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Effect of Industrial Fusing Conditions on Fabric Shrinkage and Bond Peel Strength

by

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EFFECT OF INDUSTRIAL FUSING CONDITIONS ON FABRIC SHRINKAGE AND BOND PEEL STRENGTH

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ABSTRACT

An all-wool, an all-polyester and a wool/polyester blend fabric were each fused to the same interlining under industrial conditions. The pressure, time and temperature settings of each of 20 fusing presses in use at eight different companies were noted. The attained fusing temperature, amount of shrinkage and the strength of the bond were measured. The main findings were that the average shrinkage after conditioning was at an acceptable level. However, bond peel strengths varied from very low values to acceptable levels and no individual company or type of press produced consistent results.

INTRODUCTION

The fusing process can be described as an application of heat and pressure for definite lengths of time to an outer fabric and a fusible interlining to form a laminate. The laminate should have a high bond peel strength with acceptable dimensional stability[1,2]. It should also retain adequate bond strength after dry cleaning, wetting and flexural fatigue[1].

The quality of the fused laminate, for given fabrics and adhesive, mainly depends on the fusing parameters of temperature, pressure and time. The moisture content of the fabrics to be fused can also have a significant effect on the efficiency of the fusing process[3]. When some of the energy applied during fusing is used to dry the fabrics, the bond temperature attained may be lower especially when the water vapour so produced cannot escape from the fabric, (e.g. in the case of tray presses).

The structure and properties of the outer fabric may necessitate the use of different fusing press settings[1,4-7]. Previous workers[8-14] showed that the fusing process caused some dimensional change in the outer fabrics and interlinings, and that the amount of change (shrinkage) depended on the fusing parameters and the fabric.

The effect on shrinkage and bond peel strength of the various fusing presses at typical settings used in industry, is the subject of this investigation.

EXPERIMENTAL

Three different 2/2 twill outer fabrics were each fused to a selected interlining to produce a laminate. These were: a 100% wool worsted fabric, (mass 330 g/m^2), a 45/55 wool/polyester worsted fabric (mass 250 g/m^2) and a

100% textured polyester fabric (mass 250 g/m^2).

The interlining was a plain weave, cotton/rayon blend, (135 g/m^2), coated with a polyamide adhesive. The recommended glue line temperature of the interlining was 127 - 135°C.

Eight clothing companies were selected for this study. Twenty different fusing presses, coded A-T, including SAWTRI which provided the control results were used in the study (see Table II). The presses were: Wagner — 4, Reliant — 5, Kannigeiser — 5 and Meyer — 6.

The samples of outer fabrics and interlinings were cut and measured under standard conditions at SAWTRI and then allowed to condition in the factory fusing room under ambient conditions for a minimum of 12 hrs before being fused. The relative humidity and temperature in the fusing room were recorded and are shown in Table I. The settings of the fusing presses as used under factory conditions (temperature, pressure and time) were noted. Measurements were then made of the actual fusing time and temperature for each individual press. The pressures were not measured but taken as shown on the pressure dial of the machine. The actual fusing temperatures, that is the temperature between the outer fabric and interlining, were measured with thermostrips (IBV TM-strips). No alteration of the settings on any of the 19 industrial fusing presses was made during the experiment. It was accepted that a press may not have been operating at its optimum for the particular fabric samples used in this experiment, but it was noted that in practice more than one type of fabric were often put through the same press at the same settings.

TABLE I

TEMPERATURE AND HUMIDITY IN THE VARIOUS FUSING ROOMS

CONDITION	COMPANY							
	1	2	3	4	5	6	7	SAWTRI
Room Temperature (°C)	21	22	16	22	23	27	27	22
Relative Humidity (%)	42	55	54	43	53	43	50	65
Average temperature setting of presses	150	170	200	165	170	160	158	180

The dimensions of the fabric samples were measured prior to fusing, again immediately after fusing, and later after conditioning at standard atmospheric conditions, (20° C and 65% RH) and the percentage shrinkage calculated.

The peel strength of the bonded fabrics were determined by a standard test method (AATCC Test Method 136-1972) for the laminates after conditioning after wetting, drying and conditioning, and again after dry cleaning (one, five and ten cycles, respectively) and conditioning.

