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DIMENSIONAL STABILITY OF KNITTED WOOL FABRICS TREATED WITH SYNTHAPPRET LKF

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ABSTRACT

Knitted all wool fabrics were treated with Synthappret LKF, autoclave steamed after evacuation and finally tested for dimensional stability. A commercially viable process by means of which knitted wool fabrics can be dimensionally stabilised, is described.

KEY-WORDS

Wool – Synthappret LKF – autoclave steaming – relaxation shrinkage – felting shrinkage – dimensional stability.

INTRODUCTION

The shrinkage of knitted wool fabrics during laundering can be attributed mainly to relaxation shrinkage (due to relative movement of the *yarns* in the *fabric*) and felting shrinkage (due to relative movement of the *fibres* in the *yarns*).

Felting shrinkage can be prevented by chemical treatment of the wool or by treating the wool with a polymer. With the Hercosett 57-process[1], however, the wool is chemically modified and a polymer is deposited on it.

Chemical modification is mainly confined to the surface of the fibre and the reaction is aimed at a modification of the scale tips. By softening the scale tips, the differential frictional effect is reduced which in turn reduces felting shrinkage. These chemical processes, however, result in certain undesirable effects such as reduced wet-fastness properties of certain dyes, lower abrasion resistance and, in some cases, severe yellowing. It must be emphasised, however, that relaxation shrinkage of jersey fabrics has not as yet been successfully inhibited by chemical treatment of the fibre. The wool is normally treated in top or yarn form and relaxation shrinkage occurs after knitting due to the release of strains imposed during knitting.

Shrinkproofing wool with a polymer involves depositing a thin layer of the polymer on the surface of the wool. Such a treatment leaves the fibre chemically intact and, as a result, fibre strength and whiteness are relatively unaffected. Furthermore, because of the high resistance to abrasion of polymers, the treated fabric frequently has a higher abrasion resistance than the untreated wool. The application of solvent-soluble reactive prepolymers is an effective means of stabilising knitted fabrics in respect of both felting and relaxation shrinkage. Felting shrinkage is inhibited by coating the surface of the fibres as well as bonding or 'spotwelding' of crossing fibres[2]. The mechanism by which relaxation shrinkage is inhibited is not

fully understood but it is probably due to the partial setting of the knitted loops, still in their distorted states. Yarn swelling and bulking could also be major causes of relaxation shrinkage[3] and preventing this by setting will also reduce relaxation shrinkage. It has also been found that relaxation shrinkage could be stabilised by autoclave steaming at 6 Kg/cm^2 x min of double jersey fabrics produced from Dylan treated yarn[3].

The purpose of this investigation was to find a method by which knitted structures would be made dimensionally stable by combining the processes of resin treatment and autoclave setting.

EXPERIMENTAL

The prepolymer used was a solvent-soluble isocyanate known as Synthappret LKF (Bayer). The commercial product consists of an 80% solution in ethyl acetate of a prepolimerised product of a polyhydric alcohol and a di-isocyanate. The prepolymer has free isocyanate groups which can polymerise further after spreading on the wool fibre to form a crosslinked polyurethane. Synthappret LKF does not crosslink with the wool and it seems as though crosslinking is limited to the polimerisation products themselves[2].

The samples used for treatment were of a Punto-di-Roma structure knitted from a R 30 tex yarn of a 64's quality wool (See Table I).

All samples were drycleaned in perchlorethylene, prior to Synthappret LKF treatment, in a Permac-Böwe drycleaning machine to remove all residual fatty matter which could affect the resin treatment substantially.

The samples were treated with Synthappret LKF in a perchlorethylene solution containing various amounts of Synthappret LKF (based on the weight of wool) and the treatment was carried out in the machine already referred to. The method of treatment was the dip-tumble method described by Bayer[4] and the sequence of operations was the following:

The material was soaked for 2 min in the Synthappret LKF solution with the drum stationary and the circulation pump in operation. While the solution was being pumped back into the stock tank the material was tumbled for 2 min, after which the drum remained stationary for 1 min followed by a final 2 min tumble. The material was then dried with the temperature of the outlet air thermostat set at 70–80°C.

