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A Comparison of the Wrinkling Properties of Aged and Deaged Wool/Synthetic Blend Fabrics Using Different Wrinkling Tests

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ABSTRACT

The wrinkle recovery properties of plain and 2/2 twill lightweight all-wool, different blends of wool/polyester and wool/acrylic, and all-polyester and all-acrylic fabrics have been compared, both in the aged and deaged states. The different test methods used (AKU, FRL, Monsanto and IWS) generally gave similar trends on the deaged fabrics, but this was not always the case for the aged fabrics. Deageing decreased the wrinkle recovery values of all *the fabrics. The wool/polyester fabrics generally had better wrinkle recovery than the wool/acrylic fabrics, while the twill fabrics had superior wrinkle recovery properties to the plain fabrics.*

INTRODUCTION

In a series of studies at SAWTRI[1-3] the effect of blend level (polyester or acrylic of different types) on wrinkle recovery was investigated. The fabrics were generally deaged prior to wrinkling and it was considered of some interest to establish whether similar trends existed when the fabrics are tested in an *aged state* since, when worn, fabrics (garments) can sometimes be in a state approaching that of an aged fabric. Furthermore, in a recent review article[4], the wrinkle recovery properties of polyester and *aged* wool were given as virtually identical.

It was decided to compare the wrinkle recovery properties of the fabrics studied earlier[1-3], using different test methods and testing the fabrics in both their aged and deaged states. For the purposes of this study, all fabrics which had been on the shelf for $1^1/_2$ years or longer, generally in a conditioned atmosphere, were classified as aged since it is doubtful whether, in practice, fabrics will ever be more "aged" than this unless, of course, accelerated ageing (annealing) is carried out and a way is found of making this state permanent.

The literature on wrinkling will not be reviewed since two comprehensive review articles have recently appeared[4,5].

EXPERIMENTAL

Plain and 2/2 twill lightweight fabrics (approximately 200 g/m^2), prepared for earlier studies[1-3], were used in this investigation. Only the fabrics

produced from intimate blends of 64's merino wool with a normal polyester (®Trevira type 220) and regular acrylic (relaxed 4,9 dtex acrylic), respectively, were used. For each synthetic fibre type there were six blend levels ranging from all-wool to all-synthetic. The synthetic content of the fabrics was increased in steps of 20% (absolute).

Details of the fabrics and processing conditions were given in earlier publications[1, 3]. After finishing by the usual routine the fabrics were *decatised.* These fabrics were taken as "aged" since the *plain* wool/polyester fabrics, the *twill* wool/polyester fabrics and the wool/acrylic fabrics had been stored at 65% RH/20° C for more than (approximately) 3 years, $1^1/_2$ years and 2 years, respectively.

The wrinkling properties (or wrinkle performance) of each range of fabrics were determined in the aged and deaged states. The fabrics were deaged according to a similar process to that used elsewhere[6-8]. Briefly, the method was as follows: The fabrics were soaked for 30 minutes in water at 20° C, containing 0,5 g/ℓ ®Lissapol N (nonionic), spin-dried in a domestic spin drier for 30 seconds and then steam pressed using the following cycle: 10 seconds steam with head locked; 10 seconds bake with head locked and no steam, and finally 10 seconds vacuum with head open.

The following wrinkle test methods were used:

(a) Tentative IWS thermobench method[9, 10],
(b) FRL wrinkle test[11], modified by Slinger[12],
(c) AKU wrinkle test[13] and
(d) Monsanto crease recovery test[14].

The procedure for the IWS thermobench test was briefly as follows: After deageing, the samples were preconditioned at 65% RH/20° C for 24 ± 4 hours, and then they were pressed (creased) at constant regain for 30 minutes at 35° C, using four samples under a load of 2 kgf, i.e. 167 g/cm of crease. The residual crease angle (expressed as percentage wrinkle recovery) was measured after a recovery period of 30 minutes at 65% RH/20° C. Four warp and four weft specimens per fabric were tested.