RESULTS AND DISCUSSION

FABRIC SHRINKAGE

Previous investigations[8-14] showed that fabric shrinkage in the warp direction was usually greater than that in the weft direction and both decreased during conditioning. It was also shown that the amount of shrinkage depended upon fusing temperature, pressure, time and fabric raw material.

Analysis of the present data confirmed these general trends. Because warp shrinkage was greater than weft shrinkage, the discussion is confined to the warp results, only the conditioned values being considered.

The data in Table II show that the Wagner Presses were used over a range of pressures but the times employed tended to be short. The data for the Reliant presses showed that these machines were set with medium pressures and times while the Kannigeiser presses covered medium pressures for long times. The Meyer presses were operated at low pressure and medium to long times. The temperature settings varied from 130° to 200° C settings. Pressure varied from 1 to 10 bars and time from 7s to 26s.

Effect of Conditioning

It is important that laminates (garment pieces) are similarly conditioned or alternatively allowed to recover over a period of time before sewing. Shrinkage or deformation due to differential shrinkage should then generally not be a problem. The amount of shrinkage of the fabrics measured *after conditioning*, was found to be small (see Table III).

In general the data showed that in laminate form the interlining shrank less than the outer fabric, e.g. 0,4% and 0,7%, respectively. When the outer fabric alone was subjected to the same fusing conditions the shrinkage was higher, 1,2%, which agrees with previous results[8,14]. Of the four press types considered, the Meyer presses tended to give an opposite trend to the other presses in that the interlining shrank more than the outer fabric.

Effect of Pressure, Time and Temperature on Shrinkage

The effect on shrinkage of the press settings and the types of presses used was studied by regression analysis. Although these regressions confirmed

TABLE II

EFFECT OF FUSING TIME, TEMPERATURE AND PRESSURE

TYPE OF PRESS		Fusing Conditions (Settings)			Shrinkage (%) (warp direction only, after conditioning)											
					Actual Fusing Temperature (°C)	Outer Fabric: Wool*			Actual Fusing Temperature (°C)	Outer fabric: Wool/Polyester*			Actual Fusing Temperature (°C)	Outer fabric: Polyester*		
		Pressure (bars)	Time (s)	Temperature (°C)		I	O	'O'		I	O	'O'		I	O	'O'
Wagner	A	2,0	10	150	116	0,1	0,8	1,0	118	0,6	0,2	1,0	119	0,3	0,5	1,0
	B	6,9	9	150	138	0,4	0,3	0,7	146	0,4	0,5	1,0	146	0,3	0,5	2,1
	C	10,0	10	160	110	0,2	0,4	1,1	113	0	0,5	1,2	116	0,4	0,5	1,8
	D	3,2	16	174	138	0,1	1,0	1,0	157	0,3	0,6	0,8	166	0,7	0,6	1,6
Reliant	E	3,5	18	150	116	0,4	0,8	2,0	118	0,2	0,5	1,3	121	0,4	0,8	1,8
	F	5,0	7	130	143	0,4	1,0	0,4	143	0,5	0,4	1,0	143	0,3	1,2	—0,4
	G	4,0	15	160	121	0,3	1,1	1,5	121	0,5	0,4	1,0	130	0,7	0,9	2,0
	H	5,5	15	160	127	0,4	0,6	1,6	125	0,6	0,7	1,3	132	0,4	0,8	2,0
	I	2,0	15	180	139	0,3	1,1	2,0	138	0,5	0,7	1,7	139	0,6	1,1	1,1
Kannigeiser	J	4,0	11	210	143	0,4	0,6	1,5	143	0,3	0,3	1,3	143	0,2	0,8	3,2
	K	3,0	20	170	132	1,0	1,3	1,4	135	0,2	0,6	0,7	135	0,2	1,4	1,6
	L	3,2	16	170	127	0,1	0,5	1,4	127	0,1	0,3	0,8	128	0,2	0,6	0,3
	M	3,3	25	170	132	0,6	1,4	1,6	143	0,3	0,7	1,0	152	0,6	1,2	—0,2
	N	5,2	20	132	141	0,3	1,0	—0,1	141	0,3	0,4	0,9	141	0,3	0,3	1,3
Meyer	O	4,0	15	200	143	0,2	—0,3	0,3	143	0,1	0	0,3	143	0,2	1,1	—0,3
	P	1,8	25	170	121	2,8	—1,2	0,5	119	1,0	—0,1	0,9	121	2,0	—1,7	0,7
	Q	1,0	15	180	110	0,6	0,9	0,9	116	0,7	0,5	0,9	116	0,6	1,3	—2,9
	R	1,8	24	170	116	3,8	—1,1	0,8	121	1,4	0,1	0,9	130	1,9	—1,4	—1,7
	S	1,2	16	170	143	0,4	0,3	0,6	143	0,1	0,2	0,6	143	0,4	1,0	—0,1
	T	1,1	18	164	119	0,6	0,9	1,9	117	0,3	0,7	1,3	118	0,3	0,9	1,7

