ASPECTS OF THE MECHANICAL PROCESSING OF WOOL COTTON BLENDS

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Abstract

A modified system of spinning wool and wool-rich blends on the cotton system is described. The wools used were of average length 40mm but had a non-square fibre length distribution. A major feature of the processing sequence is the use of slip drafting stages from the drawframes to the ringframe.

Introduction

The concept of processing wool on the cotton system is not new, as cotton spinners have frequently tried it, attracted by the apparently higher profits on the yarns. However, only a limited range of wools exists for conventional processing on this system, and the proportion of wool in such blends is generally 10-30% and seldom above 50%. Even when blends of above 50% wool are tried, the wools used are expensive because they are produced either by cutting or breaking conventional worsted wools, involving an additional processing stage, or by carefully selecting and blending very short wools into a top, such wools being in relatively short supply and difficult to deal with because of their irregularity.

This report describes work to extend the application of spinning wool on the cotton system to wools that are more readily available and offer processing and cost advantages. Three types of wool supply have been evaluated:

(a) dry-and oil-combed noils;
(b) carbonised lambs wools (25 mm and 25-38mm mix); and
(c) dry-combed 40-mm wool in both 'open' (loose stock) and 'bump' top form. This wool had a non-square fibre length distribution and had been stretch broken to suit the needs of the cotton system.

All were found to be suitable for the production of fine count yarns, but the processing efficiency of types (a) and (b) was limited(1). This report concentrates on wools of type (c) which proved to be highly attractive in trials carried out at this laboratory.

One Australian mill and one Indian mill have processed wools of this type commercially using the processing sequence described below. A major feature of the sequence is the use of slip drafting at all drafting stages from the drawframes to the ringframe.

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Materials

Wool
The properties of the wool used are given in Table 1, and its fibre-length distribution can be appreciated from Figure 1. The supplier, a commercial topmaker, was able to produce a relatively uniform product, and, at the time of purchase, this wool was much cheaper than an average 64's worsted top.

Synthetic Fibres
A wide range of staple synthetic fibres was evaluated in blends with the wool, including polyester, nylon, acrylic and some flame-resistant fibres eg Cordelan. A typical array of 38-mm polyester fibres is shown in Figure 2.

Cotton
A S.M. 29-mm Australian cotton was used in all the wool/cotton blends. This was added either as loose stock after a preliminary cleaning or as combed sliver at the drawframe. A fibre array is shown in Figure 3.

Fibre Lubrication

Wool
Preliminary work showed that wool with a total extractable grease content of more than 0.5% (o.w.f.) had a tendency to load the card. Wools with a total grease content of less than 0.5% to which 0.5% (o.w.f.) of antistatic lubricant had been added performed satisfactorily in carding and spinning.

When components were blended at the drawframe, particularly with wool/cotton blends, the stage at which the lubricant was added during the wool topmaking was critical. The earlier the finish could be applied, the more evenly distributed it became and therefore the less likely it was to cause difficulties during subsequent processing. Furthermore, the type of finish was also critical for efficient processing. Of the finishes evaluated to date, only a few have been found satisfactory for high-speed roller drafting of wool and wool blends and special care in selection, especially with wool-cotton is required.

Synthetic
These were used as provided commercially and contained an antistatic lubrican finish below 0.5% (o.w.f.) applied during fibre manufacture.

Processing

General
The choice of blend composition is influenced by the end-product. Although pure-wool yarns of acceptable quality have been made successfully from short wool(2), blends

with synthetic or cotton offer greater potential for product development in both knitting and weaving. The practical spinning limit for a pure wool yarn made from the 40-mm, 21µm wool used is about 32Nm.

Our work concentrated largely on blending at the drawframe, but blowroom blending was also considered.

The sequence used for spinning wool or wool-rich blends was that normally used for cotton and cotton-synthetic blends, viz. Opening, carding and two passages (three for blends) of drawing followed by single-passage speed frame, and ring spinning.