The samples were subsequently steamed at 0.35 kg/cm^2 in an Andrews Minisetter for various periods of time. A vacuum of 710 mm of mercury was drawn for 2 min before and after steaming.

All samples were finally washed according to the Australian Wool Board Specification for Machine Washability[5] as a means of assessing the effectiveness of the treatment.

An R 30 tex yarn spun from a 64's quality wool was treated with 0.5% chlorine with the aid of the Melafix DM (Ciba)[7] method using Fichlor 60's at pH 4.0 and

Fichlor 60's at pH 6.0[8], to investigate the influence of prechlorination upon the shrinkproofing properties of Synthappret LKF. The yarn described above was knitted into a Punto-di-Roma structure, the fabric treated with Synthappret LKF and steamed in an autoclave as described above.

RESULTS AND DISCUSSION

Table II shows that a relatively short period of autoclave steaming is most effective in giving dimensional stability of a fabric treated with Synthappret LKF. This is of significant importance because wool yellows upon prolonged steaming[6]. It was also observed that autoclave steaming facilitates immediate curing of the resin. This is possibly due to the catalytic effect of water on polymerisation. The use of high temperature with steam pressure is considered of major importance because steaming Synthappret LKF treated fabrics under atmospheric conditions for 30–60 sec does not cause polymerisation[2]. This observation is of utmost importance because under normal conditions 4–5 days are required for the curing of Synthappret LKF.

By comparing Tables III and IV it can be seen that a substantial relative improvement in shrink resistance is obtained by autoclave steaming for 2 min at 0.35 kg/cm^2 as compared with the normal procedure where the treated cloths are left for 7 days to facilitate curing of the Synthappret LKF.

Table III illustrates the effect of the softener, Synthappret LW, on the shrinkproofing properties of Synthappret LKF. It is concluded that the addition of Synthappret LW has a detrimental effect on the anti-felting treatment and since the improvement in handle was marginal the use of this softener is not justified.

Tables II and IV show a marked difference in the shrinkage values obtained for length and width after cubex washing. This may be due to the fact that the

TABLE I

DETAILS OF FABRIC STRUCTURES

STRUCTURE	Yarn Count	Machine Tightness Factor[9]
Punto-di-Roma	R 30 tex	17.5
Interlock	R 30 tex	15.9
Milano Rib	R 30 tex	17.1
Swiss Double Piqué	R 30 tex	15.6
French Double Piqué	R 30 tex	15.6
Plain	R 90 tex/3	14.8
1 x 1 Rib	R 90 tex/3	16.1

TABLE II

THE EFFECT OF STEAMING TIME UPON WASHING SHRINKAGE OF A PUNTO-DI-ROMA TREATED WITH 2.5% SYNTHAPPRET LKF.

Steaming Time in min.	% Shrinkage after 3 min wash		% Shrinkage after 45 min wash	
	Length	Width	Length	Width
0	12.0	1.3	15.1	5.5
2	1.6	-0.8	5.8	2.1
4	1.8	-0.1	7.7	1.9
6	1.8	-0.4	6.3	2.8
8	2.1	0.3	6.2	3.3
10	1.8	1.0	8.0	3.3
12	2.0	0.5	7.9	3.7
14	1.7	-0.9	8.4	3.3
16	1.6	0.4	7.4	4.5
18	3.5	1.2	8.7	4.7
20	2.9	1.2	7.5	4.5

(Steaming pressure = 0.35 Kg/cm^2

TABLE III

SHRINKAGE VALUES OBTAINED FOR PUNTO-DI-ROMA FABRIC.

Number of days after application of Synthappret LKF	% SHRINKAGE							
	With 25% Synthappret LW				Without Synthappret LW			
	After 3 min wash		After 45 min wash		After 3 min wash		After 45 min wash	
	Length	Width	Length	Width	Length	Width	Length	Width
1	6.2	6.7	8.2	8.2	7.3	5.6	8.4	7.8
4	6.7	6.5	13.4	10.9	6.0	3.8	7.7	8.5
7	7.1	5.1	14.3	10.1	4.2	5.9	7.5	7.7
14	7.0	4.0	15.5	9.5	5.6	3.4	9.9	6.9

Fabric treated with 2.5% Synthappret LKF and 25% Synthappret LW and washed at different stages of curing.
(Concentration of Synthappret LW based on weight of Synthappret LKF).

fabric used for the experiments in Table II was not yet in the fully dry relaxed state when treated with Synthappret LKF while the fabrics for the other experiments were left long enough to reach the fully dry relaxed state.