The "wrinkle height" was measured after both FRL[11, 12] and AKU[13] wrinkling using a method devised by Slinger[12]. The deageing procedure was similar to that used for the IWS thermobench test except that, after deageing, the samples were first dried for 2 hours at 65% RH/20° C and then pre-conditioned for 2 hours at 20% RH/40° C. After this they were conditioned overnight at 75% RH/27° C and then creased (both FRL and AKU) in this atmosphere. The wrinkle height was obtained after 1 hour recovery at 65% RH/20° C. The wrinkle recovery (WR) rating in the case of the AKU test was obtained after 24 hours recovery at 65% RH/20° C using the standard replicas.

The Monsanto crease recovery angle was obtained on samples which had been deaged and pre-dried in the same manner as for the FRL and AKU tests. The fabric samples were then conditioned overnight at either 65% RH/20° C or 75% RH/27° C, according to the particular test, after which they were creased in the atmosphere in which they were conditioned. Recovery was allowed to take place at 65% RH/20° C in both cases.

RESULTS AND DISCUSSION

The results are presented in Tables I and II as well as in the various figures (Figs 1 to 5). The various trends can be clearly seen from the figures and will not be discussed in any depth except for certain general trends.

All the test methods clearly distinguised between the aged and deaged fabrics. *Deaged* all-wool fabrics always showed very much poorer wrinkle recovery than the corresponding *aged* all-wool fabrics (Figs 1—5). As the polyester content of the wool/polyester blend fabrics increased so the difference between the aged and deaged fabrics decreased, i.e. as the polyester content increased so the aged and deaged states converged. Surprisingly enough even the all-polyester fabrics exhibited a small difference between the aged and deaged states. In the *aged state* the wrinkle recovery of the series of wool/polyester blend fabrics generally depended less on the polyester content, i.e. the effect of polyester content was not as marked as was the case for the deaged fabrics. In fact for the *IWS thermobench method* the *aged* all-wool *plain* fabrics performed better than the all-polyester *plain* fabrics although the all-wool *twill* fabrics were slightly worse than the all-polyester *twill* fabrics. The difference in the behaviour of the plain and twill fabrics could be due to an interaction with ageing time since the twill fabrics had been "aged" for a shorter period than the plain weave fabrics. The discrepancy between the thermobench results on the one hand and the FRL and AKU test results on the other, i.e. the fact that the *aged all-wool* fabrics had a *poorer wrinkle recovery* performance than the *aged polyester* fabrics, when tested by either the *FRL* or *AKU* method, could be at least partly due to the different atmospheric conditions employed. It may also be due to the fact that a certain amount of deaging of the aged fabrics occurred when these fabrics were transferred from the 65% RH/20° C atmosphere to the 75% RH/27° C atmosphere. Furthermore, the relatively high temperature used in the IWS test (35° C) would have a greater adverse effect on the polyester component than on the wool component whereas the high humidity (75% RH) used for the AKU and FRL tests would have a greater deleterious effect on the wool component.

The wool/acrylic fabrics showed an approximately constant difference between the aged and deaged states as the acrylic content increased, i.e. the curves for the aged and deaged states were approximately parallel to each other.

