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Cotton/Wool (70/30) Blended Fabrics and their Properties after some Durable Press Treatments

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COTTON/WOOL (70/30) BLENDED FABRICS AND THEIR PROPERTIES AFTER SOME DURABLE PRESS TREATMENTS

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ABSTRACT

Fabrics were woven from 30/70 wool/cotton yarns, two of them being plain weaves of 200 g/m² and 140 g/m², and one a poplin of 200 g/m². These fabrics were treated with aminoplast resins at various levels of application in order to achieve durable press performance. After treatment the fabrics were washed and their physical properties measured.

It was found that the wrinkling performance after treatment of all the fabrics was acceptable, but too high a level of treatment caused a marked deterioration in strength and flex abrasion. Non-uniform distribution of resin in the different fabric structures seem to be the major cause for the deteriorations. The optimum level of treatment for a given fabric would be determined by the fabric structure, density and fibre composition. Pilling propensity was decreased by all the treatments.

The properties of different wool/cotton blends of similar construction were also compared.

KEY WORDS

Wool/cotton blends – fabric properties – durable press treatments – resins – wrinkling – creasing – pilling – flex abrasion.

INTRODUCTION

The properties of fabrics made from wool/cotton intimately blended yarns have already been the subject of some preliminary investigations[1–5]. It has been suggested that on blending these fibres, the desirable properties of each could be maintained and combined, while some of their undesirable properties may be eliminated. To achieve satisfactory durable press performance which would be commercially acceptable, however, such fabrics require some chemical treatments. The level of application of such treatments depends upon the percentage of cotton and wool in the fabric. If the same amount of resin is used in the durable press treatment of blends containing cotton as for 100% cotton fabrics, over-treatment of the cotton fibres can easily occur resulting in excessive strength and abrasion losses of the blended fabric[6]. This fact was taken into account in previous work[4, 5] on wool/cotton blends where the resin levels were reduced in proportion to the mass of cotton in the blends.

The present investigation was undertaken to establish the permanent press properties of a cotton-rich blend treated with different durable press treatments in contrast to wool-rich blends which were investigated in previous work[4, 5]. Three different fabrics woven from 70% cotton/30% wool intimately blended yarn were studied in this investigation.

EXPERIMENTAL

Fabrics:

A short spinner's style wool of about 6/7 months was combed on a rectilinear comb to produce a wool top of 36,7 mm mean fibre length (C.V. = 35,8%). The combed wool sliver was blended with a combed cotton sliver of 28 mm staple length in the ratio of 70% cotton and 30% wool (by mass), by four passages through a conventional worsted gill box. The draft was kept to a minimum and the ratch setting as close as possible to facilitate control of the short cotton fibres.

In spite of the high irregularity of the resultant sliver caused by inadequate control of the cotton fibres, the blended tops were further drawn on a cotton intermediate frame and then spun to 16,4 Tex (36's cotton) yarns on a cotton ring frame. The yarns were then doubled to form R33 Tex S400/2 Z600 folded yarns.

Three fabrics were woven from these yarns on a 75" Saurer loom. The fabrics were subsequently subjected to a light scouring on a winch. The following densities and setts were obtained after scouring: A plain weave of 200 g/m^2 (27 x 25 ends and picks per cm), a poplin weave of 200 g/m^2 with 25 x (14 x 2) ends and picks per cm and a plain weave of 140 g/m^2 (20 x 18 ends and picks per cm).

