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115

SOME PHYSICAL PROPERTIES OF WOOL AND WOOL/MOHAIR BLEND MEDIUM-WEIGHT FABRICS

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ABSTRACT

Several worsted fabrics made from merino/Corriedale, Corriedale/mohair and merino/mohair blends were examined. The fabrics differed with respect to their handle, drape and elastic properties. The effect of weave crimp on the physical properties is discussed.

INTRODUCTION

Most fine mohair used in the worsted industry appears in mohair/wool blend fabrics and yet reviewing the literature yields scant reference to the properties of such blends. Nicholls[1] concerned himself with the properties of light-weight mohair/Terylene (55/45) fabrics. Terylene staple fibre of varying denier was used and as a result, the conclusions all refer to the effect of changing fibre diameter. Bacon-Hall *et al.*[2] reported on the processing properties of lines of Corriedale, Polworth and merino wool. They found that the differences in the processing were considerably greater than the differences in the fabrics. This is in agreement with an earlier finding of Lipson and Walls[4] who processed wools from different lines of a merino clip. As was to be expected[5], the handle of the wools followed the fibre fineness, the fabric from finer merino wool having the kindest handle. The Corriedale wool produced a fabric slightly weaker than the fabrics from the other two wools.

In a previous report the results were presented of a study of light-weight mohair/wool blend fabrics. It appeared that without the appropriate finishing techniques, such fabrics would possess many of the faults characteristic of light-weight cloth, viz. low resistance to wrinkling and poor drape. A more extensive study has now been made of medium-weight fabrics of different blends of Cape/Australian merino, Corriedale wool and kid mohair.

EXPERIMENTAL

The materials consisted of one lot of kid mohair (BSFK), and three lots of wool, viz. 64's Cape merino wool, 64's Australian merino wool and 54's Corriedale wool (the latter wool was in top form). The raw wool and mohair lots were scoured on a Petrie & McNaught pilot plant scouring set to an average residual grease content of 0.7%. The lots were carded, gilled twice, combed on the rectilinear comb, gilled once and auto-levelled once. After dyeing, the tops were recombed and blended to the desired proportions during gilling. The slivers were drawn, spun and steamed.

The warps were made on a Gordon Warin sample section warper with 151 ends per section, 16 sections, giving a total of 2,416 ends. The reed had 2/18 dpi and 36 ppi were inserted in the loom. The cloths were produced on the Saurer 100 WT loom with weft mixing. The fabrics were inspected, burled and mended before finishing. All the cloths were rope scoured followed by steaming, brushing and cropping. Finally, they were decatised (7 min steaming and 4.5 min cooling).

All the physical tests were performed by methods described in detail in previous technical reports[1,6]. The following is a resumé of the tests carried out:

AKU creasing: 2 kg load for 20 min, 1 min relaxation

Shirley creasing: 2 kg pressure for 2 min, 1 min relaxation

Bending length: According to B.S. 3356 : 1961

Young's modulus, deformability and uncrimping force: Carried out on the Instron tensile tester, 10 cm gauge length, 10 cm/min extending speed, cycled to 20% extension

Thickness: Obtained from the Reynolds & Branson tester at a pressure of 5 g/cm^2

Breaking load and breaking extension: A constant rate of traverse machine with the method in accordance with B.S. 2576: 1959.

The design of the experiment was such that no straightforward analysis could be done; however, the following comparative analyses were devised with which it was possible to make paired comparisons:

A two-way analysis of variance with a constant number of readings per cell was carried out. In this analysis two fabrics identical in every way except one (the treatment) were taken as a block. For example, when evaluating the effect of replacing the merino component in a fabric with Corriedale wool the weft results from fabrics E and H were grouped into a block. These two fabrics were nearly identical (see Table II) in every other respect except that 50% of the merino wool used in the weft of fabric E had been replaced by a corresponding amount of Corriedale wool.