TABLE I

WRINKLE RECOVERY PROPERTIES OF THE WOOL/POLYESTER BLEND FABRICS

Blend % Wool/ % Polyester	Fabric State	FRL Wrinkle Severity (SD in mm)	AKU Wrinkle Severity (SD in mm)	AKU Wrinkling (WR rating)	IWS Wrinkling (% WR)	Monsanto CRA at 20°C/65% RH (in degrees)	Monsanto CRA at 27°C/75% RH (in degrees)
Plain							
100/0	Aged	0,73	0,17	2,2	73	336	315
	Deaged	1,46	0,36	1,3	40	316	280
80/20	Aged	0,54	0,17	2,2	72	335	315
	Deaged	0,96	0,31	1,8	48	312	283
60/40	Aged	0,43	0,14	2,5	74	336	317
	Deaged	0,82	0,24	2,0	52	323	290
40/60	Aged	0,34	—	—	71	331	310
	Deaged	0,62	—	—	56	319	290
20/80	Aged	0,35	0,11	3,2	70	324	311
	Deaged	0,51	0,17	2,3	59	309	296
0/100	Aged	0,31	0,12	3,3	66	311	290
	Deaged	0,39	0,16	2,3	60	295	292
2/2 Twill							
100/0	Aged	0,45	0,15	2,7	78	339	314
	Deaged	1,15	0,32	1,8	44	309	284
80/20	Aged	0,30	0,16	2,7	79	345	327
	Deaged	0,89	0,29	1,7	48	317	299
60/40	Aged	0,25	0,16	3,0	82	341	327
	Deaged	0,69	0,21	2,2	59	323	309
40/60	Aged	0,18	0,11	3,3	84	338	330
	Deaged	0,51	0,18	2,3	67	326	314
20/80	Aged	0,16	0,11	4,0	84	344	326
	Deaged	0,38	0,18	2,3	72	327	312
0/100	Aged	0,16	0,11	4,0	85	338	—
	Deaged	0,29	0,17	2,8	78	326	—

TABLE II

WRINKLE RECOVERY PROPERTIES OF THE WOOL/ACRYLIC BLENDS

Blend % Wool/ % Acrylic	Fabric State	FRL Wrinkle Severity (SD in mm)	AKU Wrinkle Severity (SD in mm)	AKU Wrinkling (WR rating)	IWS Wrinkling (% WR)	Monsanto CRA at 20°C/65% RH (in degrees)	Monsanto CRA at 27°C/75% RH (in degrees)
Plain							
100/0	Aged	0,76	0,19	2,0	70	337	304
	Deaged	1,57	0,35	1,6	39	307	281
80/20	Aged	0,70	0,22	1,8	64	336	302
	Deaged	1,40	0,35	1,6	34	302	272
60/40	Aged	0,52	0,17	2,5	59	329	297
	Deaged	1,31	0,34	1,8	32	292	264
40/60	Aged	0,63	0,19	2,3	49	307	266
	Deaged	1,08	0,40	1,8	27	273	239
20/80	Aged	0,59	0,16	2,7	46	300	260
	Deaged	1,15	0,41	2,0	24	251	213
0/100	Aged	0,51	0,16	2,8	42	275	239
	Deaged	1,18	0,43	1,7	19	219	199
2/2 Twill							
100/0	Aged	0,71	0,22	2,2	75	333	300
	Deaged	1,07	0,30	1,6	43	307	280
80/20	Aged	0,67	0,18	2,3	75	338	305
	Deaged	1,22	0,31	1,9	39	308	285
60/40	Aged	0,66	0,20	2,2	71	332	302
	Deaged	1,03	0,28	2,0	37	303	278
40/60	Aged	0,51	0,14	2,7	69	327	310
	Deaged	1,12	0,36	1,9	35	292	269
20/80	Aged	0,46	0,18	2,8	66	324	298
	Deaged	1,08	0,39	2,0	30	286	261
0/100	Aged	0,34	0,15	3,0	58	309	289
	Deaged	1,23	0,40	1,9	26	263	236

Once again it is interesting to note that deageing decreased the wrinkle recovery of the all-acrylic fabrics as well.

Generally, the twill fabrics performed better than the plain weave fabrics, except for the wool/acrylic set of fabrics tested by the FRL and AKU methods, where almost no difference between the two weaves was observed. The IWS thermobench and the Monsanto methods showed little, or no difference between the weaves for the *all-wool* fabrics. Both these methods indicate that, as the synthetic content (i.e. either polyester or acrylic), increased so the difference between weaves increased. In contrast, the FRL method showed, for the wool/polyester fabrics, an almost constant difference between weaves as polyester content increases. For the AKU test, the wrinkle recovery of the two weaves converged as the polyester content increased. The effect due to the weave in the latter (AKU) test was small.