Chemical Treatments:

A number of durable press treatments were applied to the three fabrics by the conventional pad-dry-cure method from aqueous solutions followed by air drying, pressing and curing at 160°C for 3 minutes. Samples of 30 cm x 90 cm were treated. The chemical compounds used were some of those described previously[4, 5]: Aerotex M3 (Cyanamid), Fixapret CPN (B.A.S.F.) and a polyethylene softener Mystolube S (Catomance), in the following combinations:

C : control, untreated fabric
M : 1% Mystolube S (omf*)
A5 : 2,5% Aerotex M3 + 2,5% Fixapret CPN (omc**) with 1% Mystolube S (omf)
A8 : 4% Aerotex M3 + 4% Fixapret CPN (omc) with 1% Mystolube S (omf)
A10 : 5% Aerotex M3 + 5% Fixapret CPN (omc) with 1% Mystolube S (omf)
A15 : 7,5% Aerotex M3 + 7,5% Fixapret CPN (omc) with 1% Mystolube S (omf)
CPN : 10% Fixapret CPN (omc) with 1% Mystolube S (omf)

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* omf = on mass of fabric;
** omc = on mass of cotton in the fabric.

TABLE I

MECHANICAL PROPERTIES OF 30/70 WOOL/COTTON FABRICS

Fabric	Treatment	YARN BREAKING STRENGTH			Yarn Extension at Break (%)	Bursting Strength (Kgf/cm^2)	FLEX ABRASION (CYCLES)			Air Permeability (cm^3/sec)	Pilling* rating
		Warp (gf)	Weft (gf)	Mean (gf/tex)			Warp	Weft	Mean Loss (%)		
200 g/m^2	C	422	450	13,2	34,6	13,6	2 194	2 459	-3	4,4	2
	M	456	460	13,9	35,8	12,8	2 115	2 413	0	4,4	2
Plain	A10	335	360	10,5	27,7	10,0	1 378	1 192	43	4,1	5
Weave	A15	326	312	9,7	26,0	8,7	761	683	68	3,7	5
(27 x 25 cm^{-1})	CPN	324	329	9,9	27,1	10,6	1 034	1 184	51	4,3	4
200 g/m^2	C	429	439	13,2	33,5	10,6	1 709	2 919	15	13,2	1
	M	421	494	13,8	38,6	10,7	1 642	3 777	0	12,6	1
Poplin	A10	325	297	9,4	27,2	6,5	365	572	83	12,4	2,5
Weave	A15	296	292	8,9	25,3	5,2	235	369	89	12,3	3,5
(25 x 28 cm^{-1})	CPN	318	261	8,8	27,5	6,4	247	397	88	12,8	4
140 g/m^2	C	434	437	13,2	41,6	9,0	1 076	890	7	39,2	1
Plain	M	405	430	12,7	39,0	9,1	1 161	942	0	35,3	1
Weave	A10	290	290	8,8	27,7	5,5	177	122	86	39,0	2,5
(20 x 18 cm^{-1})	A15	273	243	7,8	29,9	4,7	81	57	93	37,5	4,5

* 1 = Worst; 5 = best (i.e. unchanged)

After treatment, the fabrics were divided into two lots. One lot was washed in a commercial washing machine for 45 minutes at 60°C and then tumble dried, whereas the other lot was washed in a Cubex machine (48 min) and oven dried.

Test Procedures:

The same test procedures as described previously were followed[5]. The following additional tests were also carried out: Single warp and weft yarns were withdrawn from the control and treated fabrics and their breaking strengths and elongations at break were measured on an Instron Tester, using a gauge length of 5 cm and a crosshead speed of 2 cm/min. The appearance of the fabrics after washing was evaluated by means of the DP replicas according to the AATCC method[7]. The air permeability was measured on a WIRA Air Permeameter. The pilling propensity of the fabrics was tested by rubbing samples of the same fabric against each other on a Martindale Tester. The evaluation of pilling was performed after 1 000 cycles under a headweight of 200 gf. The fabrics were rated 1–5 according to their degree of pilling. A rating of 1 was allocated to the fabrics which pilled most while a rating of 5 was allocated to the fabrics which appeared unchanged when compared with the untested fabric. The means of four evaluations were taken in each case.

The fabric shrinkage was determined in accordance with the AWB specifications, after washing in a Cubex[11].

RESULTS AND DISCUSSION

The mechanical properties of some of the treated and untreated fabrics are presented in Table I, while the results of the bending and wrinkling tests are given in Table II. The values given are the means of the results obtained in each case.