At all stages, humidity and temperature conditions around 60-65% r.h. and 20ºC were best, but r.h. levels around 55-60% were also satisfactory.

Blowroom

Wool has higher bulk and less cohesion than cotton, and this has to be considered when setting machinery in the blowroom. In practice, settings similar to those used for synthetics, especially acrylics were found suitable.

Open-top wool is clean to handle and therefore requires opening rather than cleaning. The wool under investigation processed well, provided the machinery settings were altered to allow for differences in bulk, etc., as mentioned above.

The carding performance of the wool was good using the card settings normally employed for cotton (Table II), except that, for satisfactory web tension, the tension draft between doffer and coiler was reduced by 5-6%. The licker-in was clothed with a special combination wire, although any standard synthetic wire for the licker-in should be suitable.

These settings have been maintained throughout the work reported here, although improved card performance in terms of reduced fibre breakage (Table III) can be achieved by using the preferred card settings for wool detailed in Table II.

In blending all-wool card sliver or bump top delivered by the top supplier, a pre-draw to bring the sliver on weight is recommended, followed by two or three heads of blending. If choking occurs due to the increased bulk of the wool, it may be advisable to slightly increase the bore of the coiler tube.

Some results of the regularity of materials before and after blending with open-top wool are given in Table V.

Drawing

To prepare satisfactory blends at the drawframe from materials significantly different in fibre-length distribution (Fig. 1-3), the drafting arrangement of the drawframe used, a Rieter DO/2, was modified to slip drafting. This procedure, used at all stages between drawing and spinning, is discussed in more detail below.

Conditions for optimum sliver regularity are shown in Table IV for both open-top and bump-top wools. These settings are applicable only to this particular drawframe, but with commonsense can be applied to a number of different drawframes.

Speedframe

In addition to using a slip-drafting system, changes made at this machine were to use a wider apron setting and to adjust the lay and winding gears to accommodate the different physical nature of the wool. Quality can also be improved by using longer drafting elements than perhaps normally used with cotton, but this is not essential. Lower twist levels, to compensate for the higher cohesion of wool, were necessary and gave increased production.

Table VI shows some typical settings used on our Rieter F1/1 frame.

Spinning

Most of the spinning was performed on a Rieter GO/1 ring-spinning frame fitted with a variable-speed drive. The drafting was top-arm three-roller double-apron F2R 36 with slip-drafting arrangement having the second top roller recessed to a depth of 1.0mm. The apron spacer was changed from 3mm used for cotton to 5mm. As with the speedframe, alterations to allow for the physical characteristics of wool must be made.

Bump Top

To avoid the extra processes with open top, and with suitable end-products, it may be advantageous to blend wool as a regular continuous sliver, or top at the drawframe.

Preferably, the top should be bought as bumped rather than balled top, to reduce the chance of troubles from twist.

Although more regular than worsted tops prepared from specially selected or squared wools, it is recommended the bump top be given a drawframe passage before blending to improve regularity and simultaneously bring it on weight for blending.

The regularity of this material at various stages is indicated in Table VII (cf. Table V). Slip drafting was used at all stages of drawing.

All processing procedures for bump top were as outlined for open-top wool after carding, which had been carded as pure wool. The only difference was the allowance in roll settings at the drawframe for the extra length (Table IV) and a possible reduction in twist at the speedframe and ringframe.

Yarn Quality and Spinning Performance

Table VIII lists the physical properties and the end-breakage rates of a range of blends spun from both wool forms. Spinning speed was a maximum at 10,500rpm on 52mm rings and was constant for all lots.

Because of their unique method of manufacture, it is difficult to compare the properties of these yarns with those of other yarns. However, all yarns produced in our work were of good quality and did not give any trouble in further processing.

Slip Drafting

The conventional cotton system is restricted to the processing of cut staple lengths greater than 40-45mm. Therefore, mills have generally preferred to use specially sorted wool tops with a squared-fibre-length distribution.

To cover the widest possible range of staple length, the old idea of a double-apron slip-draft system, as applied in the worsted industry, was revived, thereby enabling fibres up to 65mm long to be processed. As far as can be ascertained from the literature, in the past this technique has been used only at the ringframe.