Except for the Monsanto and IWS thermobench test results on the *aged plain* wool/polyester fabrics and the Monsanto test results on the *deaged* wool/polyester fabrics, the general trend was for an increase in polyester content to improve the wrinkle recovery performance, particularly for the *deaged* fabrics. For the wool/acrylic fabrics, the Monsanto and IWS thermobench methods showed a decrease in the wrinkle recovery performance with an increase in the acrylic content. The other test methods did not give such a clear picture although there was a tendency for the wrinkle recovery to improve slightly with an increase in acrylic content when the AKU and FRL tests were employed. This could not be ascribed to a difference in atmospheric conditions, since the Monsanto test results still showed a different trend even when the tests were carried out under the same conditions as the AKU and FRL tests.

General Discussion

For the wool/polyester fabrics, it was important whether the fabrics were tested in an *aged* or in a *deaged* state since, for the former the difference between all-wool and all-polyester was not as large as for the latter. According to the IWS thermobench test results, there was little difference between the all-wool and all-polyester fabrics in the *aged* state with even the possibility that the all-wool fabrics were slightly better than the all-polyester fabrics. The trends and conclusions drawn will therefore greatly depend on the state of the fabric. In practice, it can be expected that a fabric that is being worn will be in a state intermediate between the two extremes (i.e. intermediate between aged and deaged). Should such a fabric be in a state approaching a "totally" aged state, then the difference between all-wool and all-polyester fabrics will not be very great and perhaps, depending on the amount of ageing, an all-wool fabric may even perform slightly better than a similar wool/polyester fabric. In actual use, fabrics are continuously subjected, either intentionally or unintentionally, to various "treatments" (e.g. dry-cleaning and pressing) and changes in

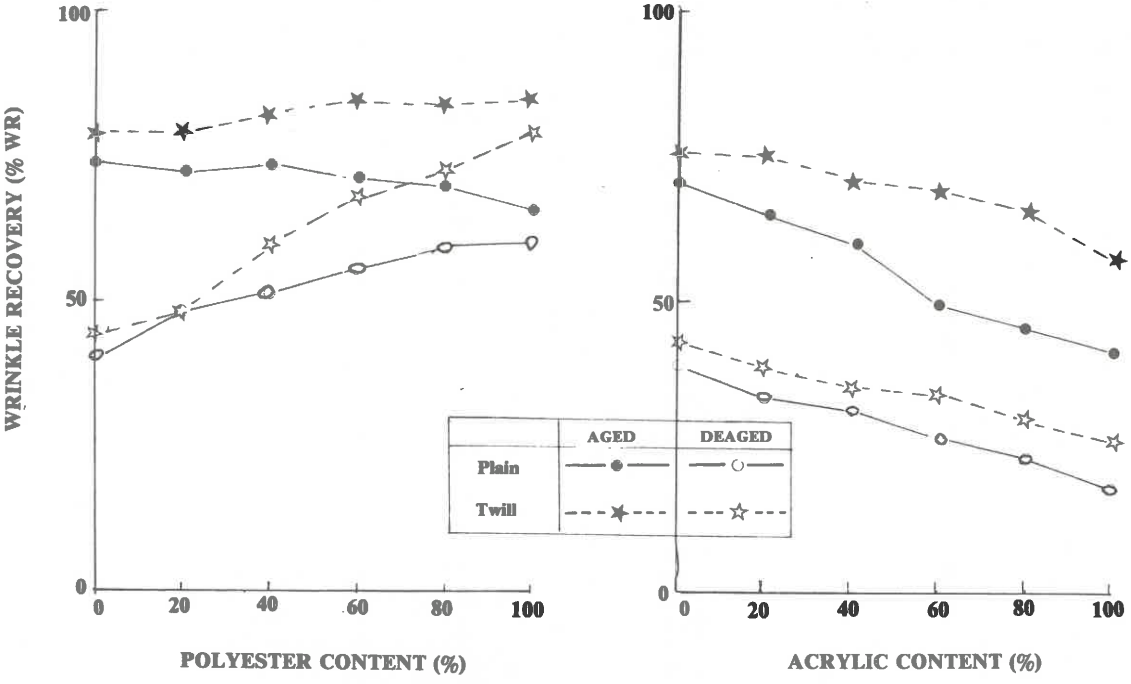

Fig. 1 The effect of synthetic fibre content on the IWS Thermobench wrinkle recovery test results for the two different fabric structures and "states"