It was now possible to make the following arrangement which divides the results into blocks for specific treatments (comparisons):

a) **The effect of construction,** i.e. replacing twofold yarn by three-fold yarn:

3 Blocks: Fabrics A and B, weft
Fabrics C and D, weft
Fabrics G and I, weft

b) **Comparison of merino and Corriedale wools:**

5 Blocks: Fabrics A and C, warp
Fabrics B and D, warp
Fabrics E and F, warp
Fabrics E and F, weft
Fabrics E and H, weft

c) **Comparison of merino and kid mohair:**

3 Blocks: Fabrics A and E, weft
Fabrics A and G, warp
Fabrics B and I, warp

d) **Comparison of Corriedale and kid mohair:**

6 Blocks: Fabrics A and H, weft
Fabrics C and F, weft
Fabrics C and G, warp
Fabrics D and I, warp
Fabrics F and G, warp
Fabrics F and G, weft

Samples of three of these fabrics (A, G and I) were rewetted, hydro-extracted and tentered under weft tension in order to alter the weft yarn crimp.

RESULTS AND DISCUSSION

Processing comments

The kid mohair gave some trouble during mechanical processing due to the low cohesion of the fibres. To obtain the necessary condition and cohesion the top was sprayed during the first gilling with Leomin KP (Hoechst), Topsol (Prices's) and water. In the warps containing mohair yarns fibre shedding was observed during weaving and section marks became noticeable after finishing. The mohair yarns in the weft also caused tight picks due to the weft plucking on the fur of the shuttle and, as with the section marks, these were only noticed after finishing. When pirn winding the mohair weft it was necessary to increase the tension considerably in order to wind a hard pirn. Very few warp breaks and weft breaks occurred during the experiment.

Bending and wrinkling properties of the fabrics

The bending length of the two-fold fabrics was slightly higher (0.05 cm) than the bending length of fabrics containing a three-fold component in its stead. It is known (see for instance, ref. 7) that the introduction of coarser fibres tends to increase the bending length of the cloth. This occurred here, with the kid mohair performing very much like an equivalent coarse wool, the difference between the effect of kid mohair and the effect of Corriedale being, in fact, non-significant. In the previous report[1] a result effectively contradicting this was obtained. The reason, however, is that those fabrics were made from yarns of low linear density so that the stress per tex on the yarns due to weaving tension was relatively large. The breaking strength of those yarns decreased with increased mohair content[8] and, it is surmised, so did their ability to deform elastically when stressed (see, for instance, the comments on the tensile properties of the fabrics in this report and in the previous report; *loc. cit.*). Hence, under the prevailing weaving tension the yarns with a greater proportion of mohair deformed plastically to a greater extent, which, in turn appeared as increased weave crimp. The increased weave crimp was, in fact, the reason for the discerned trend of bending length decreasing with mohair content. In contrast, incorporation of mohair into these fabrics in the place of merino or Corriedale wools did not alter the yarn crimp in any significant manner.

The wrinkling and creasing behaviour of the fabrics was determined by means of the AKU wrinkle test and the Shirley crease test, respectively. None of the factors altered these properties at a statistically significant level. The AKU results, however, were substantially lower than those obtained for the light-weight fabrics examined previously, reflecting the increase in fabric density. The Shirley results showed no substantial change.

The handle of the fabrics could not be analysed in the manner set out earlier but inspection of the data shows that the incorporation of coarse Corriedale wool was invariably detrimental to the handle of the fabric. No apparent differences existed between the handle of fabrics containing mohair and those containing merino wool.

Tensile properties

The uncrimping force or the initial portion of the load extension curve (Table V), did not change significantly with the interchange of the constituent fibres. There was a trend, however, for the fabrics with a kid mohair component to have a higher uncrimping force. This decreased extensibility was confirmed — at a statistically significant level — when the elastic moduli were analysed. It is apparent, and indeed obvious, that the more crimped wool fibres would make a fabric more elastic.

