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# A Comparison of Certain Physical Properties of Plain Weave Fabrics from Cotton Blended with Different Polyester Fibre Types

## Part II: Easy-Care Finished Fabrics

by

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# A COMPARISON OF CERTAIN PHYSICAL PROPERTIES OF PLAIN WEAVE FABRICS FROM COTTON BLENDED WITH DIFFERENT POLYESTER FIBRE TYPES
## PART II : EASY-CARE FINISHED FABRICS

*by I.W. KELLY*

## ABSTRACT

*Applying amounts of resin greater than 5 per cent (on mass of cotton) to cotton/polyester blend fabrics and dry curing the fabrics do not improve the easy-care properties of the fabrics to any extent. The easy-care properties of a cotton/polyester fabric treated with 5 per cent or more of resin are relatively insensitive to the type and amount of polyester used in the blend. The amount and type of polyester, however, play an important rôle in the abrasion and tensile properties of the fabric with these two properties improving as the polyester content increases.*

## KEY WORDS

Cotton/polyester blends — easy-care properties — durable press treatments — crease recovery — shrinkage — flex abrasion resistance — tear strength — bursting strength — whiteness — bending length — normal polyester — high bulk polyester — low pilling polyester.

## INTRODUCTION

Although a measure of 'easy-care' can be imparted to untreated cotton by blending it with polyester, it is only at high percentages of polyester in the blend (above 80 *per cent* polyester was indicated in Part I of this investigation) that the fabric could be described as 'easy-care' [1]. Consequently, cotton/polyester blend fabrics containing a higher percentage of cotton are normally treated with a resin thereby improving the easy-care properties of the cotton component of the blend. The resin treatment greatly improves the easy-care properties of the fabric but unfortunately adversely affects its durability. Hence the desired easy-care target has to be compromised so that an acceptable wear life can be attained.

The inherently poor crease recovery of cotton is usually improved by cross-linking the hydroxyl groups of cellulose through a finishing agent, often one of the reactant-types. At present it is believed that the crosslinking is confined almost entirely to the poorly ordered (amorphous) regions of the fibre which are capable of swelling, and that the well ordered (crystalline) regions are unaffected by the treatment. Cross-links between the hydroxyl groups reduce the plasticity of the cotton fibre and so improve its crease recovery while also reducing its extensibility. This reduction in the extensibility (or increase in brittleness) diminishes the wear life of the fabric. Textile finishing is, therefore, a compromise between imparting good easy-care properties and good durability.

There are many types of resins and curing processes available, the choice of type of resin and curing technique depending on economics and fabric end use[2]. The most important finishing procedures applied in practice are dry cure, moist cure, wet cure and multiple stage cure. For economic reasons the most important method is still the dry cure process which, although it imparts the best dry crease recovery, causes the highest strength loss.

As mentioned previously the type of resin used is determined partly by the end use. For example, dimethylol propylene urea and its derivatives, or dimethylol ethylene urea give brittle condensation products on cotton/polyester blends which impair the handle of the fabric. Dimethylol-4,5-dihydroxyethylene urea (DMDHEU) in particular and, in some cases, dimethylol carbamates are preferred finishes for cotton/polyester blends.

In a recent review of finishing procedures Wyles[3] pointed out that there is some uncertainty about the correct resin add-on to ensure a reasonable level of easy-care on cotton/polyester blends. Textile auxiliary manufacturers recommend the same add-on as for pure cotton while research suggests that a lower resin add-on, than is often recommended[3], would be adequate in a cotton/polyester blend. Cotton/polyester fabrics of different blend levels have been found to have similar resin contents after dry curing with DMDHEU and separation of the fibres in the blend showed that 90 *per cent* of the resin was associated with the cotton component[4].

Work carried out on resin treated cotton/polyester blends showed that, in durable press treated fabrics, higher strength and improved abrasion resistance were associated with higher polyester content, with no appreciable difference in durable press appearance[5]. The higher modulus polyester staple offered significant improvement over regular polyester staple in fabric tensile and tearing strength but no appreciable difference in the other properties was apparent. In another report[6] on chemically finished blend fabrics the easy-care properties and serviceability of a series of shirts of various blend levels 50/50, 65/35, 80/20 (polyester/cotton) were measured after 80 launderings. While the serviceability of all the blends was adequate, the appearance was not satisfactory for any blend level; indeed, the 80 *per cent* Polyester/20 *per cent* Cotton blend was judged poorest with little difference noted between the other two blend levels[6].