The wools selected for our work had at least 15% of their fibres longer than 65mm. Therefore, the processing system was modified further by using slip drafting at all drafting stages from the drawframes to the ringframe. As well as allowing satisfactory drafting of the longer fibres, while still maintaining control over the shorter ones, this simple technique offered other advantages. In particular, materials of very diverse length distributions, which could now be blended, resulting in acceptable end-products (Table IX). Furthermore, when fibres of somewhat similar distributions were blended, more regular products (Table IX) could be obtained than when a solid-nip-roller system was employed.

At the ringframe and speedframe, a recess depth of 1mm (2mm in diam.) was suitable for a wide range of blends. Sliver and roving counts were kept fairly constant, as there is an inter-relationship between input weight, depth of recess and fibre control.

The width of the traverse motion should be less than the width of the recess to avoid the strand passing onto the edges of the recess and being subjected to nipping.

At the drawframe, which utilized a Rieter 3 over 5 system, experiments were conducted for a range of roller settings with both solid nips and recesses of varying depths. Pure wool, wool/cotton and wool-rich/polyester blends were investigated. Results indicated that a recess of approx. 0.3mm was optimum. The setting of rollers was critical, and, although recommendations can be given (Table IV), further work is currently in hand with even longer wools.

Practical Spinning Limit

Because of the finer staple fibres more fibres can be incorporated into the yarn cross-section on the cotton system and fine and even yarns can be spun from blends. The spinning limit of such blends is dictated by the component fibres.

With the wools investigated, shorter wools have a detrimental effect on the practical spinning limit. For all wool yarns, the finest (practical) count that can be spun from the 40-mm 21µm, wool at the spinning conditions quoted, is about 32Nm.

Trials were conducted using a 2.5-denier polyester in a wide range of blends (Table X). The wool used in these trials was deliberately selected for its higher than normal fault content and was considered of borderline quality. Better spinning performances have been achieved with cleaner wools.

Our work has shown that, for the poorer quality 40-mm wools, at least 65 fibres are required in the yarn cross-section, although this may be reduced if higher percentages of synthetic are introduced and/or a better quality of wool is used. On the other hand, for a wool/cotton blend, about 80 to 85 fibres/yarn cross-section are needed for an acceptable spinning performance (Table X).

Fabrics

Some details and physical properties of a range of knitted and woven fabrics that may be of practical interest are given in Table XI. The double-jersey structures were knitted on 18-g (9 RJ) Wildt Mellor Bromley and 22-g Stibbe Mini-Jac. Machines. The single-jersey structure was made on a 22-g Mellor Bromley knitting machine. Using waxed yarn, 30-50 metres of fabric were knitted in each construction. Coloured jacquard fabrics were made using package-dyed yarns. The knitting performance of both undyed and dyed yarns (generally weaker) for the various structures reported here was very satisfactory.

Warps from two-fold yarn were woven without size, whereas singles yarn warps were sized. The weaving performance of all warps in the range of constructions reported here was satisfactory.

Finishing

All fabrics were finished on worsted equipment. The sequence used for the wool/polyester, yarn-dyed, knitted fabrics was as follows: relax, slit, heat set at 170°C, blow for 30 sec and relax. For the knitted fabrics used for piece dyeing, the general sequence was: wet relax, wind onto beam with *minimum* tension, beam scour, beam dye, hydroextract, stenter dry, heat set at 170°C, and then relax. For the woven fabric, the usual sequence was: desize (where necessary), blow in grease, dolly scour, stenter dry and heat set at 170°C, winch dye, hydroextract, stenter dry, singe, cut and blow for 30 sec.

Conclusions

Using less expensive Australian short wool tops of a non-square-fibre-length distribution, it is practical to process and prepare wool-rich blends on cotton equipment. The yarns produced cost less than those made on the worsted system. The approach involves the use of a suitable antistatic fibre lubricant and slip roller drafting at all stages of drawing for blending fibres of significantly different length distribution. The nature of the input products determines the blending point and preparatory sequence. With open-top wool, many points of blending are possible eg loose stock, picker, card or drawframe. On the other hand, with bump-top wool, blending is restricted to the drawframe.

