EASY CARE WOOL/COTTON BLENDS

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Abstract

The natural lifetime of a new product development is such that, within a few years, the advantages responsible for its success no longer command a price premium, hence the constant drive to produce new ideas, concepts and technologies to maintain market momentum. For cotton products the major developments in recent years have been the Easy Care finishes, enzyme wash-down treatments and latterly, stain resistance utilising fluorocarbon finishes, but in many product areas it is blends, which have formed the backbone of apparel product development programmes. This concept has also extended to accommodate blends of wool with cotton and, in view of the advantages in terms of aesthetics, comfort and warmth associated with such blends, it is perhaps somewhat surprising that the development of such products has not been more actively pursued.

Apart from the obvious difficulties associated with dyeing wool cotton blends to solid shades, one of the major disadvantages of this fibre combination is that of the inherent tendency of the wool component to shrink, or felt, when machine washed and/or tumble dried. This property is of course incompatible with the production of garments which exhibit the full range of modern Easy Care performance criteria, namely machine washability, wrinkle resistance, smooth drying and crease stability. However, depending on the blend and fabric structure, and also the level of performance required, wool specific chemical finishing may not necessarily be required and the full range of Easy Care properties may often be readily achieved merely by utilising conventional cotton finishing techniques.

If the performance of a wool cotton fabric processed in this way does not meet the required specifications, a number of wool and cotton chemical finishing techniques may be readily combined in such a way that a full Easy Care performance is achieved without compromising the aesthetics or physical properties of the fabric.

Introduction

Blends of wool with cotton have been produced for many years but, with the possible exception of Viyella (55/45 wool/cotton) in the 70`s, the impact of such blends on the apparel market has been somewhat limited. However, interest in the use of such blends has grown considerably in recent years and, by a combination of accentuating the best and masking the worst properties of both components there is undoubtedly a huge potential for the development of product ranges with a unique combination of aesthetics and performance qualities.

The ideal product would therefore be one which featured the casual image and hard wearing properties of cotton with the handle, drape and comfort properties of wool.

Much of the growth in the market for cotton apparel products in recent years has been in the field of Easy Care trousers and shirts and this success has prompted the development of a large number of products which are labelled as either minimum or non iron and wrinkle resist. Many of these products, in particular shirts, feature blends with polyester which is used to compensate for the loss of fabric strength associated with the cotton finishing routes. Polyester has also been used to good effect in blends with wool for the production of Easy Care trousers, although in this case, the synthetic component contributes not only to shrink-resistance and increased abrasion resistance, but also provides the option for imparting a wash stable crease by heat setting the polyester during pressing and/or garment baking.

Although the combination of wool with cotton does offer considerable scope for new product development , there is little doubt that such blends are only likely to be acceptable in traditional cotton markets provided that they exhibit a full range of Easy Care performance criteria. Consequently, it is essential that the tendency of wool to shrink, or felt, during machine washing is eliminated.

In practice, the extent to which wool felts when blended with other non-keratinous fibres depends on a number of factors including yarn and fabric construction as well as the blend ratio and, for intimate blends in a conventional fabric structure, a wool content of up to 20% may have little influence on the performance of the product during washing. However, the way in which a product is dried can also impact considerably on the performance of such fabrics since tumble drying is much more severe than machine washing in terms of its potential to promote felting Since this is an essential element in ensuring that minimum or non iron performance specifications are met, the treatment of the wool component to prevent felting will invariably be required. An obvious solution in this case would be to reduce the wool content progressively, but experience has shown that there is little, if anything, to be gained in terms of fabric aesthetics by using a wool content of much less than 20% by weight.

Whilst the intimate blending of cotton with wool leads to a reduction in the tendency of the wool component to felt, a fabric containing a significant proportion of wool (30 to 40%) will often shrink during machine washing unless the wool component is stabilised. Similarly, the inclusion of wool in a blend with cotton will enhance the wrinkle recovery properties of the fabric, but a conventional wrinkle

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 1:771-776 (1998)
National Cotton Council, Memphis TN

resist resin finish will invariably be required to stabilise the cotton component. The production of Easy Care wool cotton blend fabrics therefore often requires that both elements be stabilised using a combination of conventional cotton and wool chemical finishing techniques.