The object of the present investigation was to compare the properties of blends of cotton and three different polyester types available locally in resin treated cotton/polyester blends and to identify resin add-ons required for different blend levels. The physical properties of the untreated fabrics were reported on in a previous publication[1].

## MATERIALS AND EXPERIMENTAL METHODS

Full details of the fabric construction have been given in a previous publication[1]. Briefly, a series of plain weave fabrics (approximately 140 g/m$^2$) was produced in all cotton as well as in blends of cotton with three types of staple polyester, namely Trevira type 120 (normal), Trevira type 340 (low-pilling), and Trevira type 140 (high bulk) at the following blend levels: 80, 60, 40 *per cent* cotton content.

Two resin treatments were used, either Fixapret CPN a dimethylol dihydroxyethylene-urea resin (B.A.S.F.) by itself or in a 1 : 1 ratio with Aerotex M3 (Cyanamid) and alkylated trimethylol-melamine resin. A catalyst, zinc nitrate hexahydrate (10 *per cent* on mass of resin) and 0,2 *per cent* of a non-ionic wetting agent Tergitol Speedwet (Union Carbide) were also used.

Resin was applied by the conventional padding process from an aqueous solution with a 100 *per cent* solution pick-up. The fabrics were air dried and then cured at 160°C for 3 minutes.

In the main experiment three levels of application were employed, 5 *per cent*, 7,5 *per cent* and 10 *per cent* (on total mass of cotton). In the light of the results obtained at these add-on levels, additional experiments were carried out at two lower levels of application viz. 5 *per cent* and 2½ *per cent* (on mass of cotton), respectively.

### Test Methods

The crease recovery of the fabrics was measured under standard conditions (i.e. 65 *per cent* R.H. and 20°C) on a Monsanto Wrinkle Recovery Tester[1]. The appearance of the fabrics after home laundering was assessed using the Durable Press Replicas following a method similar to the AATCC test method (IIIB)[1]. The area shrinkage of the fabrics after home laundering was also measured.

The fabric whiteness was determined on an Elrepho Photo-electric Reflection Photometer using tristimulus filters, X, Y and Z from the following equation[7] --