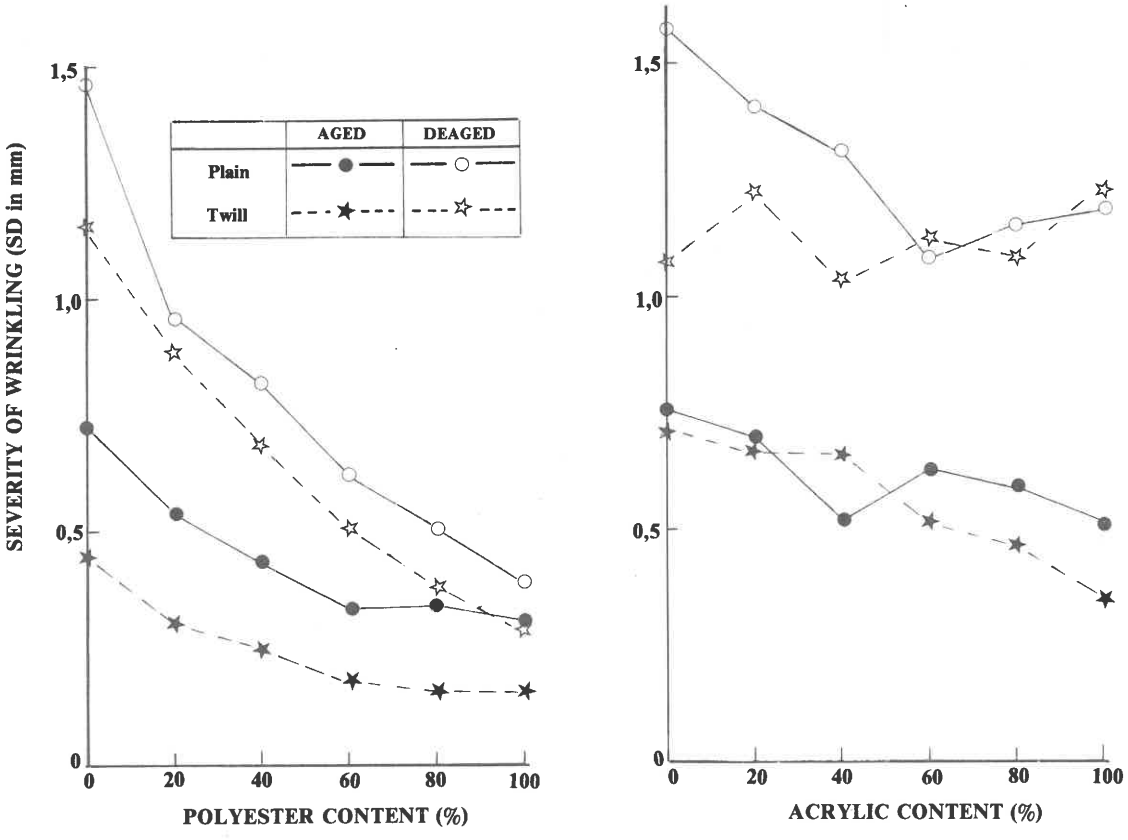

Fig. 2 The effect of synthetic fibre content on the FRL wrinkle recovery test results for the two different fabric structures and "states"