Experimental Results and Discussion

1. Comfort Properties

Whilst there is considerable potential for new product development by blending wool with cotton, it is the overall improvement in the aesthetics and comfort properties which will be instrumental in their promotion and, although a detailed consideration of all aspects associated with comfort assessment and measurement is beyond the scope of this paper, the subject clearly warrants some consideration.

Wool has traditionally been perceived as a warm product and, whilst this is of course true, its position in spring summer product ranges is now well established as a result of IWS Cool Wool promotional campaigns and product development exercises (Schneider and Holcombe, 1990). Such low weight products are cooler to wear in a warm environment because they exhibit low resistance to body heat loss and, in addition, the smooth fabric surfaces promote improved heat loss as a result of improved interfacial fabric/skin contact. The unique comfort properties of wool are a function of its ability to respond rapidly to humidity changes occurring within the garment micro-climate by absorption and desorption of moisture vapour (Holcombe, 1990). The changes in temperature that occur during these processes are readily detected by skin sensors and these properties can be utilised to enhance both coolness of fabric in a warm environment and warmth in winter.

A study of the comfort related properties of 100% cotton and 40/60 cotton wool blends unequivocably confirmed these statements and the results and observations made may be summarised as follows (Harnett 1984):

1. The wool/cotton blend exhibited a markedly greater thermal resistance, thermal resistivity and warmth/weight value. i.e superior heat insulation properties.

2. The wool/cotton fabric exhibited a smaller water vapour resistance i.e. superior breathability.
3. 1 and 2 in combination provide a greater moisture permeability index which, in essence, means that the thermal comfort i.e temperature stabilisation, is maintained over a wider range of prevailing conditions .

4. The wool/cotton fabric gave rise to a smaller transient (or initial contact) heat flow value and therefore feels less cool to the touch, irrespective of wether the fabric is dry or wet.

5. The handle of the wool cotton fabric was assessed as being superior.

These improvements in fabric properties are a function of the bulk properties of the wool fibre and are not influenced significantly either by the application of cotton wrinkle resist resins, which have little affinity for wool, or any shrink proofing treatments which may be required to stabilise the wool component since the latter are surface specific in their action.

An additional factor associated with comfort, and which was not considered in the aforementioned study concerns the tactile properties of wool or wool blend fabrics worn against the skin, or more specifically the prickle factor (Naylor and Philips 1995). This concerns the extent to which wool fibres can irritate the skin and is directly related to the quality, or fineness of the wool used in the blend. Research has shown that the extent to which this occurs is governed by the amount of coarse fibre in a blend and is effectively zero provided that no more than 5% of the wool fibres in the blend exceed 30 microns. The type of wool used in a blend with cotton should therefore reflect the nature of the product being produced and, more specifically, wether or not it is to be worn against the skin.

Easy Care Performance Criteria

The number of products which are claimed to exhibit Easy Care characteristics has increased considerably in recent years but, because the performance criteria required are often product specific, the label itself does not refer to a specific set of properties and is often accompanied by additional care instructions which, it is claimed, if followed will enhance the garment appearance and performance.

An Easy Care knitted garment, for example, might merely be expected to maintain its shape and appearance during normal use, but for shirts and trousers there are additional performance criteria which relate to the appearance of the garment after washing and drying, and therefore the amount of ironing or pressing required to return the garment to a pristine condition.

In practice, products may therefore be labelled as being either minimum iron or non- iron with the latter, and sometimes the former, emphasising the importance of tumble drying in eliminating creasing and promoting smooth drying. The influence of tumble drying in this respect is equally as important for all fabric types, including wool, but because the conditions operating during tumble drying i.e high temperature, low liquor ratio and high degree of mechanical action, are ideal for promoting felting, the wool component may have to be shrink proofed at some stage of the production pipeline.

The two main markets for Easy Care products have been those of men`s shirts and trousers, and for the latter product, the issue of crease stability must also be addressed. In this instance a minimum iron product would exhibit a degree of stability which would allow the crease to be easily re-established during normal ironing whereas a non-iron product would literally be suitable for wearing immediately after tumble drying.