$$W = Y/3 + Z - X$$

# TABLE I

## PHYSICAL PROPERTIES OF TREATED AND UNTREATED FABRICS

| FABRIC COMPOSITION | RESIN TYPE F= Fixapret, A=Aerotex U=Untreated | ADD-ON RESIN AMOUNT (%) (on mass of cotton) | MONSANTO CREASE RECOVERY ANGLE (W+F) (20° C, 65% R.H.) | DURABLE PRESS RATING | AREA SHRINKAGE (%) | STOLL FLEX ABRASION (cycles to rupture) | ELMENDORF TEAR STRENGTH (hectograms) | BURSTING STRENGTH ($kgf/cm^2$) | WHITENESS | BENDING LENGTH (cm) |
|---|---|---|---|---|---|---|---|---|---|---|
| 100% Cotton | U | 0 | 214 | 1 | 11,7 | 287 | 27,4 | 14,7 | 21,8 | 2,02 |
| | F | 4,1 | 296 | 4,5 | 0,5 | 75 | 7,0 | 6,6 | 21,1 | 1,90 |
| | F | 6,4 | 306 | 4,8 | 0 | 37 | 5,7 | 6,1 | 18,9 | 1,92 |
| | F | 8,3 | 309 | 4,7 | 0,3 | 29 | 4,8 | 5,7 | 18,8 | 1,88 |
| | F + A | 4,1 | 277 | 3,9 | 0,7 | 350 | 11,3 | 9,8 | 21,8 | 1,89 |
| | F + A | 6,2 | 278 | 4,2 | 0,5 | 158 | 8,1 | 8,3 | 21,0 | 1,89 |
| | F + A | 8,8 | 307 | 4,3 | 0,6 | 142 | 7,3 | 7,6 | 21,9 | 1,88 |
| 80% Cotton / 20% Trevira 120 | U | 0 | 242 | 2,0 | 7,8 | 426 | 26,9 | 13,1 | 23,8 | 2,01 |
| | F | 3,8 | 297 | 4,7 | 1,0 | 222 | 7,1 | 5,9 | 22,7 | 1,86 |
| | F | 5,6 | 303 | 4,5 | 0,9 | 155 | 6,7 | 4,9 | 21,8 | 1,90 |
| | F | 7,9 | 308 | 4,2 | 0,7 | 155 | 6,4 | 5,2 | 22,5 | 1,89 |
| | F + A | 3,8 | 272 | 4,0 | 1,5 | 432 | 10,7 | 8,9 | 24,7 | 1,86 |
| | F + A | 6,2 | 286 | 4,0 | 1,3 | 336 | 9,0 | 7,5 | 23,9 | 1,86 |
| | F + A | 8,3 | 289 | 4,5 | 0,7 | 307 | 8,0 | 7,2 | 24,4 | 1,88 |
| 60% Cotton / 40% Trevira 120 | U | 0 | 252 | 2,7 | 6,1 | 780 | 27,8 | 13,3 | 25,4 | 2,04 |
| | F | 4,6 | 299 | 4,3 | 0,7 | 514 | 12,6 | 10,5 | 24,9 | 1,85 |
| | F | 7,9 | 302 | 4,7 | 0,9 | 407 | 12,6 | 10,4 | 22,3 | 1,89 |
| | F | 10,0 | 307 | 4,7 | 1,1 | 408 | 11,5 | 10,3 | 21,7 | 1,89 |
| | F + A | 5,1 | 288 | 4,2 | 1,7 | 708 | 13,8 | 9,6 | 25,0 | 1,86 |
| | F + A | 8,0 | 296 | 4,0 | 1,1 | 737 | 13,0 | 9,7 | 24,3 | 1,92 |
| | F + A | 8,4 | 299 | 4,3 | 0,6 | 458 | 12,7 | 9,7 | 24,0 | 2,04 |
| [illegible] | U | 0 | 272 | 3,3 | 4,3 | 1532 | 34,0 | 16,3 | 25,4 | 2,13 |
| | F | 4,5 | 306 | 4,3 | 1,4 | 1085 | 20,6 | 14,6 | 24,8 | 1,88 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | F + A | 4,5 | 287 | 4,0 | 1,2 | 1553 | 22,2 | 14,8 | 25,8 | 1,94 |
| | F + A | 6,3 | 296 | 4,3 | 1,4 | 1180 | 21,2 | 14,5 | 25,4 | 1,99 |
| | F + A | 9,1 | 305 | 4,2 | 0,9 | 1053 | 20,1 | 14,7 | 25,3 | 2,10 |
| **80% Cotton / 20% Trevira 340** | U | 0 | 244 | 2,3 | 7,1 | 345 | 26,9 | 11,3 | 25,8 | 2,00 |
| | F | 4,8 | 302 | 4,3 | 0,4 | 124 | 6,4 | 5,1 | 24,5 | 1,85 |
| | F | 7,1 | 309 | 4,2 | 0,5 | 95 | 5,7 | 4,7 | 23,0 | 1,88 |
| | F | 10,0 | 308 | 4,7 | 0,9 | 56 | 5,4 | 4,7 | 20,5 | 1,90 |