It is not possible to differentiate between products made from open-top and bump-top wools. In commercial, applications, however, the cost differential of the materials and the processing sequences will determine the form of input. Choice of blend composition is influenced by the end-product. On cotton processing equipment, fine and uniform yarns can be made by blending with finer fibres. Wool blends with synthetic or cotton fibres offer great potential in product development for both knitting and weaving.

Acknowledgements

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Table I. Properties of the Wool Used.

Property		Unit	Wool Bump Top	Open Top
Fibre length distribution (Almeter)				
Hauteur		mm	39	40.5
C of V Hauteur		%	46	40
Length exceeded by 5% of fibres		mm	70	65
Fibre diameter (airflow)		micron	21.6	21.2
Nep content : Total		per g	6.0	4.0
: Large (>0.5mm)		per g	0.5	0.2
Veg content	1/16"=1/8"	per oz	16	11
	1/8" - ½"	per oz	12	3
Sliver weight		ktex	11	-
Regain		%	16.5	-

Table II. Card Setting and Speeds

		Cotton and Wool	Preferred Wool
1.	SETTING (1/1000 in)		
	Feed Plate to Licker-in	12	12
	Licker-in to Cylinder	7	7
	Flats to Cylinder	12	22
	Doffer to Cylinder	5	5
	Stripping Roll to Doffer	5	5
	Bottom Front Plate to Cylinder		
	Middle	22	22
	End	12	12
	Top Front Plate to Cylinder		
	Top	22	22
	Middle	22	22
	Undercasing to Licker-in	32	32
	Undercasing to Cylinder (B-C-F)	22-34-68	22-34-68
	Re-directing roll on Crosrol to Stripper	5	5
	Pressure roll to Re-directing roll	68	68
2.	SPEED		
	Flats (in/min)	4.4	4.4
	Licker-in (rpm)	767	550
	Cylinder (rpm)	272	272
	Doffer (29.75") (rpm)	16.6	13
3.	SLIVER WEIGHT (ktex)	4.0	4.0
4.	PRODUCTION RATE (kg/hr)	14	11
5.	FLAT STRIP WASTE - %	2.5	1.5

Table III. Effect of Carding on Fibre-Length Distribution

Property (Almeter)	Loose Stock	Open-top Wool Card Sliver* Cotton Settings	Open-top Wool Card Sliver* Preferred Settings
Hauteur (mm)	40.5	32.1	36.4
C.V. Hauteur (%)	40	47	42
Length exceeded by 5% of fibres (mm)	65	59	62

Table IV. Conditions of Drawing for Wool and Wool Blends

Machine	Rieter D0/2B	
Machine Speed	200 metres/min	
Input Weight	8 ends x 4 ktex (approx.)	
Feed Plate Setting	100mm	
Output Weight	4 tex	
Output Trumpet	3mm	
Drafting System	3 over 5 slip-roller drafting arrangement, with top middle recessed to a depth of 0.3mm	
Roller Settings (Nip to Nip) in mm	Front Zone	Back Zone
Bump-top Wool	60	65
Bump-top/38 mm polyester	55	55
Bump-top/combed cotton	50	50
Open-top Wool	50	55
Open-top/38mm polyester	50	55
Open-top/combed cotton	45	50

Table V. Regularity of Materials Before and After Blending Open-Top Wool

Material	Stage of Processing	Sliver Weight (ktex)	Sliver Regularity Uster C.V. (%)
Open-top Wool	Pre-drawn	4.1	4.7
Polyester (38mm)	Pre-drawn	4.5	2.5
Combed Cotton	Finisher	4.1	3.5
60/40 Wool/Polyester	Finisher	4.1	2.8
50/50 Wool/Cotton	Finisher	4.1	3.2