A two factorial analysis of variance was carried out on the results for each fabric and for each property separately, incorporating the number of individual results which differed from one test to another. The main factors were the treatments and the washing procedures. In cases where test results for some properties differed significantly between warp and weft directions the analysis was carried out on the results of one direction at a time.

In the majority of cases the effect of the different washing procedures was non-significant, and the results were grouped and only the means are given in Tables I and II. The factor of "treatments" included all treatments, as well as the A5 and A8 the results of which are not reported upon, as well as the control and the Mystolube treated fabrics (d.f. = 6).

Shrinkage:

The results of the shrinkage tests are given in Table III from which it can be seen that all the treatments reduced the shrinkage to negligible values.

TABLE II

BENDING AND WRINKLING OF 30/70 WOOL/COTTON FABRICS

FABRIC	Treatment	Crease Recovery Angle (AATCC) (W+F) (°)	DP Rating after washing	FLEXURAL RIGIDITY (mgf cm^2 per cm)		OWEN'S BENDING Mo (mgf cm^2 /cm)		Mo/B (cm^{-1})
				Warp	Weft	Warp	Weft	
200 g/m^2	C	254	2,5	119	121	33	34	0,50
	M	259	2,5	139	139	29	31	0,46
Plain	A10	279	3,5	177	194	43	44	0,51
Weave	A15	286	3,7	219	215	51	49	0,52
(27 x 25 cm^{-1})	CPN	282	3,9	145	148	36	40	0,53
200 g/m^2	C	269	2,6	80	115	30	46	0,59
	M	275	2,3	78	121	28	38	0,56
Poplin	A10	294	3,9	94	129	31	47	0,56
Weave	A15	295	4,1	104	138	33	42	0,53
(25 x 28 cm^{-1})	CPN	298	4,0	82	119	28	40	0,53
140 g/m^2	C	277	2,6	49	50	20	18	0,63
Plain	M	282	2,6	50	46	16	15	0,51
Weave	A10	303	3,9	67	60	19	16	0,47
(20 x 18 cm^{-1})	A15	311	4,0	80	69	24	19	0,49

TABLE III

PERCENTAGE AREA SHRINKAGE AFTER WASHING

FABRIC	UNTREATED	TREATED
Plain weave 200 g/m^2	4,3	0 – 1,5
Poplin weave 200 g/m^2	8,5	0,5 – 1,5
Plain weave 140 g/m^2	6,7	0 – 1,5

Mechanical Properties:

Initially the breaking strength of the yarns was the same for the three control fabrics. In the heavier plain and poplin weaves it increased slightly after the application of Mystolube S while it decreased in the lighter weight fabric. After the durable press treatments the yarn strength decreased in all cases, this effect being greatest in the lighter weight fabric. The strength losses were higher in the case of the poplin fabrics than in the case of the heavier plain weave fabric, even though both were of the same density (200 g/m^2). Yarn extension at break showed a reduction of about 20% after treatments, which implied that the toughness of the yarns would also be considerably reduced.

In spite of the untreated plain weave and poplin fabrics being woven of the same yarns and to the same densities, the bursting strengths differed significantly. The poplin was less capable of resisting the pressure possibly because its structure lends itself to a more uneven distribution of the pressure. As could have been expected, the lighter weight fabric showed the lowest bursting strength. The effect of the washing procedures on the bursting strength of the various fabrics was not significant, whereas the durable press treatments caused considerable losses. The percentage loss in bursting strength after treatment was slightly greater for the poplin fabric than for the lighter plain weave fabric, whereas it was least in the case of the heavier plain weave.