*I = Interlining   O = Outer fabric   'O' = Outer fabric alone

TABLE III

EFFECT OF CONDITIONING ON THE PERCENTAGE WARP AND WEFT SHRINKAGE OF THE OUTER FABRIC OF A LAMINATE

	SHRINKAGE OF OUTER FABRIC (%)					
	All-Wool		Wool/Polyester		All-Polyester	
	Warp	Weft	Warp	Weft	Warp	Weft
Before conditioning	1,0	0,9	0,6	0,2	0,7	0,8
After conditioning	0,5	0,2	0,4	0,1	0,6	0,8

general trends the percentage fit tended to be low due to many uncontrolled conditions. Generally, shrinkage increased when either temperature, time or pressure was increased.

BOND PEEL STRENGTH

The data in Table IV show the bond strengths obtained after fusing and conditioning, and after wetting or after drycleaning.

The dependence of bond strength on pressure, time, temperature and press type was studied by regression analysis. The equations indicate the general trends found in the clothing industry and these are shown in Table V.

From these results it can be seen that under the prevailing conditions the all-wool fabric when bonded to the interlining had relatively low bond strengths, the polyester fabric gave relatively high bond strengths and the blends were intermediate.

Effect of Wetting

Generally, wetting out had no effect on the strength of the bond between the all-wool outer fabric and the interlining, the blend fabric showed a small reduction and there was a significant reduction in bond strength of the 100% polyester outer fabric/interlining laminate.

Effect of Drycleaning

Drycleaning caused reductions in bond strength similar to those after wetting.

TABLE IV

EFFECT OF FUSING CONDITIONS ON BOND PEEL STRENGTH (AFTER VARIOUS TREATMENTS)

Type of Press		Fusing Conditions (Settings)			Original Bond Strength (N)			After Wetting (N)			After Drycleaning* (N)								
		Pressure (bars)	Time (s)	Temperature (°C)	All Wool	Wool/ Polyester	All Polyester	All Wool	Wool/ Polyester	All Polyester	All Wool			Wool/ Polyester			All Polyester		
											1	5	10	1	5	10	1	5	10
Wagner	A	2,0	10	150	2,1	3,9	8,3	1,7	3,1	5,4	1,4	1,2	0,9	3,2	3,0	2,6	4,1	3,9	3,2
	B	6,9	9	150	8,5	20,0	22,7	9,1	12,5	13,2	7,9	6,8	8,9	13,7	10,3	10,8	15,4	11,5	11,0
	C	10,0	10	160	10,7	12,8	22,4	10,4	11,9	13,9	8,8	8,1	8,5	9,8	8,4	8,5	14,7	11,5	10,5
	D	3,2	16	174	4,0	6,1	10,6	4,6	6,0	8,7	3,5	3,7	3,2	5,1	5,2	5,7	7,1	7,1	7,7
Reliant	E	3,5	18	150	5,0	9,1	21,4	4,5	7,1	12,9	3,5	3,0	2,9	6,3	5,7	5,9	13,3	10,8	4,9
	F	5,0	7	130	2,3	4,6	16,6	2,0	3,7	8,9	1,7	1,5	1,5	3,4	3,1	2,6	10,0	9,3	8,4
	G	4,0	15	160	6,4	11,0	24,0	6,2	8,2	11,7	5,8	5,5	5,7	6,3	5,8	5,8	11,5	9,6	9,3
	H	5,5	15	160	4,8	11,7	22,6	5,6	10,8	14,2	5,7	5,5	6,2	10,5	9,6	8,6	15,9	15,4	15,9
	I	2,0	15	180	5,1	12,0	17,1	5,7	9,4	13,4	5,5	5,1	7,8	9,9	8,2	9,1	12,7	12,0	12,4
Kannigeiser	J	4,0	11	210	4,4	7,5	18,9	3,7	6,3	11,3	3,4	3,7	2,9	5,0	5,0	4,5	11,8	8,9	8,8
	K	3,0	20	170	5,0	9,5	19,2	4,4	5,1	10,8	4,4	4,5	4,7	10,5	5,3	5,3	5,7	9,3	7,9
	L	3,2	16	170	5,3	5,0	13,2	3,3	3,6	7,9	3,7	3,7	4,5	4,2	4,5	4,3	9,7	8,4	9,3
	M	3,3	25	170	8,4	8,4	18,8	6,7	6,6	12,1	6,1	5,8	5,8	6,3	6,3	6,7	14,1	12,1	12,9
	N	5,2	20	132	7,7	9,5	13,5	6,5	8,3	10,5	9,1	7,5	7,7	8,9	8,7	8,5	9,8	7,8	6,6
Meyer	O	4,0	15	200	2,8	5,2	12,3	2,9	4,5	7,2	2,6	2,7	2,5	3,8	4,2	4,0	8,0	6,7	6,5
	P	1,8	25	170	5,2	8,8	16,8	5,3	7,0	11,3	5,1	4,8	4,5	5,6	4,8	4,8	8,3	8,4	8,6
	Q	1,0	15	180	3,3	5,4	14,9	5,1	7,4	10,9	3,5	3,6	4,1	4,8	3,6	4,4	8,4	7,2	7,2
	R	1,8	24	170	7,1	9,1	21,2	6,4	8,4	12,9	7,1	6,3	6,3	7,2	5,5	6,7	14,9	11,2	10,6
	S	1,2	16	170	3,3	6,3	15,7	3,6	5,1	8,1	3,0	2,7	2,8	5,0	3,7	3,6	7,4	6,1	6,1
	T	1,1	18	164	3,7	5,9	14,4	3,5	5,9	10,7	3,9	3,2	3,6	5,1	4,7	5,3	11,6	7,4	6,9