When autoclave steaming at 0.35 kg/cm^2 was applied after evacuation at set times after treatment with Synthappret LKF, it was found that steaming should be carried out as soon as possible after treatment of the fabric with the polymer. The shrinkproofing efficacy is seriously affected if too long a period of time is allowed to elapse after treatment with Synthappret LKF and before autoclave steaming is carried out. It is accordingly recommended that autoclave steaming be carried out within 24 hours after treatment of the fabric with the Polymer (See Table IV).

Messrs. Bayer recently introduced a catalyst, Catalyst CA 4478, to facilitate curing of the Synthappret LKF during drying thereby eliminating the normal curing period of 4–5 days. Table V shows that a slight improvement in shrink resistance was obtained when jersey fabrics were treated with Synthappret LKF and Catalyst CA 4478 and washed immediately after treatment. The handle, however, was adversely affected. The results also show that the shrink resistance of the fabric treated with Synthappret LKF only and autoclave steamed afterwards was superior to the recommended applications. Synthappret LW impaired the effectiveness of the shrinkproofing of the 1 x 1 Rib structure even when the fabrics were steamed. The handle of the fabrics was not improved by the addition of Synthappret LW and incorporating this reagent is therefore not recommended.

TABLE IV

SHRINKAGE VALUES OBTAINED FOR PUNTO-DI-ROMA FABRIC

Number of days after resin treatment before steaming	% SHRINKAGE			
	After 3 min wash		After 45 min wash	
	Length	Width	Length	Width
1	2.3	1.8	2.5	2.4
4	2.3	2.7	6.7	5.1
7	3.0	2.2	7.3	5.3
14	2.2	2.2	9.7	5.5
Untreated	13.3	12.0	30.6	15.6
Untreated but steamed	6.0	4.9	25.5	12.0

Fabric treated with 2.5% Synthappret LKF, washed after autoclave steaming at 0.35 Kg/cm^2 for 2 min at set intervals.

TABLE V

THE EFFECT OF SYNTHAPPRET LW AND CATALYST CA 4478 UPON THE SHRINKPROOFING PROPERTIES OF SYNTHAPPRET LKF

STRUCTURE	TREATMENT	% SHRINKAGE							
		No Steam				2 Min Steam			
		After 3 min wash		After 45 min wash		After 3 min wash		After 45 min wash	
		Length	Width	Length	Width	Length	Width	Length	Width
Punto-di-Roma	2.5% Synthappret LKF	8.2	12.4	15.6	15.3	1.6	1.0	1.8	3.2
	2.5% Synthappret LKF + 3.5% Catalyst CA 4478	4.3	8.8	6.5	12.7				
	2.5% Synthappret LKF + 7.0% Catalyst CA 4478	4.9	8.5	7.8	12.3				
1 x 1 Rib	3.0% Synthappret LKF	9.9	-0.1	13.1	3.9	3.3	4.6	4.5	6.5
	3.0% Synthappret LKF + 3.5% Synhtappret LW	11.8	2.3	15.0	14.8	3.6	4.1	11.1	10.9
	3.0% Synthappret LKF + 3.5% Synthaprett LW + 7.0% Catalyst CA 4478	2.1	5.9	12.4	14.9				

(Concentrations of Synthappret LW and Catalyst CA 4478 are based on the weight of Synthappret LKF).

TABLE VI

SHRINKAGE VALUES OBTAINED BY TREATING DIFFERENT STRUCTURES WITH DIFFERENT AMOUNTS OF SYNTHAPPRET LKF AND SUBSEQUENT AUTOCLAVE STEAMING AT 5LB/IN^2 FOR 2 MIN.

