, a different additive should be chosen for 55/45 wool/polyester blends compared to that used for the pure wool if the frequency of faults is to be kept to a minimum.

Series 2 (Hosiery yarns – Trevira Type 340)

It is apparent from Table V that the irregularity (CV) and frequencies of thin and thick places were always lower for both the 70/30 wool/polyester and 55/45 wool/polyester blend yarns than for the pure wool yarns. The 70/30 wool/polyester yarns generally tended to be superior to the 55/45 wool/polyester yarns in this respect. The frequency of neps appears to be independent of the blend. As far as the effect of additives on the yarn properties, under discussion, is concerned no consistent trend is apparent although the control (W) and the additive A appeared to give slightly inferior results to the other additives.

The Classimat results (Table VI) reveal that the application of additive A affected these results adversely. The results also show that both the 70/30 and

TABLE V

IRREGULARITY AND IMPERFECTION RESULTS FOR YARNS FROM SERIES 1 AND 2*

CODE	Series 1 (Trevira Type 330 – Weaving Yarns)								Series 2 (Trevira Type 340 – Hosiery Yarns)											
	100% Wool (Blue-Black)				55/45 Wool/Polyester (Charcoal)				100% Wool (Blue)				70/30 Wool/Polyester (Blue)				55/45 Wool/Polyester (Blue)			
	CV (%)	T	T.P.	Neps	CV (%)	T	T.P.	Neps	CV (%)	T	T.P.	Neps	CV (%)	T	T.P.	Neps	CV (%)	T	T.P.	Neps
Single																				
W	21,2	318	103	8	18,4	115	30	7	18,1	92	31	4	16,6	32	15	3	17,1	47	16	6
A	20,9	310	109	15	19,5	245	95	23	19,0	85	22	5	16,7	36	7	3	17,1	44	21	11
D	21,3	338	116	6	20,6	262	61	10	17,5	48	16	3	16,6	36	12	4	16,7	32	7	7
O	20,7	304	99	6	19,7	204	41	7	17,3	52	15	4	16,7	37	9	4	17,0	36	7	4
E	21,0	321	104	9	20,0	256	52	13	17,4	70	12	2	17,0	55	9	4	16,6	38	9	3
Two-Ply																				
W	15,3	6	9	3	14,6	2	3	0												
A	15,1	3	9	2	16,5	17	40	19												
D	14,7	6	7	6	15,1	0	8	4												
O	15,0	9	11	4	14,6	4	3	2												
E	14,8	3	7	5	14,6	4	5	1												

* CV = Irregularity in %; T = Thin places per 1 000 metres; T.P. = Thick places per 1 000 metres; Neps = Neps per 1 000 metres

TABLE VI

FREQUENCY OF THICK PLACES (FAULTS)* IN YARNS FROM SERIES 1 AND 2

Code	Series 1 (Trevira Type 330 – Two-ply Weaving yarns)				Series 2 (Trevira Type 340 – Singles Hosiery Yarns)					
	100% Wool (Blue-Black)		55/45 Wool/Polyester (Charcoal)		100% Wool (Blue)		70/30 Wool/Polyester (Blue)		55/45 Wool/Polyester (Blue)	
	Total	Objection-able	Total	Objection-able	Total	Objection-able	Total	Objection-able	Total	Objection-able
W	80	12	81	12	164	19	124	14	287	25
A	118	13	630	37	332	31	188	22	311	30
D	109	17	65	7	149	21	78	12	89	15
O	74	19	85	13	97	9	69	12	95	11
E	136	10	41	4	77	13	56	7	55	9

* The faults were counted and classified on a Classimat fault classifying instrument.
"Total" refers to the totals of classes A_1, B_1, C_1 and D_1 per 100 km of yarn.
"Objectionable" refers to the totals of classes A_4, B_4, C_3 and D_2 per 100 km of yarn.

55/45 wool/polyester yarns were generally superior to the pure wool yarns and that the 70/30 wool/polyester yarns were generally superior to the 55/45 wool/polyester yarns.