| | F + A | 4,7 | 289 | 4,0 | 1,2 | 270 | 9,6 | 7,5 | 25,7 | 1,88 |
| | F + A | 7,1 | 299 | 4,3 | 1,1 | 212 | 7,9 | 6,6 | 24,2 | 1,87 |
| | F + A | 9,4 | 304 | 4,9 | 0,6 | 235 | 7,3 | 6,1 | 24,4 | 1,86 |
| **60% Cotton / 40% Trevira 340** | U | 0 | 259 | 3,0 | 5,7 | 452 | 22,7 | 11,3 | 25,9 | 1,98 |
| | F | 5,4 | 308 | 4,2 | 0,6 | 152 | 8,6 | 5,3 | 26,3 | 1,80 |
| | F | 8,0 | 307 | 4,0 | 1,1 | 133 | 8,1 | 5,6 | 25,3 | 1,85 |
| | F | 10,7 | 313 | 4,3 | 0,9 | 124 | 7,9 | 5,1 | 24,5 | 1,86 |
| | F + A | 5,5 | 310 | 4,7 | 1,2 | 320 | 9,9 | 6,9 | 26,6 | 1,85 |
| | F + A | 8,3 | 299 | 3,9 | 1,2 | 361 | 9,6 | 6,2 | 26,2 | 1,86 |
| | F + A | 10,7 | 303 | 3,8 | 1,4 | 256 | 8,7 | 6,0 | 26,0 | 1,92 |
| **40% Cotton / 60% Trevira 340** | U | 0 | 295 | 3,8 | 3,3 | 1425 | 32,0 | 11,6 | 25,3 | 1,93 |
| | F | 5,2 | 313 | 4,0 | 1,0 | 949 | 15,3 | 10,0 | 25,1 | 1,78 |
| | F | 6,8 | 313 | 3,9 | 0,9 | 591 | 14,2 | 9,7 | 25,6 | 1,82 |
| | F | 10,0 | 316 | 3,9 | 0,7 | 615 | 14,4 | 10,2 | 22,7 | 1,84 |
| | F + A | 5,0 | 310 | 4,2 | 0,9 | 1097 | 16,8 | 9,8 | 25,7 | 1,79 |
| | F + A | 7,5 | 309 | 4,0 | 0,8 | 958 | 16,0 | 10,0 | 25,6 | 1,90 |
| | F + A | 10,3 | 307 | 3,6 | 1,7 | 983 | 14,5 | 9,9 | 25,1 | 1,94 |
| **80% Cotton / 20% Trevira 140** | U | 0 | 253 | 2,2 | 7,1 | 679 | 31,6 | 11,7 | 24,3 | 1,92 |
| | F | 4,9 | 300 | 4,2 | 0,6 | 211 | 7,3 | 5,3 | 22,9 | 1,82 |
| | F | 7,5 | 308 | 4,2 | 1,0 | 148 | 6,6 | 4,9 | 21,9 | 1,80 |
| | F | 10,1 | 306 | 4,2 | 0,5 | 122 | 6,4 | 4,5 | 20,9 | 1,84 |
| | F + A | 4,7 | 291 | 3,9 | 1,3 | 436 | 10,6 | 7,4 | 24,3 | 1,82 |
| | F + A | 7,5 | 290 | 4,0 | 0,7 | 347 | 8,3 | 6,3 | 26,2 | 1,85 |
| | F + A | 10,1 | 303 | 4,0 | 1,1 | 355 | 7,8 | 6,1 | 22,9 | 1,87 |
| **60% Cotton / 40% Trevira 140** | U | 0 | 276 | 3,2 | 5,6 | 1514 | 34,9 | 11,5 | 25,3 | 1,92 |
| | F | 4,9 | 300 | 4,0 | 0,7 | 994 | 13,9 | 9,9 | 24,6 | 1,80 |
| | F | 8,1 | 305 | 4,7 | 1,2 | 698 | 13,3 | 9,9 | 22,6 | 1,79 |
| | F | 10,3 | 314 | 4,5 | 1,0 | 499 | 12,5 | 9,8 | 23,6 | 1,82 |
| | F + A | 5,0 | 292 | 4,2 | 1,2 | 889 | 14,7 | 9,2 | 26,2 | 1,79 |
| | F + A | 7,9 | 303 | 4,2 | 1,2 | 756 | 12,4 | 9,5 | 25,0 | 1,89 |
| | F + A | 10,6 | 306 | 4,3 | 0,7 | 862 | 12,7 | 9,3 | 25,3 | 1,93 |
| **40% Cotton / 60% Trevira 140** | U | 0 | 277 | 3,5 | 4,2 | 1610 | 27,8 | 14,3 | 26,1 | 2,00 |
| | F | 5,3 | 305 | 4,2 | 1,1 | 1143 | 20,3 | 13,9 | 26,4 | 1,80 |
| | F | 8,1 | 304 | 4,2 | 0,6 | 928 | 19,1 | 14,0 | 23,9 | 1,87 |
| | F | 10,1 | 309 | 4,5 | 0,5 | 906 | 17,4 | 13,8 | 25,5 | 1,93 |
| | F + A | 4,3 | 302 | 4,1 | 1,4 | 903 | 19,6 | 14,1 | 25,8 | 1,90 |
| | F + A | 7,9 | 300 | 4,5 | 1,5 | 1035 | 18,1 | 13,9 | 26,1 | 1,95 |
| | F + A | 10,7 | 302 | 4,2 | 1,4 | 992 | 18,1 | 13,7 | 26,1 | 2,31 |

