(REFEREED RESEARCH)

RESEARCH CONCERNING THE HEAT-SEALED TREATMENT PARAMETERS INFLUENCE ON THE MAIN CHARACTERISTICS OF A DOUBLED ENSEMBLE

İKİ KATLI BİRLEŞTİRME İŞLEMİNİN ANA KARAKTERİSTİKLERİNE ISI İLE BİRLEŞTİRME İŞLEMİNİN ETKİSİ ÜZERİNE BİR ARAŞTIRMA

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ABSTRACT

In the manufacturing process, the heat-sealed treatment is an important step, because it contributes to the shape of the product and to dimensional stability during its use. In the heat- sealed treatment it is important to choose the proper values of pressure and temperature, correlated with the time needed for each phase, because the adhesive temperature increases as the surface temperature of the base material rises. This paper presents some results concerning the correlation between the heat- sealed parameters and some characteristics of a doubled ensemble (the detachment capacity, wrinkling recurrence and rigidity) by taking into account the direction by which the adhesive material is attached to the base one.

Keywords: Heat-sealed parameters, Capacity of detachment, Rigidity, Wrinkling recurrence.

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1. INTRODUCTİON

The garment quality is determined by the model features (fashion trend line), the materials chosen for the manufacturing process (composition, colour, structure, number, etc.), general aspect (dimensional stability), measurements, manufacturing accuracy, etc. The special finishing treatments applied on the garment and on the reinforcing materials of different parts of the product ensures a good dimensional stability when the garment is worn or cleaned. In the clothing industry there is a great variety of base and reinforcing materials. The reinforcing materials differ one from another by their surface unit mass, dimensional stability, composition, fibres orientation, manufacturing process, etc. (1,2,6,9). For these reasons, the heat-sealing parameters must be carefully correlated with the types of the adhesive and base materials, because during this process a thermo- plastic linkage is realized between them, and it must not destroy the properties of the base material. During the heat- sealing process, it is also important to correlate the parameters of the process with the setting possibilities of the equipment (the heat sealed press) in order to avoid undesirable phenomena, such as: adhesive migration on the face of the base materials, the destruction of the material, the hardening of the material, holes or spots. In a garment, different parts of it are reinforced with different types of material by using adhesives. In the industrial manufacturing process, it is very difficult to control the values of the heat- sealing parameters (temperature, pressure and treatment time) so that the final aspect of the product is evaluated by the main indexes that express the quality of the ensemble: the detachment resistance, contractions, elongations and changes in tone or colour (5, 6, 7, 8). On these terms, the process temperature should

correspond to the temperature of the adhesive adherence, for any type of process. The other parameters (treatment time and pressure) are correlated with the temperature in order to be adequate with the transformations of the base and reinforcing materials: thickness, porosity, fibre composition, etc. This study is focused on determining the influence of the treatment parameters (temperature, pressure and time) on the characteristics of a doubled ensemble (the detachment capacity, wrinkling recurrence and rigidity of the doubled ensemble) by taking into account the direction by which the adhesive material is attached to the base one.

2. EXPERIMENTAL PART (MATERIALS AND METHODS)

The experimental work plan of the study is presented in Table 1. The time of the heat-sealed treatment is the sum of the following treatment time categories:

a) The time needed to raise the temperature of the adhesive agent until it reaches the gelatine level (according to the properties of the material);

b) The needed value of the adhesive penetration into the fibres of the base material to gain strong adhesive power.

Most of the heat-sealed presses are equipped with a timer which automatically controls the pressing time. In some cases, the time needed to open or close the top plate is included in the established pressing time value. In this case, it is necessary to take into account the difference between the predetermined time and the real pressing time, because the pressure level affects both of the time categories.