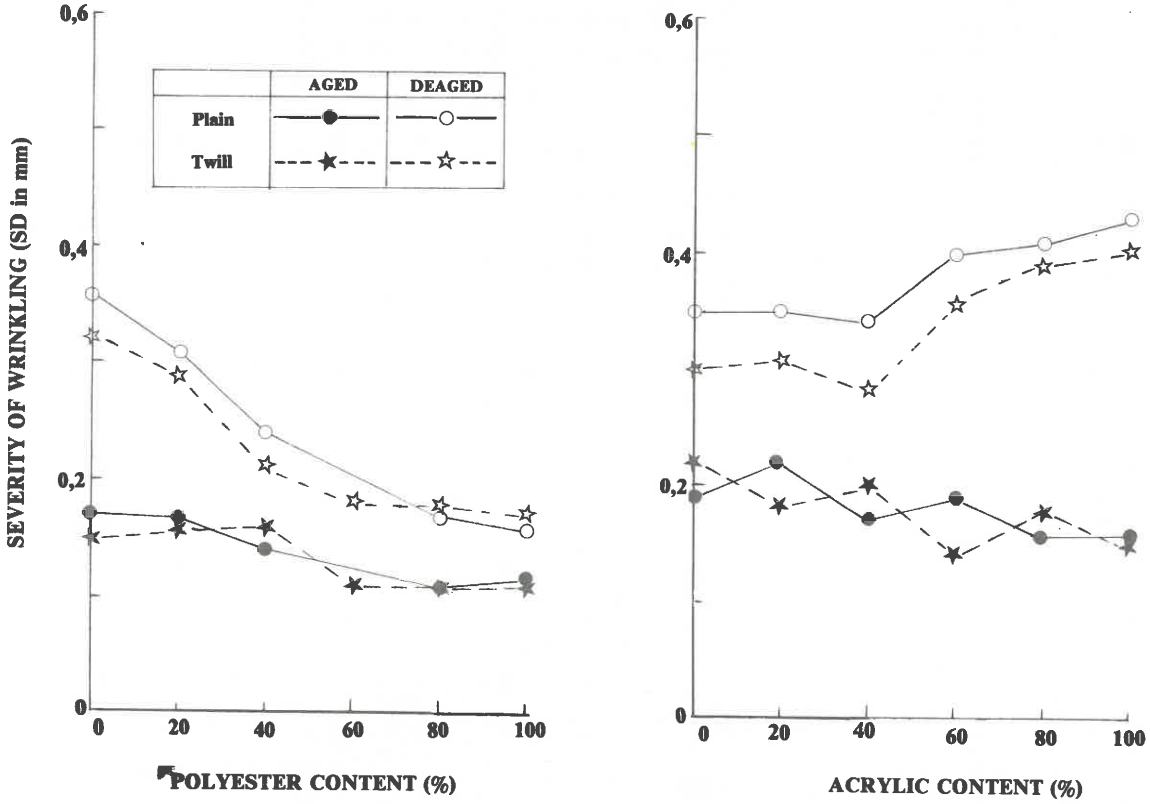

Fig. 3 The effect of synthetic fibre content on the AKU wrinkle recovery test results for the two different fabric structures and "states"