Options for Producing Wool Cotton Blends

Numerous options are available for the production wool cotton blends but the route chosen may well influence the overall performance of the fabric/product and therefore the finishing procedures ultimately required.

Intimate Blends

The simplest route for the production of an intimate wool/cotton blend is to ring spin or open end spin on the short staple system, in which case a wool quality of 19-21.5 micron wool should be used with a fibre length of between 40-45 mm, with the latter usually being scoured as broken top. Optimum results in terms of yarn strength and extensibility are obtained by using combed cotton and blending at the draw frame. Blend ratios of between 20/80 and 55/45 wool cotton may be readily produced in this way but yarn count restrictions do operate at higher wool content values and the reduction in yarn extensibility does impact on both spinning and weaving efficiency.

Twist Yarns

This route features the twisting of a conventional worsted spun yarn with a cotton short staple spun yarn and the blend ratio is varied simply via yarn count modifications.

Bi-component

In this case the pre-spun filament is replaced with a short staple spun cotton yarn.

Warp and Weft Insertion

For wool weavers, who are not equipped for size removal, an alternative route to the production of a wool blend is to maintain the wool warp and use a cotton weft, with the situation being reversed with cotton weavers.

Experimental Easy Care Assessment

Washability

Area Felting Shrinkage (AFS) is assessed using IWS TM 31 which features an Electrolux Wascator (FOM 71) Relaxation shrinkage is determined separately from felting shrinkage by washing for 1x7A cycle which is equivalent to a domestic Woolmark cycle on a front loading washing machine. This is then followed by a series of accelerated cycles (5A cycle), each of which is equivalent to between 8 and 10 7A cycles in terms of felting potential. Woolmark standards for wool or Woolblend fabrics in trousers specify a maximum shrinkage (including relaxation) of no more than 3% in both the warp and weft directions after 3x5A cycles. Felting shrinkage is usually very apparent in knitted wool products, but with wovens, it is quite possible to meet the specifications for AFS but yet fail on the basis of seam or edge felting which ultimately manifests itself as puckering. Samples prepared for wash testing therefore also feature a seam in both the warp and weft directions and the sample is deemed to have failed if the difference in shrinkage along the fold of the seam is more than 1% above that measured in the bulk of the fabric. This is termed as Differential Cuff Shrinkage (DCS) and, although a 1% differential would appear to be somewhat small, such values often result in a significant level of pucker which will ultimately lead to a marked deterioration in the appearance of the garment when washed. This phenomenon also occurs with wool blend fabrics and a realistic assessment of how a fabric will perform in a garment construction will not be possible unless this property is assessed.

The Woolmark test for washability is based upon the use of a front loading washing machine which is most prevalent in Europe and it is accepted that the action and felting severity of this type of machine will be different from that of a top loader as commonly used in the US. However, it has been confirmed that a 7A cycle is approximately equivalent to a 2 minute low level cycle on a Kenmore top loading washing machine. No accelerated test procedure currently exists for assessing the shrinkage of wool or wool containing products during tumble drying and, where appropriate, this was assessed using the procedures described in AATCC TM 135 –1992.

Wrinkle recovery assessments were carried out using AATCC – 128-1989
and Durable Press rating using AATCC -143-1992.

Fabric Treatment

Unless otherwise specified, all chemical application levels are expressed as a percentage of the product on weight of wool (o.w.w.).

Cotton Finishing

The cotton resin systems used in this evaluation included a conventional DMDHEU resin type supplied by BIP (UK), Fixappret Eco (BASF) and
Knittex FEL (Ciba). The application levels chosen and the conditions used to achieve full curing of these resin systems were those recommended by the respective companies.

Wool Finishing

Polymers

The wool shrink-resist polymers used in this evaluation were Synthaprett BAP (Bayer), Dicrylan WSR (Ciba) and Basolan MW (BASF).