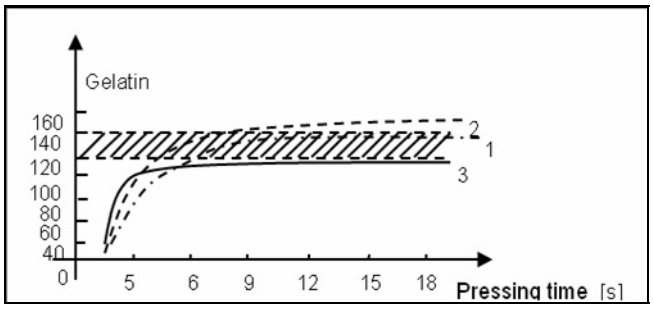


Fig 1. The variation of the gelatine temperature depending on the pressing time

Table 1. The experimental work plan

No.	Pressure value p (bar)	Temperature T (°C)	Treatment time (s)					
			18	17	16	15	14	13
1	2.5	120	1	11	21	31	41	51
2		130	2	12	22	32	42	52
3		140	3	13	23	33	43	53
4		150	4	14	24	34	44	54
5		155	5	15	25	35	45	55
6		160	6	16	26	36	46	56
7		165	7	17	27	37	47	57
8		170	8	18	28	38	48	58
9		175	9	19	29	39	49	59
10		180	10	20	30	40	50	60
11	3.5	120	61	71	81	91	101	111
12		130	62	72	82	92	102	112
13		140	63	73	83	93	103	113
14		150	64	74	84	94	104	114
15		155	65	75	85	95	105	115
16		160	66	76	86	96	106	116
17		165	67	77	87	97	107	117
18		170	68	78	88	98	108	118
19		175	69	79	89	99	109	119
20		180	70	80	90	100	110	120
21	4.5	120	121	131	141	151	161	171
22		130	122	132	142	152	162	172
23		140	123	133	143	153	163	173
24		150	124	134	144	154	164	174
25		155	125	135	145	155	165	175
26		160	126	136	146	156	166	176
27		165	127	137	147	157	167	177
28		170	128	138	148	158	168	178
29		175	129	139	149	159	169	179
30		180	130	140	150	160	170	180

The diagram (see Figure 1) shows how the base material temperature changes depending on different values of the press temperatures (140°C (1), 160°C (2) and 120°C (3)) in combination with steam. If the adhesive agent requires a gelling temperature of 120÷140°C, it takes around 7÷10 seconds to reach this level, when the temperature of the press is set at 160°C. If the base material is thin and it has a high thermal conductivity, the tolerance value of the heat shield is very narrow and a temperature of 160°C is actually dangerous. When the base material has a low thermal conductivity, the heat-sealed process must take place at 160°C with a slow rate of temperature rising. If the press temperature is fixed at 140°C, the adhesive agent will reach the gelatine temperature after 7 seconds (under standard conditions). There are situations when the temperature has a lower growth rate, even if steam is used along with pressure during the process. When the temperature is higher than 100°C (after 20 seconds), the adhesive agent may be unable to reach the gelatine temperature.

Although the experimental researches were made on a significant number of groups of material, this paper presents the results obtained for a base material used to manufacture jackets (which contains 40% rayon and 60% polyester) reinforced with a special adhesive material with melted granules. The detachment capacity, wrinkling recurrence and rigidity were determined according to the special methodology from literature (2, 9).

The experimental results of the mean values of the detachment capacity (P), wrinkling recurrence (λ) and rigidity (R) are presented in Table 2.

With the particular values from Table 2 the following polar charts were obtained (see Figures 2, 4 and 6).

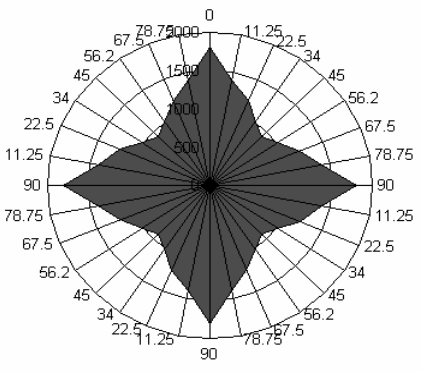


Fig 2. Polar chart of the detachment resistance after the heat sealed process

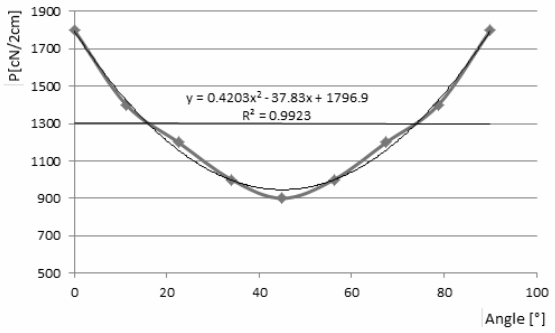


Fig 3. The correlation between the detachment resistance and the direction of the layers orientation

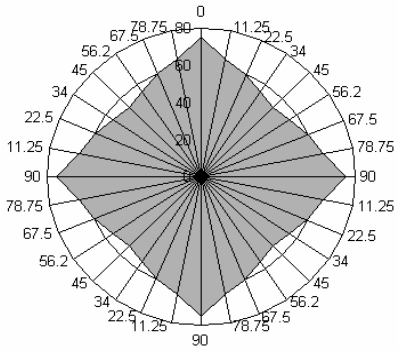


Fig 4. Polar chart of the wrinkling recurrence

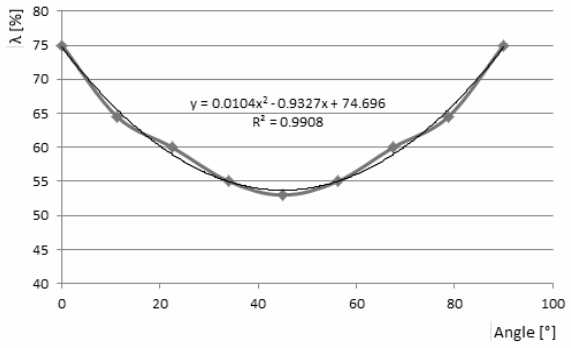


Fig 5. The correlation between the wrinkling recurrence and the direction of the layers orientation