Further analysis of the fabric deformability confirmed the tendency of mohair to decrease the elasticity and increase the plasticity, or the propensity to deform permanently. The difference between the components with respect to permanent deformation was very pronounced, the difference being significant beyond the 0.1% level for kid mohair and Corriedale wool, for example. Changing the weft from a two- to a three-fold yarn did not alter any of the tensile properties. In line with what occurred at the lower portion of the load extension curve, the fabrics differed considerably in respect of their breaking extensions. Merino wool gave the highest breaking extension, followed by Corriedale, with the kid mohair being the least extensible. On the other hand, the breaking load was not sensitive to the changes since it was not affected by the constituent fibre or by the substitution of three-fold for two-fold yarn.

The effect of re-tentering under weft tension

Commercially produced mohair worsted fabrics have been found to possess relatively low weft crimp[3]. It is surmised that the weft crimp is decreased by tentering under weft tension and/or by chemical setting. The low crimp level had the effect of increasing the weft bending length. In order to ascertain the extent to which the physical properties of the present fabrics being reported on, can be altered, swatches from three of these fabrics were tentered (as described under Experimental) and certain mechanical properties measured (see Table I).

Comparing the results in Table I with those in Table IV, it is evident that tentering decreased the weft crimp, as expected, while it increased the warp crimp. The crimp interchange, in every case, decreased the bending length in the warp direction and increased it in the weft direction.

TABLE I

Mechanical properties of tentered fabrics

Fabric	Yarn Crimp (%)	Bending length (cm)	AKU (1 min) Tentered	AKU (1 min) Relaxed
A : Warp	12.4	1.64	16	18
: Weft	4.1	1.93	17	16
G : Warp	8.4	1.75	16	17
: Weft	4.3	1.92	18	16
I : Warp	8.2	1.76	15	17
: Weft	5.3	1.87	15	15

TABLE II

Details of blends used in fabrics

Cloth A	:	warp 2/28's 50% 64's Cape, 50% 64's Aust.
	:	weft 2/20's 60% Kid mohair, 20% 64's Cape, 20% 64's Aust.
Cloth B	:	warp 2/28's 50% 64's Cape, 50% 64's Aust.
	:	weft 3/30's 60% Kid mohair, 20% 64's Cape, 20% 64's Aust.
Cloth C	:	warp 2/28's 25% 64's Cape, 25% 64's Aust., 50% 54's Corriedale
	:	weft 2/20's 60% Kid mohair, 20% 64's Cape, 20% 64's Aust.
Cloth D	:	warp 2/28's 25% 64's Cape, 25% 64's Aust., 50% 54's Corriedale
	:	weft 3/30's 60% Kid mohair, 20% 64's Cape, 20% 64's Aust.
Cloth E	:	warp 2/28's 50% 64's Cape, 50% 64's Aust.
	:	weft 2/20's 50% 64's Cape, 50% 64's Aust.
Cloth F	:	warp 2/28's 25% 64's Cape, 25% 64's Aust., 50% 54's Corriedale
	:	weft 2/20's 25% 64's Cape, 25% 64's Aust., 50% 54's Corriedale
Cloth G	:	warp 2/28's 60% Kid mohair, 20% 64's Cape, 20% 64's Aust.
	:	weft 2/20's 60% Kid mohair, 20% 64's Cape, 20% 64's Aust.
Cloth H	:	warp 2/28's 50% 64's Cape, 50% 64's Aust.
	:	weft 2/20's 25% 64's Cape, 25% 64's Aust., 50% 54's Corriedale
Cloth I	:	warp 2/28's 60% Kid mohair, 20% 64's Cape, 20% 64's Aust.
	:	weft 3/30's 60% Kid mohair, 20% 64's Cape, 20% 64's Aust.

TABLE III

Constructional details of fabrics

	A	B	C	D	E	F	G	H	I
Density (oz/yd^2)	6.47	6.62	6.68	6.70	7.03	7.06	6.46	7.00	6.59
Ends per inch	39.0	38.6	40.6	41.2	39.2	41.2	40.4	39.0	40.4
Picks per inch	34.0	33.6	33.8	33.8	34.4	33.8	33.8	34.0	33.8
Thickness (mm)	0.543	0.547	0.602	0.576	0.587	0.608	0.550	0.588	0.555
Yarn linear density (tex)									
: warp	63/2	63/2	63/2	63/2	63/2	63/2	63/2	63/2	63/2
: weft	88.6/2	88.6/3	88.6/2	88.6/3	88.6/2	88.6/2	88.6/2	88.6/2	88.6/3
Crimp (%)									
: warp	6.6	6.8	6.3	6.1	7.5	7.6	3.9	7.6	4.1
: weft	5.8	5.9	8.4	6.9	6.1	8.5	8.1	5.6	9.4