* = No. of dry cleaning cycles: 1,5 or 10

TABLE V

REGRESSION EQUATIONS ILLUSTRATING THE EFFECT OF FUSING CONDITIONS ON BOND STRENGTH (B)

Outer fabric used (after conditioning)	Regression Equation	% Fit
All Wool	$B = 0{,}73\ PT - 0{,}0081\ D_1\ PC + 4{,}2\ D_1 + 0{,}0025\ PC - 0{,}3$	81,8
Wool/Polyester	$B = 0{,}97\ P - 5{,}1$	31,9
All Polyester	$B = 1{,}42\ P - 0{,}256\ D_1T + 9{,}8$	42,5

B = Bond strength
P = Pressure
T = Time

DUMMY VARIABLE CODING

Press	D_0	D1
Wagner	0	0
Reliant	0	1
Kannigeiser	1	0
Meyer	1	1

Effect of Ambient Conditions

Regression analysis of bond strength and of attained fusing temperature in the presses and the fusing room ambient conditions (Table I) showed that ambient temperature had no effect on bond strength or fusing temperature. The attained fusing temperature increased significantly with the relative humidity. From Table I it appears that the setting of the fusing temperature was related to the ambient humidity. This compensation was sufficient to reduce the effect of relative humidity on the bond strength which did not decrease significantly.

SUMMARY AND CONCLUSIONS

The effect on shrinkage and bond peel strength of 20 fusing presses at typical industrial settings on three different outer fabrics fused to a selected interlining has been investigated. This investigation confirmed that the amount of fabric shrinkage was dependent on fusing conditions of pressure, time and temperature, as well as the type of outer fabric. Generally, shrinkage levels (after conditioning) were low and at an acceptable level. Bond strengths in many cases, however, were not acceptable. Polyester outer fabrics or outer fabrics containing some polyester gave strong bonds and generally the all-wool outer fabrics produced lower bond strengths.

The varied settings found on similar types of presses, and at the same factories in some cases, gave anomalous results.

All the presses gave an acceptable bond in the case of a polyester outer fabric while only five presses did so in the case of the all-wool outer fabric.

An increase in fusing time and pressure gave increased bond strengths.

The relative humidity and temperature of the fusing room did not have a significant effect on fabric shrinkage or bond strength.

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USE OF PROPRIETARY NAMES

The names of proprietary products, where they appear in this report are mentioned for information only. This does not imply that SAWTRI recommends them to the exclusion of other similar products.

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