Table VI. Conditions at the Speed Frame

Machine	Rieter F1/1
Flyer Speed	1200 rpm
Drafting System	3-roller double-apron slip-drafting arrangement using 1.0-mm deep recess in top middle roll.
Cradle	F.2R.36 F.2R.43
Bottom Roll Settings	
Front Zone	44mm 56mm
Back Zone	55mm 55mm
Sliver Input	4 to 4.2 ktex
Condensers	Feed 16 x 4 mm, middle 11mm and delivery 14mm
Apron Spacers	9mm
Roving Count	600 tex
Roving Twist Factor	9.0-9.5

Table VII. Regularity of Material Before and After Blending Bump-Top Wools

Material	Stage of Processing	Sliver Weight (ktex)	Sliver Regularity Uster C.V. (%)
Bump Top	As purchased	11.0	10-12
Bump Top	After 1st Drawing	4.1	7-9
Bump Top	After 2nd Drawing	4.1	4-5
Bump Top/Polyester	Finisher Sliver	4.1	2.7
Bump Top/Combed Cotton	Finisher Sliver	4.1	3.3

Table VIII. Physical Properties of Some Wool Blend Yarns

Material Description	Recess t Draw frame	Tex	Twist Factor	Multi-End C.S.P.	Tensile Properties			Regularity Uster CV (%)	Spinning Performance	
					Single End				No. Of SP. Hr	EDMSH
					Tenacity (mN/tex)	CV Strength (%)	Extn. At Break (%)			
60% Bump-top Wool/40% Polyester-1	No	21	34	1551	129	16.9	14.6	20.0	1025	92
(38mm x 2.5 den.)	Yes	21	34	1759	132	13.7	15.2	18.4	1620	32
60% Open-top Wool/40% Polyester-2	No	22	38.5	1457	93	18.7	14.0	21.6	840	110
(38mm x 2.5 den.)	Yes	22	34	1534	112	13.4	13.3	20.4	1222	42
60% Bump-top/40% Acrilan (38mm x 3.0 den.)	Yes	27.5	32	1050	70	12.3	17.3	17.5	250	35
60% Bum-top/40% Polyester-3 (64mm x 2.5 den.)	Yes	27.5	30	1715	117	12.4	20.2	17.3	270	59
60% Bump-top/40% Polyester-4, pill resist (51mm x 2.5 den.)	Yes	27.5	32	1428	89	14.2	14.5	17.6	2086	38
60% Open-top/40% Polyester-4, pill resist (51mm x 2.5 den.)	Yes	27.5	32	1430	87	10.9	14.7	17.5	1150	23
Pure Wool (Bump-top)	Yes	32	34	-	51	11.6	11.0	16.9	1862	62
50% Open-top Wool/50% combed cotton	Yes	16	34	-	89	14.2	6.0	19.7	168	48
Shrinkproofed)		20	34	1477	91	11.2	6.7	18.2	564	36
50% Bump-top/50% combed cotton	Yes	20	34	1521	86	-	6.0	17.2	264	53
50% Bump-top/50% carded cotton	Yes	20	35	1150	74	15.2	6.6	20.9	-	-

Table X. Spinning Performance of Various Blends [spindle speed 10,500 rpm]

	Wool/Polyester Ratio						Wool /Cotton
	100/0	90/10	80/20	70/30	60/40	50/50	50/50
Tex	30.592	28	26	25	22.5	22.0	20.5
E.D.M.S.H.	92	88	78	72	63	37	52
No. Of Fibres in Yarn Cross Section	68	65	65	65	62	63	80

Table XI. Particulars and Physical Properties of Some Knitted and Woven Fabrics [1]