The flexural rigidity of the treated fabrics was determined by the Cantilever method.

In addition to the above tests the tensile properties of the fabrics were measured. Tear strength was measured on an Elmendorf Tear Strength Tester while bursting strength was measured on a Standard Mullen Tester.

Resistance to flex abrasion, a common test used to assess embrittlement of resin treated cellulosic fabrics, was measured on a Stoll Abrasion Tester.

## RESULTS AND DISCUSSION

The results of the physical tests on the treated fabrics for the main experiment are presented in Table I.

A multiple regression analysis was performed on the results of each of the treated fabrics with resin type, percentage resin (on mass of cotton), percentage cotton and polyester type as the independent variables (Table II). Monsanto crease recovery angle, appearance after washing, area shrinkage during washing, bending length, flex abrasion, tear strength, bursting strength and whiteness were the dependent variables. The "dummy variable technique"[8] was used to accommodate the polyester and resin types. The magnitude of the main effects is shown in Table III in which the mean values of the most important fabric properties have been summarised.

### Monsanto Crease Recovery Angle

The statistical analysis shows that all four independent variables significantly affected the crease recovery angles. By considering the average values of the main effects one can appreciate their magnitude. For example, when Fixapret CPN was used on its own the crease recovery angles were, on average, nine degrees higher than those when Fixapret was used in a 1 : 1 ratio with Aerotex M3. Increasing the resin add-on from 5 to 10 *per cent* (on mass of cotton) improved the mean crease recovery angle by roughly seven degrees (see Table III). The similarity in the crease recovery angles for the three resin add-ons, at first may seem surprising. However, by adding 5 *per cent* Fixapret CPN (on mass of cotton) to the fabric, the crease recovery angles approached the maximum attainable crease recovery angle, i.e. all Monsanto crease recovery angles were greater than 296 degrees.

As was the case with the untreated fabrics[1] the low pilling polyester had a higher crease recovery angle than the other two polyester types, the mean difference between the normal and the low pilling polyester blends being ten degrees (see Table III).

## TABLE II

## t-VALUES OF THE REGRESSION ANALYSIS CARRIED OUT ON THE FABRIC PROPERTIES

| DEPENDENT VARIABLE | t-VALUES OF THE REGRESSION COEFFICIENTS | | | | |
|---|---|---|---|---|---|
| | Percentage Polyester | Resin type | Resin add-on | Polyester type | Polyester type |
| Monsanto Crease Recovery Angle | 4,2** | -6,9** | 4,7** | 2,6* | 5,5** |
| Durable Press Rating | -1,9 | -2,4* | 1,7 | — | -2,1* |
| Area Shrinkage | 2,4* | 4,1** | -1,7 | — | -1,1 |
| Flex Abrasion | 13,2** | 4,0** | -2,4* | — | -4,4** |
| Tear Strength | 24,7** | 3,4** | -4,3** | — | -8,2** |
| Bursting Strength | 17,0** | 2,1* | -1,7 | — | -8,2** |
| Whiteness | 6,2** | 6,5** | -3,7** | — | 3,6** |
| Bending Length | 3,0** | 2,9** | 4,4** | -2,8** | -3,7** |

* indicates significance at the 95 *per cent* confidence level

** indicates significance at the 99 *per cent* confidence level

### Appearance After Home Laundering

All four of the independent variables had a significant effect on the fabric appearance. From Table III it is apparent that increasing the percentage resin add-on (on mass of cotton) from 5 *per cent* to 10 *per cent* increased the Durable Press rating by 0,14 of a grade, the 7,5 *per cent* add-on fabrics lying intermediate. The difference between the resin types was of the order of 0,16 of a grade with Fixapret CPN on its own being the better of the two.