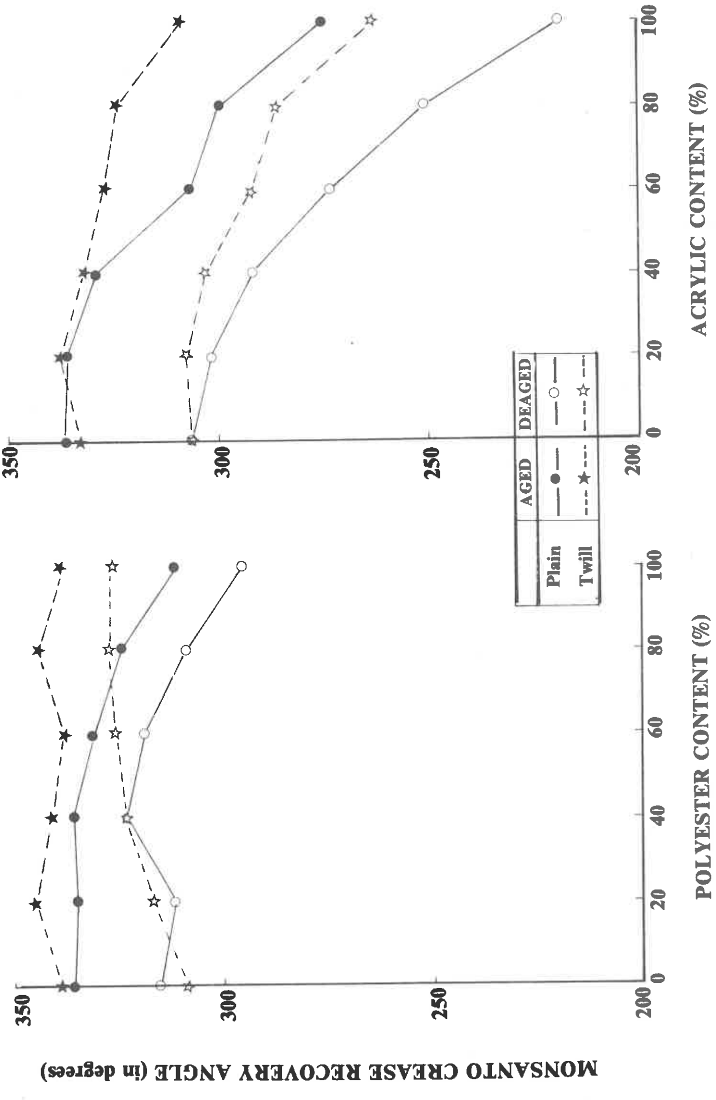

Fig. 4 The effect of synthetic fibre content on the Monsanto crease recovery angle obtained for the two different fabric structures and "states" (fabrics creased and recovered at 20° C/65% RH)

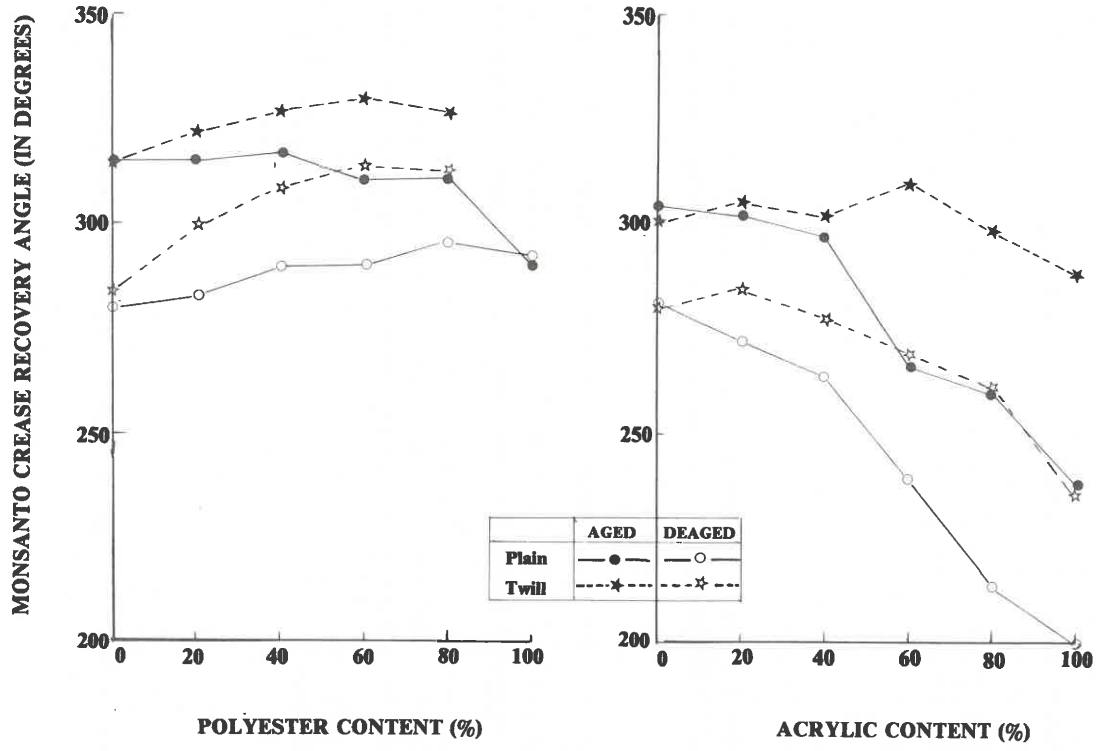

Fig. 5 The effect of synthetic fibre content on the Monsanto crease recovery angle obtained for the two different fabric structures and "states" (fabrics creased at 27° C/75% RH and recovered at 20° C/65% RH)