Oxidation

Piece Treatment using Permonosulpuric acid was carried out using padapplication techniques followed by the

development of shrink resistance via the exhaust application of sodium sulphite under alkaline conditions

Results and Discussion

Easy Care Finishing

Intimate Blends

Because cotton fabrics must invariably be resin finished to meet standards relating to wrinkling and smooth drying and also because wool can felt, or shrink, during washing, the production of a true Easy Care wool cotton fabric is normally only possible by utilising a combination of wool and cotton finishing techniques. However, the significance of each type of finish will vary depending on the blend ratio as well as the yarn and fabric structure and the results on unfinished fabrics (Table 1) graphically demonstrate the influence of wool in terms of fabric stability when subjected to machine washing.

Clearly, the felting propensity of the intimate blends is much lower than those fabrics which feature a 100% wool yarn in one direction and the performance in this respect is strongly influenced by the proportion of wool in the blend as well as the performance required i.e. whereas a fabric may be readily machine washed it may not necessarily be capable of being tumble dried.

For these blend ratios shown in Table 1, full machine washability will not be achieved unless the wool component is shrinkproofed, and the results shown in Table 2 for a 50/50 wool cotton intimate blend demonstrate the marked improvement in performance one might expect to achieve via either a top (Jackson et.al. 1990) or piece treatment routes (Byrne, 1996).

Whilst the option of using shrinkproofed top is relatively simple, the additional cost of the treatment, plus stretch breaking to achive the necessary fibre length distribution may be prohibitive; in addition the Hercosett option would not be favoured because of the problems associated with dyeing such a blend to a solid shade. A more practical solution might be to shrinkproof the wool component in piece form, in which case good results may also be obtained using PMS oxidation.

The influence of drying conditions on product performance is such that, in certain markets, a tumble dry performance would be important/essential. Subsequent testing of these fabrics according to the AATCC 128-1989 confirmed that an acceptable performance was eminently possible via the piece treatment route, although, irrespective of the shrinkproofing treatment used on the wool, the positive influence of the cotton resin finish on dimensional stability was also very apparent. (Table 3).

The performance in terms of felting for an intimate wool cotton blend finished as in Table 3 will improve considerably as the proportion of wool decreases and, depending on the level of performance required, it may not be necessary to chemically finish the wool component; in which case the fabric may therefore be chemically finished via a conventional cotton finishing route.

The primary disadvantage associated with the use of conventional cotton resin finishing techniques is the marked reduction in physical properties which accompanies the treatment. The extent to which this occurs is a function of the degree of cross -linking achieved and, since this is subsequently reflected in the Easy Care performance of the fabric, in particular wrinkle recovery properties, the normal procedure is therefore to establish a compromise between performance and the damage sustained. However, substantial reductions in physical properties are still observed and it is not uncommon to observe a reduction in abrasion resistance of 40 – 50% as a result of the treatment (Basinger, 1995).

A similar situation also exists with certain oxidative shrinkproofing technologies, although the overall reduction in abrasion resistance is not nearly as dramatic and, as with 100% cotton fabrics, the design and construction should be such that the loss in performance which accompanies the finishing route is readily accommodated in the final end product.

Some studies carried out on wool fabrics to determine the relative contribution of a PMS wool treatment and cotton resin finishing techniques in terms of fabric damage confirmed that although the reduction in abrasion resistance associated with the PMS treatment was significant, it was subsequently compensated for by the application of a conventional cotton resin finish, suggesting therefore that the inclusion of wool in a blend with cotton may even lead to an improvement in the physical properties of the fabric.Table 4. This is consistent with the results from another study (Mehta, 1995) in which the effect of non-formaldehyde based cotton resin finishing techniques on the physical properties of an an 80/20 cotton wool blend were assessed. It was found that, whilst the reduction in strength which accompanied these treatments was greater with the blend than with with 100% cotton, the absolute values obtained for the blend were considerably higher both before and after treatment. The smooth drying properties of a wool/cotton blend are a function of the blend ratio, which in turn will influence the nature of the chemical finish required. Consequently, a fabric which features a high proportion of cotton will benefit in this respect from a conventional cotton resin finishing route. However, for a blend which contains a relatively high proportion of wool, optimum results in terms of smooth drying will only be obtained if the fabric is effectively set. In a wool finishing mill this is most effectively achieved either by KD setting or crabbing but, for a cotton specific finishing plant, the former is not an available option and some form of crabbing must be accommodated.