Fabric Structure	Blend Ratio	Yarn Tex	Threads/ cm(2)	Weight per m^2	Martindale Abrasion x 10^3 (Mean)	Tear Strength of Wovens (Newtons		% Area Shrinkage Dynamic	
						Warp	Weft	Relax(3)	Washing (4)
18g, 4-col Jacquard DJ	75w/25p	29	10.0x15.0	306	16			7.8	16.0
18g, Punto-di-Roma DJ	75 2/25p	29	10.0x15.0	310	29			8.7	18.0
22g, Punto-di-Roma DJ	60w/40p	22	14x19.5	338	30			3.7	4.0
22g, 3-col. Jacquard DJ	50w/50p	20	14.0x17.0	277	21			4.2	6.0
22g, SJ	50w/50p	28	13.0x16.5	185	20.5			5.0	6.0
Gabardine, woven	75w/25p	R50/2	36x16.5	309	39	No tear	35	4.7	5.0
Gabardine, woven	57w/25p	50	37x16.5	304	58	No tear	32	3.4	4.0
Plain woven	75w/25p	R55/2	19x15	217	28	45	36	3.9	5.0
Plain woven	75w/25p	55	20x15	210	33	46	38	2.0	3.0
Light weight 2/2 Twill	60w/40p	22	33.5x30.5	156	34	37	35	1.0	1.0
Plain woven	60w/40p	R55/2	19.0x15.0	212	30	52	55	2.7	3.4
Plain woven	60w/40p	55	19.5x14.5	217	39	55	46	1.8	3.0
Light weight 2/2 Twill	50w/50c	20	33.0x30.0	132	10	17	16	2.5	4.0

(1) Only fabrics made from the 40mm wool are considered here.
(2) Knitteds: Wales x Courses; Wovens: ends x picks.
(3) 3 min Cubex at 50ºC.
(4) ½ hr Cubex at 50ºC.

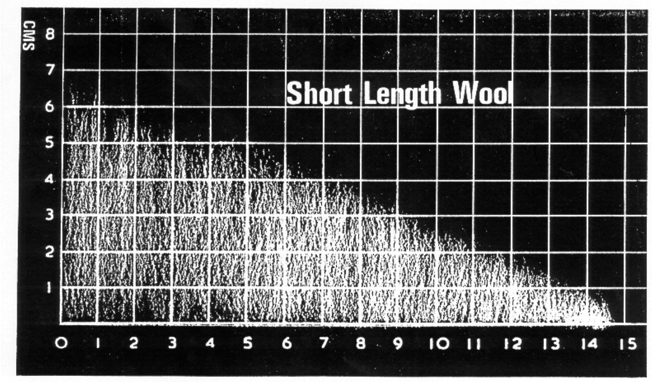

Figure 1. Fibre array of bump-top wool

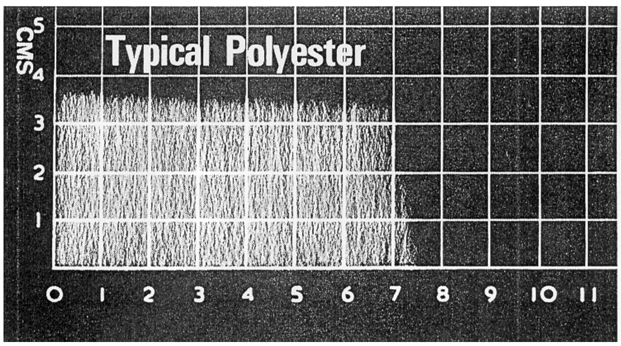

Figure 2. Fibre array of 38-mm polyester

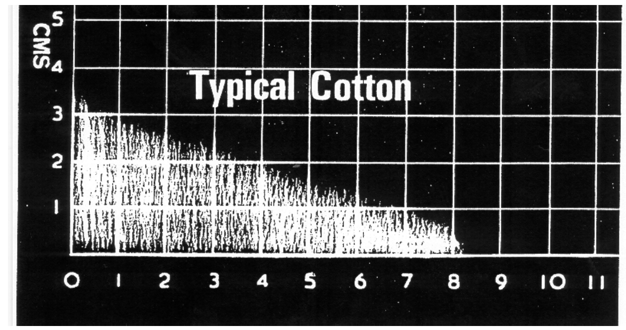

Figure 3. Fibre array of combed cotton