Series 3 (Weaving yarns – Trevira Types 220 and 330)

From Table VII it appears that the overall trend was for the yarn irregularity (CV) and the frequencies of thin and thick places to decrease as the polyester content increased with no consistent difference between the two polyester types. If anything, the type 330 was slightly superior to the type 220. As far as the frequency of neps is concerned there appears to be no consistent trend with polyester content although the type 220 generally produced fewer neps than the type 330.

The results of the Classimat test (see Table VII) indicate that, in the case of the Trevira type 220, the total number of faults was always far less than in the case of the Trevira type 330 although there was not much to choose between the two polyester types as far as the number of objectionable faults was concerned. This suggests that the type 330 generally produced far more nep type faults (i.e. short faults with not too large a cross-section) than the type 220. This confirms the trend observed in the case of the frequency of neps.

Table VII also shows that the total number of faults per 100 000 metres increased quite steeply with increasing polyester content, particularly in the case of the Trevira type 330. The only exception to this was the 100% polyester type 220 yarn which showed a sharp drop in the total number of faults. As far as the number of objectionable faults is concerned there was a tendency for the 40/60 wool/ polyester yarns to contain more of these faults than the other blends.

SUMMARY AND CONCLUSIONS

This investigation has been concerned with wool/polyester blends. The effect of both the type of polyester and type of additive as well as of polyester level on the end-breakage rate during spinning and on the physical properties of the resulting yarns has been investigated. Three polyester types (Trevira types 220, 330 and 340) in blends with a 64's quality merino wool have been covered.

The effect of the abovementioned parameters on the end-breakage rate during spinning was small.

In general the type of additive did not have a great effect on the results obtained although the application of a fumed alumina additive tended to increase the yarn strength and the number of neps and total number of Classimat faults in the yarn.

It appeared that yarn strength increased consistently as the polyester content increased, with the normal polyester (i.e. type 220) producing yarns which had significantly higher breaking strength and extension than those of the yarns containing the low pilling (i.e. type 330) polyester.

TABLE VII

IRREGULARITY AND FREQUENCY OF FAULTS FOR YARNS FROM SERIES 3

Blend Wool/Polyester	Irregularity (CV in %)	Thin Places per 1 000 metres	Thick Places per 1 000 metres	Neps per 1 000 metres	Faults per 100 000 metres	
					Total *	Objectionable **
SINGLES YARN						
100/0	20,7	266	125	46	–	–
Trevira Type 220						
80/20	20,1	195	108	33	–	–
60/40	20,3	166	44	36	–	–
40/60	19,4	96	59	38	–	–
20/80	19,0	92	63	46	–	–
0/100	19,5	72	36	20	–	–
Trevira Type 330						
80/20	20,4	207	106	46	–	–
60/40	20,0	161	88	48	–	–
40/60	19,3	106	65	56	–	–
20/80	19,1	59	64	56	–	–
0/100	16,6	28	20	47	–	–
TWO-PLY YARN						
100/0	14,6	5	5	5	87	1,5
Trevira Type 220						
80/20	14,1	1	6	5	95	6
60/40	14,2	2	6	9	117	16
40/60	13,9	2	2	8	153	27
20/80	14,0	4	8	12	154	7
0/100	12,6	1	2	6	106	6
Trevira Type 330						
80/20	14,4	2	5	7	110	6
60/40	14,4	0	3	19	149	1
40/60	13,4	2	6	18	229	18
20/80	13,4	0	6	25	424	8
0/100	11,9	0	5	31	485	8

* Total number of faults occurring in classes A_1, B_1, C_1 and D_1

** Total number of faults occurring in classes A_4, B_4, C_3 and D_2

In the case of the polyester types 220 and 330 the yarn irregularity (CV in %) and the frequencies of thin and thick places tended to decrease with an increase in polyester content, with no consistent differences between the two polyester types. In the case of the polyester type 340, used in the hosiery yarns, both the 70/30 and 55/45 wool/polyester blends were more even than the pure wool yarns, with the 70/30 blend superior to the 55/45 blend.

The polyester type 220 was associated with significantly fewer faults (as assessed on a Classimat instrument) and neps than the type 330.

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PROPRIETARY NAMES

The fact that substances with proprietary names have been used in this investigation does not imply that there are not others equally good or better.

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