After treatment the flex abrasion decreased considerably in both directions, whereas the effect of washing was again non-significant. The poplin fabric had a much higher resistance to flex abrasion in its weft direction than in its warp direction. After the durable press treatments the loss in flex abrasion for this fabric was most pronounced. The loss in flex abrasion with the increasing percentage of Aerotex M3 + Fixapret CPN is illustrated in Figure 1. The resistance to flex abrasion of the lighter weight plain weave was originally less than half that of the heavier fabrics. The lighter plain weave and poplin fabrics suffered flex abrasion losses of the order of 45–60% at resin add-on levels of approximately 5%, whereas the heavier plain weave fabric sustained a loss in flex abrasion of only about 16%. The severe loss in flex abrasion of the poplin fabric can possibly be ascribed to the uneven distribution of resin in the fabric. The uneven distribution of crosslinks in a fabric was recently discussed by Miro *et al*[8]. By using a fluorescence dyeing technique they showed that crosslinking density is lower at yarn intersection zones in a woven cotton fabric. It is claimed that such an uneven distribution can lead to over-treatment of certain yarn segments which is considered as one of the major causes for the deterioration of the abrasion properties of easy-care cotton fabrics. The effect of fabric structure, in addition to the density of the fabric, therefore, plays an important role in determining the optimum level of resin application.

The results of the air permeability measurements show extremely large differences between the three fabrics: The poplin structure was far more porous than the heavier plain weave fabric although both were woven from the same yarns and to

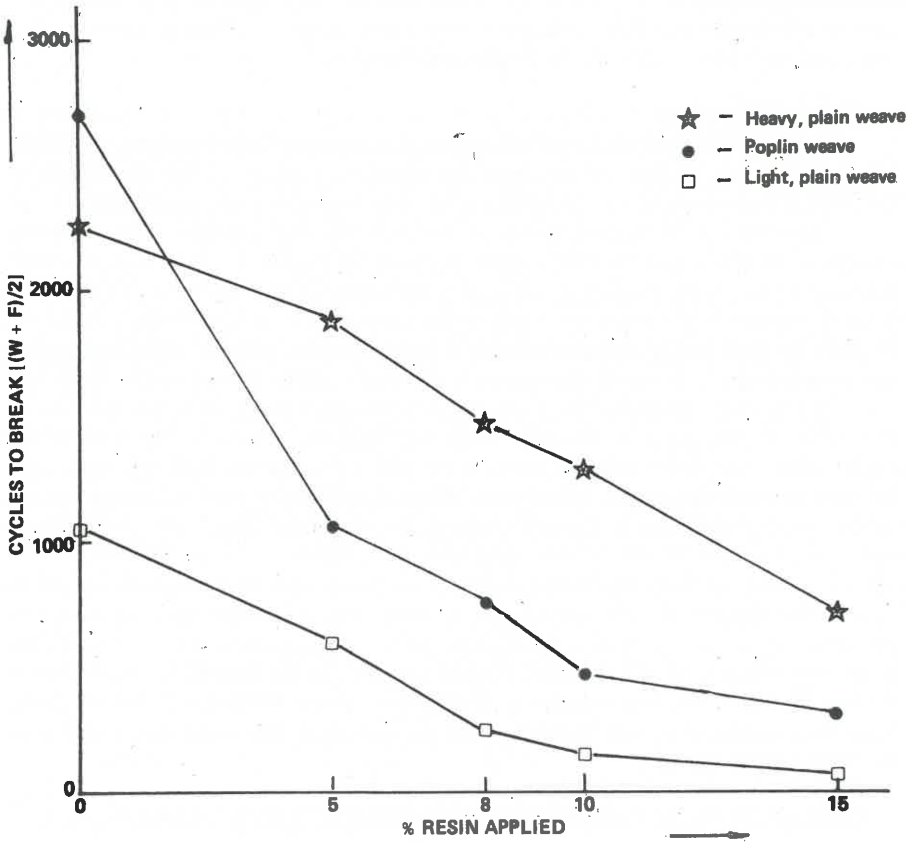

FIGURE 1

Flex Abrasion vs Percentage Aerotex M3 + Fixapret CPN applied the same density and sett. The lighter plain weave fabric was, obviously more permeable than the heavier fabrics. Neither washing procedures nor the chemical treatments affected the air permeability significantly.