Non Intimate Blends

The options for producing wool cotton fabrics via routes other than intimate blending are numerous but such options do compromise the performance of the fabric in terms of felting shrinkage and are also more difficult to stabilise in terms of smooth drying properties because the cotton resin finishes are not as efficient as they are with intimate blends. The fabrics used in this evaluation featured a wool warp and a cotton weft in plain and twill structures.

The use of shrink resist treated wool is of course an option which will provide a high degree of resistance to felting during repeated washing and tumble drying and, furthermore, allows the use of conventional worsted or woollen spun wool yarns. However, if products produced from these yarns are to exhibit the full range of Easy Care performance criteria then it will be necessary to treat the cotton component using conventional resin techniques and a significant reduction in production costs could therefore be achieved if both the wool and cotton components could be stabilised simultaneously.

Once such combination examined was that of Fixaprett ECO conc.(BASF), a low formaldehyde cross linker, in combination with Basolan MW(BASF), an amino-functional silicone micro- emulsion which is used to good effect as a wool shrinkproofing agent, albeit normally in combination with an oxidative pre-treatment.

The results shown in Table 5 confirm that this combination is extremely effective on intimate blends producing excellent durable press ratings and resistance to felting as well as an excellent handle, the latter being consistent with what one would hope to achieve with such a high proportion of wool. However, the durable press ratings obtained for the wool warp fabrics were poor and were effectively compromised due to high shrinkage values.

Clearly the degree of shrink-resistance imparted to the wool component by the Basolan MW (BASF) alone is insufficient but this may be enhanced considerably by oxidatively pre-treating the fabric with PMS. The performance in terms of washability would be enhanced still further by combining this treatment with the application of Basolan MW, a combination which has been shown to be particularly effective on 100% wool wovens The efficiency of a PMS oxidative pre-treatment was confirmed on intimate blends and, when used in combination with the Fixapret/MW combination, the results obtained were excellent both in terms of felting shrinkage and after-wash appearance; however, unlike with the intimate blends, the drop in abrasion resistance was significant (36,000 rubs to 14,750).

Although it is not possible to readily determine the relative contributions of the resin finish and PMS oxidation stages to the reduction in abrasion resistance, both are likely to have made significant contributions. An alternative shrinkproofing agent was therefore considered which is effective without an oxidative pre treatment, namely Dicrylan WSR (Ciba). and which, when applied to wool fabrics, provides an excellent after-wash appearance ,often in combination with a significant increase in abrasion resistance.

The results obtained on the wool warp, cotton weft fabrics were excellent in terms of washability and smooth drying (Press rating of 3.5) and
Excellent results in terms of abrasion esistance were also achieved (34,000). However, despite the advantages associated with this finish over the oxidatively based route, the handle was decidedly crisp and not consistent with the proportion of wool in the blend.

The remaining property which must be addressed if an Easy Care wool/cotton trouser is to be produced is that of crease stability since a minimum or non iron care claim will not be possible unless the crease will survive repeated machine wash/tumble dry cycles. For 100% cotton products this level of crease stability is achieved by actually cross linking the cotton fibre structure via the use of DMDHEU type resins in the garments pressed configuration (Metzler, R.B 1995). This is done by partially curing the resin during fabric finishing and then fully curing after making up by a combination of pressing and garment baking.

These resin systems have little chemical affinity for wool and therefore are ineffective in terms of crease stabilisation; other options must therefore be sought and the techniques used will again depend upon the blend being processed and the fabric construction. Clearly, since trousers are normally constructed from fabrics which are cut lengthwise in the warp direction, a wool cotton blend which features a cotton weft will respond positively to a conventional cotton resin, provided of course that the potential for the wool component to felt has been addressed. If, on the other hand, an all wool weft is used, then crease stabilisation may be achieved via the use of an extended pressing cycle in conjunction with the application, either at fabric or the garment stage, of a suitable formulated reducing agent. (Speakman 1960)

The garment application technique has been used commercially on wool garments in selected markets, notably Japan, for a number of years but the conditions required during pressing are essentially incompatible with a cotton production route and an alternative route must therefore be sought.

Once again, the best results in terms of crease stability will be obtained using conventional cotton resins, with the degree of crease stability obtained effectively reducing as the proportion of wool in the blend increases. Improved results on wool cotton blends would only be obtained if a wool specific resin system with delayed cure potential could be incorporated into the formulation.