TABLE IV

Bending and wrinkling properties of the test fabrics

Fabric	A	B	C	D	E	F	G	H	I
Shirley : warp ff (degrees)	144.6	144.2	145.4	147.0	142.4	144.5	145.2	142.7	143.9
(1 min) bb	149.0	148.1	141.6	144.5	148.6	145.8	147.3	146.3	143.6
: weft ff	145.8	143.9	146.1	145.0	144.7	145.2	143.3	142.8	146.5
bb	146.8	145.8	145.4	145.3	146.4	147.6	144.7	143.0	145.9
Bending length (cm)									
: warp	1.78	1.75	1.89	1.87	1.78	1.88	1.90	1.74	1.96
: weft	1.95	1.90	1.92	1.89	1.79	1.89	1.88	1.94	1.87
Flexural rigidity (mg-cm)									
: warp	123	120	153	148	135	159	151	125	168
: weft	163	154	160	153	137	161	145	174	146
Handle score	5	6	11	10	5	14	5	11	5
AKU (1 min)									
: warp	11.9	9.3	11.4	13.1	11.3	10.0	11.6	8	9.1
: weft	11.2	12.5	10.3	10.0	14.9	12.3	13.5	14.5	10.6
(24 hr)									
: warp	4	2	2	3	4	4	2	2	1
: weft	2	3	2	1	3	3	3	2	1

TABLE V

Tensile properties of the fabrics

Fabric	A	B	C	D	E	F	G	H	I
Elastic modulus (kg)									
: warp	159	165	140	169	166	189	203	183	231
: weft	198	217	207	187	170	156	186	176	192
Deformability (%)									
: warp	7.0	6.6	6.5	6.8	6.9	6.9	7.3	7.0	7.4
: weft	7.9	7.8	7.8	7.7	7.2	6.8	7.6	7.1	7.3
Uncrimping force (kg)									
: warp	3.3	3.8	2.5	4.3	3.9	5.4	5.6	4.7	7.6
: weft	2.3	3.6	3.5	1.8	2.2	1.4	1.9	2.1	2.1
Breaking load (kg)									
: warp	31.5	30.9	30.2	31.6	33.5	34.5	32.4	33.4	32.4
: weft	35.2	33.6	35.4	35.4	35.9	35.9	32.9	35.6	35.4
Breaking extension (%)									
: warp	45	42	44	41	46	39	38	44	39
: weft	43	37	41	43	48	45	41	44	45

The wrinkle resistance of the tentered fabrics must be compared with that of fabrics which have been relaxed in warm water (60°C) for an hour followed by steam pressing. The reason for this is that the wetting and drying which occurs during tentering causes the wrinkle resistance to deteriorate relative to the wrinkle resistance of the stored or unwetted fabrics (compare the figures in Table IV). From Table I it appears that tentering had a small but consistent influence: where the yarn crimp decreased (weft) the wrinkle resistance worsened and where the crimp increased (warp) it improved.

SUMMARY

During processing only the mohair tops and yarns gave some difficulty, the tops possessing too low a cohesion while tight picks and section marks occurred during weaving. With respect to the drape, the fabrics behaved as expected, the coarse fibres giving a greater bending length. The handle of the fabric containing Corriedale wool was the poorer, but no difference between the handle of the mohair and that of merino fabrics was discernible. The crimped wools imparted an elasticity to the fabrics which should distinguish all-wool fabrics in wear from those having a mohair component.

Tentering with weft-way tension decreased the yarn crimp in the weft direction and increased it in the warp direction. The bending length of the fabric changed as a consequence, increasing in the weft direction and decreasing in the warp. The increased yarn crimp improved the AKU wrinkling score, *and vice versa*.

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