Although the amount and type of polyester significantly affected the appearance after laundering, the results run contrary to the crease recovery results, which is at first surprising. Similar conclusions have also been reported recently for all cotton and polyester/cotton, chemically finished fabrics[6]. It was reported that for all-cotton chemically finished fabrics the durable press rating, after tumble drying, depended on both the wet and dry crease recovery angles, after a minimum dry crease recovery angle had been exceeded. No similar relationship between the crease recovery angles and appearance after laundering for a cotton/polyester blend, however, was observed. The overall mean values of the durable press ratings for the low pilling polyester were 0,17 of a grade lower than for the normal polyester and the mean values of the 60 *per cent* polyester were 0,14 of a grade lower than those of the 20 *per cent* polyester. Nevertheless, differences of less than 0,2 of a grade can be considered to be of little practical importance and the results do not contradict the findings of Waters *et al*[5] who found that in durable press treated cotton polyester blends there were no appreciable differences in durable press appearance between low and high polyester content fabrics.

### Shrinkage During Home Laundering

Neither polyester type nor resin amount had a significant effect on the area shrinkage while the resin type significantly altered the area shrinkage with that of the fabrics treated with Fixapret CPN resin alone being lowest. The difference between the shrinkages of the two treatments was 0,4 *per cent* at 5 *per cent* resin add-on and 0,2 *per cent* at 10 *per cent* resin add-on. (See Table III). The polyester content had a small but significant effect on the area shrinkage, the mean of which increased by 0,2 *per cent* as the polyester content increased from 20 to 60 *per cent.*

### Stoll Flex Abrasion

All four independent variables had a significant effect on the resistance to flex abrasion. As the polyester content increased from 20 *per cent* to 60 *per cent* the mean value of the cycles to rupture increased from 238 to 954 cycles with the abrasion resistance of the 40 *per cent* polyester content fabrics lying between the two. It is also apparent that the resistance to abrasion of the blends containing the low pilling polyester was markedly lower than that of the blends containing the other two polyester types. The mean of the number of cycles to rupture of the low pilling blends was roughly 70 *per cent* that of the normal and high bulk blends.

The resistance to flex abrasion of the Fixapret CPN treated blends was significantly lower than that of the Fixapret + Aerotex treated fabrics the difference being 130 cycles at low add-ons and 200 cycles at higher add-ons.

**Elmendorf Tear Strength**

Once again the low pilling polyester blends performed very much worse than the other two polyester types with the mean of the tear strengths for the low pilling blends being 70 *per cent* of that of the other two. The percentage polyester in the blend had a marked effect on the tear strength, with the tear strength of the blend containing 20 *per cent* polyester being less than half of that of the 60 *per cent* polyester blend.

Resin type, however, played a minor rôle in the tear strength results, the overall mean tear strength of fabrics treated with the Fixapret – Aerotex combination was 0,4 hectograms higher than that of the fabrics treated with Fixapret alone. The percentage resin on the fabrics had a larger effect than resin type on the tear strength with the mean of the 10 *per cent* add-on being 1,5 hectograms lower than the mean of the fabrics treated with 5 *per cent* of resin (see Table III).

**Bursting Strength**

As the percentage polyester in the fabrics increased so the bursting strength of the fabrics increased markedly, with that of the 60 *per cent* polyester blend fabrics being twice that of the 20 *per cent* polyester fabrics. Polyester type also played a significant rôle in the fabric bursting strength, with that of the low pilling polyester being lowest.

Fabrics treated with Fixapret CPN only, had a 10 *per cent* lower mean bursting strength than those treated with Fixapret CPN plus Aerotex M3. The decrease in the mean bursting strength with increasing resin add-on was small with the difference between the 5 *per cent* and 10 *per cent* add-ons only being 0,3 kgf/cm$^2$ .