atmospheric conditions. Changes such as these can affect the aged state and wrinkle recovery of the fabric detrimentally. Changes in atmospheric conditions during or immediately prior to wrinkling can also adversely affect wrinkle recovery. These changes will probably have a greater adverse effect on wool in the aged state than on polyester.

After 24 hours recovery, the AKU wrinkle recovery ratings (according to standard replicas) showed similar trends to the wrinkle recovery height results plotted in Fig 3 (See Tables I and II).

In the case of wool/acrylic fabrics, certain of the tests indicated that the inclusion of acrylic resulted in a deterioration in the wrinkle performance (Fig 1, 4, 5), whether the fabrics are in the aged state or not, while in other tests (see Figs 2, 3) the fabrics containing acrylic had a wrinkle recovery performance approximately equal to or better than that of the all-wool fabrics. Clearly then, contradictory results can sometimes be obtained depending upon the test method, fabric state and atmospheric conditions and only actual wearer trials can resolve such anomalies.

SUMMARY AND CONCLUSIONS

The wrinkle recovery performance of lightweight fabrics (200 g/m^2) in all-wool, all-synthetic, and in different wool/polyester and wool/acrylic blends were measured by several methods in the *aged* and *deaged* states. The effect on the wrinkle recovery of weave, fibre type, synthetic content and fabric state was assessed.

It appeared that, in the case of *deaged* fabrics in all-wool, wool/polyester and all-polyester, similar trends were generally observed for the results obtained by means of the different test methods. These trends were for the *wrinkle recovery* to *improve* with increasing polyester content, with the twill fabrics generally performing better than the plain fabrics. For these fabrics, *ageing* generally improved the performance of the all-wool and wool/polyester fabrics relative to the all-polyester fabrics, and in fact for the IWS thermobench and the Monsanto tests the trends were sometimes even reversed (i.e. the inclusion of polyester caused a deterioration in the wrinkle recovery of the *aged plain* fabrics).

For the *deaged* wool/acrylic fabrics the general trend was for the wrinkle recovery to deteriorate with an increase in acrylic content, except for the results obtained with the FRL test on the *deaged plain* fabrics. For the *aged* fabrics, the AKU and FRL results showed different trends to the IWS thermobench and Monsanto results as the acrylic content increased. In the case of the former tests carried out on these *aged* fabrics, an increase in acrylic content was associated with an improvement in the wrinkle recovery whereas when the other two test methods were used the reverse trend was observed. This difference in trend could not be solely ascribed to differences in atmospheric conditions since Monsanto

tests carried out under the same atmospheric conditions as the AKU and FRL tests still showed an opposite trend. It would appear, therefore, that, in certain cases, different trends can be obtained when an ordered crease is inserted in the fabric (e.g. IWS and Monsanto tests) to those when more random creases (wrinkles) are inserted in the fabric (e.g. AKU and FRL tests).

Deageing generally caused a deterioration in the wrinkle recovery of all the fabrics even that of the all-synthetic fabrics, although the effect was generally less marked for the all-polyester than for the all-wool fabrics.

The wrinkle recovery properties of the wool/polyester fabrics were generally superior to those of the wool/acrylic while the *twill* structure was generally superior to the plain structure.

It can be concluded that, although the results of the different test methods showed the same trends in terms of the effect of deageing on wrinkle recovery, the difference between plain and twill structures and the effect of polyester content on the wrinkle recovery, they exhibited contradictory results for the wool/acrylic fabrics and also for certain of the aged wool/polyester fabrics. Clearly, such anomalies can only be resolved by carrying out extensive wearer trials.

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THE USE OF PROPRIETARY NAMES

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The fact that products 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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