Recent commercial scale trials in Europe on 100% wool fabrics have confirmed the potential for certain reactive polyurethanes (Protolan 367, Rotta and Dicrylan WSR (Ciba) in this respect and the effective combination of this type of product with a cotton resin finish would therefore provide the ideal product for finishing wool cotton fabrics produced via a number of different routes. However, because cotton resin systems are applied under acidic conditions and the active constituent of these wool specific polymers cures under alkaline conditions, the potential for simultaneous application would appear to be limited. Preliminary experiments have have however shown that under certain specified conditions, both the wool and cotton resins can be sufficiently cured to ensure that both components are effectively treated. A detailed consideration of the conditions necessary to achieve optimum results in terms of the full range of Easy care performance criteria is beyond the scope of this article but will form the basis of a further publication on the subject.

Conclusion

The aesthetic advantages and improved comfort properties of wool cotton blends has long been realised but it is only recently that product development opportunities have been fully appreciated. The huge boost in consumer awareness of easy care apparel properties brought about by the success of cotton and polyester cotton products set the standard for this market and focussed the attention of wool and cotton finishers on the possibilities of effectively combining these two fibres to produce products which could be described as trans seasonal without having to compromise on the high standards of Easy Care normally associated with cotton products.

There is little doubt that the most viable option for producing Easy Care wool cotton blend products is via the use of intimate blends and, depending on the fabric construction and the blend ratio, excellent results in terms of washability, handle and durable press rating may be achieved via a variety of different chemical treatments, including either conventional cotton resin treatments and/or elements of wool specific shrinkproofing treatments. As with 100% cotton, the fabrics must be designed and structured in such a way that the loss in strength which accompanies the chemical treatments used does not compromise the performance of the end product, however, there is evidence to suggest that the inclusion of wool in an intimate with cotton can significantly improve the physical properties of the fabric.

Where intimate blends are not the option chosen, such fabrics are more difficult to stabilise in terms of Easy Care properties as the efficiency of both the wool and cotton finishes is compromised. This is particularly apparent with regard to wool felting and the most efficient option is to use wool which has been shrink-resist treated in top form. However, the use of a PMS based pre-treatment, either alone or in combination with a wool specific polymer, has in many cases been shown to produce excellent results and could provide a more cost effective option.

The ultimate Easy Care route for a woven wool/ cotton blend is one which, in addition to providing good wrinkle resistance, press ratings and stability during washing, will also provide the option of imparting a wash stable crease via a delayed cure mechanism i.e garment bake. For intimate blends the efficiency of cotton resins in this respect is reduced progressively as the wool content increases, although a wool content of 30% would not necessarily produce an unacceptable result. Optimum results would be obtained by the simultaneous application of cotton and wool specific resins which both offer the potential for a delayed cure mechanism. The active constituents of Dicrylan WSR (Ciba) and Protolan 367 (Rotta) do have an affinity for both wool and cotton and results from commercial scale treatments on 100% wool wovens have confirmed the potential of these products in terms of crease stabilisation and the ideal combination of these products with cotton resin finishes are currently being examined.

It is generally perceived that much of the development in terms of wool cotton blends will be via cotton weavers and finishers and, as a result, a major priority in the promotion of wool cotton blends is the development of a chemical finishing procedure which requires little additional input in terms of either finishing or equipment. A polymer system which is currently used to good effect on 100% wool fabrics to achieve the full range of Easy care properties, including a wash stable crease, currently offers considerable potential for use with cotton resins on wool cotton blends via a delayed cure/garment bake route and could therefore offer considerable potential in the development of products which combine the improved comfort properties of wool with the hard wearing properties and casual image of cotton.