## TABLE III

## AVERAGE VALUES FOR THE VARIOUS PHYSICAL PROPERTIES OF THE FABRICS SHOWING THE MAGNITUDES OF THE MAIN EFFECTS

| EFFECT | MONSANTO CREASE RECOVERY ANGLE (DEGREES) | DURABLE PRESS RATING | AREA SHRINKAGE (%) | STOLL FLEX ABRASION (CYCLES) | TEAR STRENGTH (HECTO GRAMS) | BURSTING STRENGTH ($kgf/cm^2$) | BENDING LENGTH (cm) | WHITENESS |
|---|---|---|---|---|---|---|---|---|
| Normal Polyester | 297 | 4,27 | 1,07 | 656 | 13,9 | 10,4 | 1,92 | 24,0 |
| Low Pilling Polyester | 307 | 4,11 | 0,93 | 422 | 10,4 | 6,9 | 1,86 | 24,8 |
| High Bulk Polyester | 302 | 4,21 | 0,99 | 679 | 13,3 | 9,7 | 1,88 | 24,5 |
| 20% Polyester | 298 | 4,26 | 0,88 | 238 | 7,6 | 6,0 | 1,86 | 23,4 |
| 40% Polyester | 303 | 4,27 | 1,03 | 515 | 11,6 | 8,5 | 1,87 | 24,7 |
| 60% Polyester | 305 | 4,12 | 1,08 | 954 | 18,3 | 12,8 | 1,93 | 25,1 |
| Fixapret CPN | 306 | 4,28 | 0,85 | 501 | 11,9 | 8,8 | 1,86 | 23,6 |
| Fixapret + Aerotex | 298 | 4,12 | 1,14 | 670 | 12,3 | 9,4 | 1,91 | 25,2 |
| 5% Resin | 298 | 4,13 | 1,06 | 667 | 13,3 | 9,4 | 1,84 | 25,1 |
| 7½% Resin | 302 | 4,21 | 1,02 | 580 | 12,4 | 9,0 | 1,88 | 24,3 |
| 10% Resin | 306 | 4,26 | 0,91 | 510 | 11,8 | 8,9 | 1,94 | 23,8 |

**Whiteness**

The Fixapret CPN plus Aerotex M3 treatment yielded significantly whiter fabrics than the fabrics treated with Fixapret only. The difference between the means of the two treatments was 1,5 units. The fabrics containing 80 *per cent* cotton were significantly yellower than those containing 40 *per cent* cotton. This is to be expected because at a constant resin add-on the degree of yellowing will depend on the amount of cotton in the fabric.

**Bending Length**

Once again all the dependent variables made a significant contribution to the regression equation involving the bending length. The mean bending length (i.e. stiffness) increased by 0,07 cm when the polyester content increased from 20 to 60 *per cent* and a similar increase in bending length was observed when the resin add-on increased from 5 to 10 *per cent*. The Aerotex M3 plus Fixapret CPN treatment gave the greater mean bending length.

**Subsidiary Experiment**

In the main experiment it was observed that there was little improvement in the Durable Press ratings and the crease recovery angles when the resin add-on was increased above 5 *per cent*. It seemed worthwhile, therefore, to investigate if acceptable Durable Press ratings could be obtained in the blended fabrics with lower add-ons, which would not only effect a cost saving but could also lead to higher tear strength, flex abrasion and bursting strength.

A summary of the statistical analysis is given in Table IV. The design was a 2 x 2 x 2 Analysis of Variance with the three factors, polyester amount, resin type and resin amount occurring at two levels. No interaction terms were found to be significant.

Decreasing the amount of resin on the fabrics from 5 *per cent* to 2,5 *per cent* significantly lowered both the crease recovery angle and the durable press rating and increased the area shrinkage (at the 95 *per cent* confidence level). The mean crease recovery angle fell by 34 degrees while the mean durable press rating fell by 0,8 of a grade (i.e. from 4,1 to 3,3) and the area shrinkage increased by 1 *per cent* to 2,2 *per cent*. The type of resin did not significantly affect the durable press rating. As expected, the decrease in the amount of resin applied from 5 *per cent* to 2,5 *per cent* significantly increased the resistance to flex abrasion, tear strength and bursting strength