Structure	% Synthappret LKF Applied	% SHRINKAGE									
		After 3 min wash		After 45 min wash		After 90 min wash		After 135 min wash		After 180 min wash	
		Length	Width	Length	Width	Length	Width	Length	Width	Length	Width
Plain	2.5	1.0	2.5	1.5	2.8	3.1	2.7	2.9	4.4	4.4	4.3
	3.0	1.9	2.4	3.1	2.9	5.3	5.0	8.1	7.1	9.6	9.0
1 x 1 Rib	3.0	-0.4	-6.4	0.4	1.7	1.8	-3.8	1.5	-1.5	1.8	-2.3
	3.5	0.4	-10.4	0.4	6.0	1.1	1.6	1.8	0.2	1.8	1.0
French d.P	2.0	0.9	2.7	1.6	5.0	2.4	5.7	5.2	9.1	7.2	11.1
	2.5	0.9	3.0	2.1	5.1	1.7	5.0	2.8	6.4	4.8	9.2
Milano Rib	2.0	1.5	2.0	2.9	3.8	3.0	2.7	4.2	4.5	5.9	5.2
	2.5	1.0	1.4	1.6	3.7	2.0	2.3	3.2	3.4	4.8	5.2
Swiss d.P.	2.0	1.7	2.1	3.3	4.4	3.7	2.9	4.3	4.7	4.2	4.0
	2.5	0.9	2.9	3.1	5.8	2.8	3.7	3.4	4.2	2.6	4.2
Interlock	2.0	0.8	-1.7	1.0	0.4	3.4	-2.7	4.2	-0.8	5.8	-2.2
	2.5	0.4	-3.8	0.8	-3.1	2.6	-8.9	2.4	-6.2	2.2	-6.7
Punto-di-Roma	2.0	2.1	0.5	2.8	0.6	4.4	1.8	6.5	2.7	7.0	2.5
	2.5	2.1	-1.0	3.3	0.1	4.5	0.7	5.3	1.2	5.5	1.0

Although all results were obtained by using a Punto-di-Roma structure, Table VI shows that most double jersey and single jersey structures can be shrinkproofed satisfactorily using Australian Wool Board Specifications as the norm. The table shows that these fabrics maintained dimensional stability even when washed for prolonged periods of time. It is possible that the level of treatment with the polymer is critical as can be seen from the results obtained for French Double Piqué and Interlock structures. The minimum concentration should therefore be determined for each type of structure.

The effect of a prechlorination treatment upon the shrinkproofing properties of Synthappret LKF is summarised in Table VI. It can be seen that prechlorination decreases the resistance to shrinkage as compared with the sample with no pretreatment. It seems therefore as though a prechlorination treatment has an antagonistic rather than a synergistic effect upon the shrinkproofing properties of Synthappret LKF.

TABLE VII

THE EFFECT OF A 0.5% PRECHLORINATION TREATMENT

PRETREATMENT	% SHRINKAGE							
	No Steam				2 Min Steam			
	After 3 min wash		After 45 min wash		After 3 min wash		After 45 min wash	
	Length	Width	Length	Width	Length	Width	Length	Width
None	9.2	10	19.8	12.4	1.5	0.6	3.2	2.4
0.5% Chlorine by the Melafix DM Process	8.0	3.6	25.3	8.0	3.0	0.6	7.2	2.0
0.5% Chlorine by treatment with Fichlor 60's at pH 4.0	9.0	6.1	21.4	8.3	2.5	2.8	8.4	6.6
0.5% Chlorine by treatment with Fichlor 60's at pH 6.0	8.2	6.4	24.4	10.6	2.1	3.3	7.8	5.9

(Punto-di-Roma structure treated with 2.5% Synthappret LKF applied to a Punto-di-Roma structure).

SUMMARY AND CONCLUSIONS

All-wool jersey structures can be stabilised in respect of both relaxation and felting shrinkage by treatment with Synthappret LKF from a perchlorethylene solution and subsequent autoclave steaming at 0.35 kg/cm^2 for 2 min.

A prechlorination treatment has a detrimental effect on the shrinkproofing properties of Synthappret LKF. Chemical pretreatment of the wool is therefore not recommended.

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THE USE OF PROPRIETARY NAMES

The fact that chemicals with proprietary names have been mentioned in this report, does not in any way imply that SAWTRI recommends them or that there are not substitutes which may be of equal value of even beter.

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