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Table 1. Felting Properties of Untreated Wool Cotton Fabrics

Fabric	**Washability**							
	%AFS				***%DCS***			
	1x5A		**3x5A**		**1x5A**		**3x5A**	
	l	w	l	w	l	w	l	w
Tw 68/32	3.1	4.9	7.3	17.5	0	1	0	1
Pl 45/55	1.5	1.3	3.9	2.2	0	0	0	0
Ga 50/50	7.0	0.5	20.3	4.2	2.1	2.7	4.4	0

Tw=Twill, (68/32) Wool/Cotton Blend: Warp is an intimate wool cotton blend, weft is 100% wool).
Pl=Plain, (45/55) Wool/Cotton Blend: Warp and weft are an intimate wool cotton blend)
Ga=Gaberdine, (50/50) Wool/ Cotton Blend: Warp is 100% wool, weft is 100%cotton.
AFS=Area Felting Shrinkage: DCS=Differential Cuff Shrinkage
L=length, W=width.

Table 2 Felting Properties of a Chemically Finished Intimate Wool Cotton Blend (50/50 Twill)

Treatment	Washability							
	%AFS				%DCS			
	1x5A		3x5A		1x5A		3X5A	
	L	W	L	W	L	W	L	W
Piece	0	0.4	1	0.4	0	-0.8	-0.2	-0.4
Cl/Top	0.5	0.4	0.5	0.4	0	0	0	-0.5
Cl/H Top	0.8	0.8	1.3	0.4	-0.8	-0.8	-0.9	-0.4

Piece = Piece Treatment with PMS plus DMDHEU resin
Cl/Top = Wool Chlorinated in top form (2% Chlorine oww)
Cl/Htop = Wool Chlorine Hercosett Treatment (2% Chlorine oww plus 2% Hercosett (solids) oww.

Table 3. Machine Wash/Tumble Dry Assessment of Treated Intimate Wool Cotton (50/50 Twill) Blend

Treatment	AATCC TM 135-1992 5 Wash/Tumble Dry Sequences	
	% Width Shrinkage	***% Width Shrinkage***
PMS(PT)	4.4	5.3
PMS/DMDHEU	1.2	2.1.
Cl/Top	3.2	4.4
Cl/Top/DMDHEU	2.0	2.0
Cl/H Top	2.9	4.0
Cl/H Top/DMDHEU	0.4	2.0

PMS = Permonosulphuric Acid
PT = Piece Treatment
Cl/Top = Top Chlorination
Cl/H = Chlorine Hercosett Top Treatment
DMDHEU = Cotton Resin Treatment.

Table 4. Influence of PMS and DMDHEU on Abrasion Resistance of Wool Fabrics

Fabric 100% Wool	Abrasion Resistance*		
	Untreated	PMS	PMS+DMDHEU
Serge	34,000	29,000	43,000
Twill	31,000	17,000	33,000

PMS=Permonosulphuric Acid.
* Martindale

Table 5. Influence of Combined Wool and Cotton Resin Finishes On the Properties of a 45/55 Intimate Blend.

Trearnent	**DP 3x5A**	**Washability**			
		%AFS		***%DCS***	
		3x5A		**3x5A**	
		l	w	l	w
Eco/MW Pl	3.5	0.6	0 *	0	0.6
WSR/FEL Pl	3.5	1.5	0.5	1	1
Eco/MW Tw	3.0	1.3	0 *	0	0
WSR/FEL Tw	4.0	1.5	0.5	1.0	0.5

Eco=Fixappret Eco (BASF); MW=Basolan MW(BASF)
WSR=Dicrylan WSR (Ciba); FEL=Knittex FEL(Ciba)
Tw=Twill; Pl=Plain weave.
DP= Smooth Drying according to AATCC Test Method 143-1992.
Samples also passed after 5x5A cycles.

Table 6. Influence of Combined Wool and Cotton Resin finishes on the Properties of Union Wool Cotton Blends (Wool Warp/Cotton Weft)

Treatment	DP	Washability			
		%AFS		%DCS	
		3x5A		3x5A	
	5x5A	l	w	L	w
Eco/Mw/Tw	2.0	4.7	1.2	2.8	-1.8
PMS/Eco/MW/ Tw *	3.5	1.6	0.5	-1.1	-0.5
BAP/Tw*	3.5	1.6	1.1	1	1

Eco=Basolan Ecofix (BASF): MW=Basolan MW(BASF)
PMS=Permonosulphuric Acid.
BAP=Synthaprett BAP (Bayer).

- Samples also passed after 5x5A Cycles.