## TABLE IV

**SUMMARY OF THE SIGNIFICANCE OF THE MAIN EFFECTS FROM AN ANALYSIS OF VARIANCE ON THE RESULTS OF THE SUBSIDIARY EXPERIMENT (F-values)**

| SOURCE OF VARIANCE | MONSANTO CREASE RECOVERY ANGLE F | DURABLE PRESS RATING F | AREA SHRINKAGE F | STOLL FLEX ABRASION F | TEAR STRENGTH F | BURSTING STRENGTH F |
|---|---|---|---|---|---|---|
| Polyester amount | 21,1** | 2,5 | 0,09 | 31,7** | 5,2* | 12,8** |
| Resin Type | 6,7* | 0,93 | 6,5* | 1,5 | 0,008 | 3,8 |
| Resin Amount | 39,1** | 30,7** | 29,1** | 16,6** | 10,7** | 10,5** |

* indicates significance at the 95 *per cent* confidence level

** indicates significance at the 99 *per cent* conficende level at the 95 *per cent* level of confidence. The mean flex abrasion increased by 50 *per cent,* tear strength by 25 *per cent* and bursting strength by 15 *per cent*.

**Cost of Resin**

Table V gives the approximate costs (South African cents per $m^2$ of fabric) of locally available DMDHEU and alkylated trimethylol-melamine resins.

## CONCLUSIONS

The results indicate that acceptable easy-care properties can be imparted to the full range of cotton/polyester blends from cotton-rich to polyester-rich by applying 5 *per cent* resin (on mass of cotton) of Fixapret CPN either by itself or in a 1 to 1 ratio with Aerotex M3. The amount of polyester and type of polyester used in the blend and type and amount of resin, although having a statistically significant effect on the easy-care properties of blended cotton fabrics, are individually of little practical importance, although cumulatively they may have a noticeable effect.

The amount and type of polyester, although playing a minor rôle in influencing the easy-care properties of the fabrics, play a major rôle in determining the wear properties of the fabric. The results suggest that about 40 *per cent* polyester is necessary to give the fabrics adequate wear life, with the normal and high bulk polyester types performing considerably better than the low pilling polyester in this respect.

Fabrics treated with a combination of Fixapret CPN and Aerotex M3 showed better flex abrasion resistance, tear strength and bursting strength and, less yellowing and lower crease recovery angles than fabrics treated with Fixapret CPN alone.

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## THE USE OF PROPRIETARY NAMES

The fact that products with proprietary names have been used in this investigation in no way implies that there are not others as good or even better.

## TABLE V

## APPROXIMATE COST OF LOCALLY AVAILABLE RESINS

| RESIN | COST (Cents/m$^2$)* | | | | |
|---|---|---|---|---|---|
| | TOTAL ADD-ON (% ON MASS OF COTTON) | 100% COTTON | 80% Cotton/ 20% Polyester | 60% Cotton/ 40% Polyester | 40% Cotton/ 60% Polyester |
| DMDHEU | 2,5 | 0,51 | 0,41 | 0,31 | 0,20 |
| DMDHEU + ATMM | 2,5 | 0,57 | 0,46 | 0,34 | 0,23 |
| DMDHEU | 5 | 1,02 | 0,82 | 0,61 | 0,41 |
| DMDHEU + ATMM | 5 | 1,14 | 0,91 | 0,68 | 0,46 |
| DMDHEU | 7,5 | 1,53 | 1,23 | 0,92 | 0,61 |
| DMDHEU + ATMM | 7,5 | 1,71 | 1,37 | 1,02 | 0,69 |
| DMDHEU | 10 | 2,04 | 1,64 | 1,23 | 0,82 |
| DMDHEU + ATMM | 10 | 2,28 | 1,82 | 1,37 | 0,91 |

DMDHEU : dimethylol dihydroxyethylene-urea
ATMM : alkylated trimethylol-melamine

** South African cents per square metre of fabric
(Mass of fabric assumed to be 140 g/m$^2$)

A further 20 per cent (approximately) of the above costs must be added for the other chemicals used (e.g. catalyst and wetting agent). Should it be necessary to apply a softener the cost would obviously be increased further.

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