The results of the pilling test (Table I) show that the durable press treatments caused a marked reduction in the pilling propensity of all the fabrics. According to the mechanism of pilling proposed by Brand and Bohmfalk(9), pilling resistance should be improved by slowing down the rate of fibre migration to the fabric surface. Farmer *et al*(10) have shown that in practice this situation is brought about after polymer treatments, where the pilling rating improved with increasing levels of polymer treatment. This was also found to be the case in the present tests. It is also possible that the slowing down of fibre migration is accompanied by a reduced yarn extension-at-break, such as occurred in the present case. Whether in all cases lower yarn or fabric extensibilities indicate a better resistance to pilling is, however, not clear, and may form a subject for future investigation.

Bending and Wrinkling:

The durable press subjective rating showed that the Cubex washing procedure followed by oven drying did not have any significant effect on the appearance of the fabrics. Improvement of the fabrics after resin treatment was significant.

The effect of increasing levels of Aerotex M3 and Fixapret CPN (in equal amounts) on the crease recovery angle is shown in Figure 2. The crease recovery angles increased with increasing levels of treatments. Treatment with 15% resin did not improve the crease recovery angles much above those obtained with a treatment of 10%. In view of the requirement for a good balance between wrinkling performance and strength, it would appear as if a 10% resin add-on should not be exceeded.

The flexural rigidity of the fabrics was higher after treatments, but even at the 15% level of treatment it did not reach unacceptable values. In the case of the poplin fabric the differences between warp and weft flexural rigidities were high, the weft results being nearly 40% higher. Similar trends were observed in the flexural rigidity results obtained by Owen's method. The frictional couple (Mo) was slightly higher in the case of the fabrics washed in the Cubex, than in the case of the fabrics washed in the commercial washing machine. This was especially so in the case of the heavier plain weave fabrics. Possibly this difference may be related to the very slight, although non-significant, inferior appearance after washing and crease recovery angles of the Cubex washed samples. In the case of the poplin fabric Mo was considerably higher in the weft direction (about 40%) due to the structure. Both the residual curvature Mo/B and Mo did not show any consistent trends after the chemical treatments.

COMPARISONS BETWEEN DIFFERENT WOOL/COTTON BLEND RATIOS

The results of the tests carried out on the heavier plain weave 30/70 wool/cotton fabric were compared with those previously obtained[4, 5] from other blends

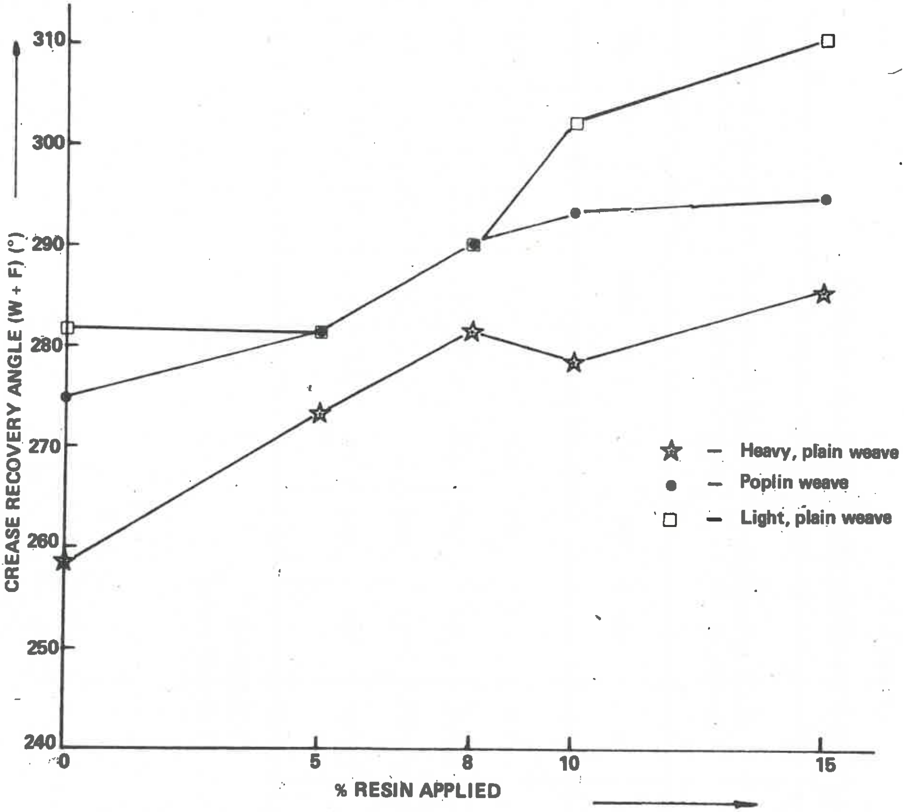

FIGURE 2

Crease Recovery Angles vs Percentage Aerotex M3 + Fixapret CPN applied

of similar structure and density. The comparison between some major properties of the different fabrics is shown in Table IV in which the results of the Mystolube treated fabrics (used as control), the 10% combined Aerotex M3 and Fixapret CPN, and the 10% Fixapret CPN treated fabrics are given.

The bursting strength of the untreated blends decreased with an increase in the wool component, while in the treated fabrics the trend was reversed. This was probably due to a deterioration in the strength of the cotton component whereas it appears as if the wool component maintained most of its original strength after treatment. The flex abrasion results seem to have followed a more complex pattern. The 30/70 wool/cotton blend seemed to be more resistant to abrasion than the other fabrics. This can possibly be due to the lower yarn counts in this fabric. Further work on wool/cotton blends, however, might clarify this point. Both treatments

TABLE IV

SOME PROPERTIES OF COTTON/WOOL 200 G/M² PLAIN WEAVES

% COTTON/ % WOOL	BURSTING STRENGTH (Kgf/cm²)			FLEX ABRASION (cycles), (W + F)/2			CREASE RECOVERY AATCC (°), (W + F)			FLEXURAL RIGIDITY (mgf cm² per cm)		
	M	A10	CPN	M	A10	CPN	M	A10	CPN	M	A10	CPN
100/0*	13,8	9,4	5,9	1 434	345	46	208	252	292	230	243	212
70/30**	12,8	10,0	10,6	2 264	1 285	1 109	259	279	282	139	185	146
45/55*	12,4	11,6	11,0	1 630	922	908	277	279	282	123	145	137
25/75*	10,2	9,6	9,8	1 370	889	728	295	290	287	81	118	156

* Reference 5

** Present results.

decreased the resistance to flex abrasion to a considerable extent, but it appears as though this property tends to improve with an increase in the cotton component as was the case for the bursting strength of the treated fabrics.

The crease recovery angles as measured under standard atmospheric conditions (AATCC method) improved significantly with the increasing wool content. Good results were obtained for all the durable press treated blend fabrics.

In all cases the flexural rigidity decreased with an increase in the wool component, even after resin treatment. A satisfactory performance of treated wool/cotton blends was indicated by these results.

SUMMARY AND CONCLUSIONS

Supplementary to previous studies on wool-rich wool/cotton blends, the properties of cotton rich blend fabrics were also studied. Three fabrics were woven from 30/70 wool/cotton yarns, two of them being plain weaves of 200 g/m^2 and 140 g/m^2, and one a poplin of 200 g/m^2. It has been found that different fabric structures and densities appear to require different levels of durable press treatments in order to achieve a good balance between certain mechanical properties and the wrinkling performance of the fabrics. The higher porosity and uneven directional properties of a poplin weave are considered as an important factor and this fabric should not be treated by the same level of resin as a plain weave fabric of the same density and made from similar yarns. Less resin should be applied to a lighter weight fabric than to a heavier one.

The major physical properties of the fabrics were not significantly affected after the fabrics had been subjected to a severe washing test.

The tendency for wool/cotton fabrics to pill can be overcome by durable press treatments apparently by slowing down migration of the fibres to the surface of the fabric.

An increase in the wool component improves the mechanical performance of DP treated blends and decreases the flexural rigidity.

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