Table 2. The mean values of the detachment capacity, wrinkling recurrence and rigidity

The angle of the heat-sealed process A(°)	The detachment capacity P (cN/cm^2)	The wrinkling recurrence λ(%)	Rigidity R(mg.cm)
0	1800	75	1500
11.25	1400	64.5	1650
22.5	1200	60	1900
34	1000	55	2200
45	900	53	2500
56.2	1000	55	2200
67.5	1200	60	1900
78.75	1400	64.5	1650
90	1800	75	1500

The values of the wrinkling recurrence (see Figure 4) are very close one to another, so the direction of the heat-sealed process has no major influence on this indicator. Also, it is important to notice that for an angle of about 45°, the wrinkling recurrence value is very low.

We can say that an appropriate arrangement of the reinforcement material on the base one is going to determine good assembling properties (the desired shape and stability).

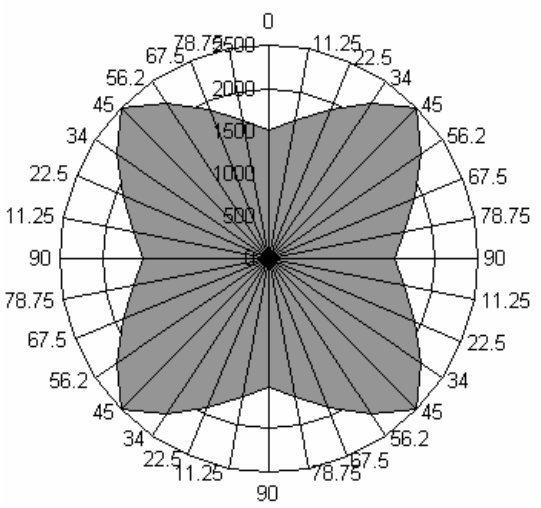


Fig 6. Polar chart of rigidity

During the heat- sealed process, the values of rigidity are different from an area to another as a result of the uneven deposition of adhesive grains. The polar chart from Figure 6 indicates that the highest values of rigidity are achieved for a 45° angle (which expresses the direction of the reinforcing material with respect to the base one) and the highest flexibility degree is achieved for 0° and 90° angles. As for the reinforcement assemble, the highest value of detachment is achieved for 0° or 90° angles, while the lowest value (the poorest resistance) is achieved for an angle of about 45° (see Figure 3). The same behaviour of the reinforcement ensemble can be noticed for the wrinkling recurrence (see Figure 5). The flexibility associated with the rigidity of the material reaches its highest values for the 0° and 90° angles and its lowest value for a 45° angle (see Figure 7).

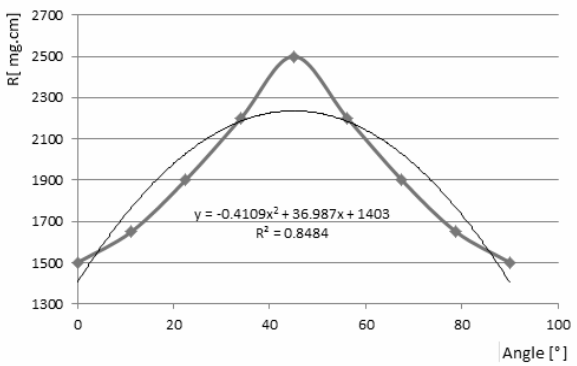
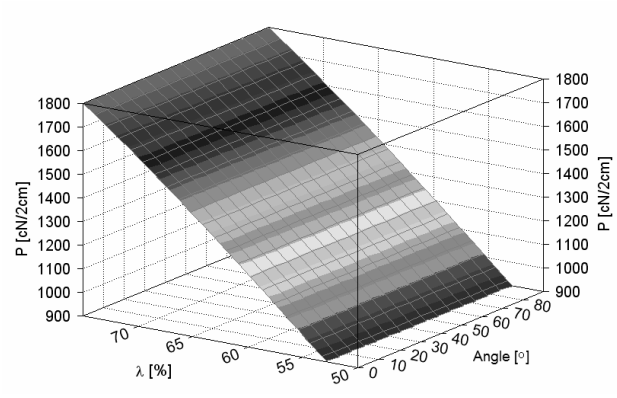


Fig 7. The correlation between the rigidity values and the direction of the layers orientation

3. RESULTS

For a good heat- sealed process (with a major influence on the quality of the garment), it is important to analyse the correlations between the detachment capacity, the direction of the reinforcing materials with respect to the base ones, the wrinkling recurrence and rigidity. Experimental data were analysed using the TC32 programme. The graphs and mathematical models are presented in Figures 8-10.



The mathematical model is:

z=a+blnx+clny, where

z – the detachment resistance (P)

y – the direction of the reinforcement material (A)
x – the wrinkling recurrence (λ)

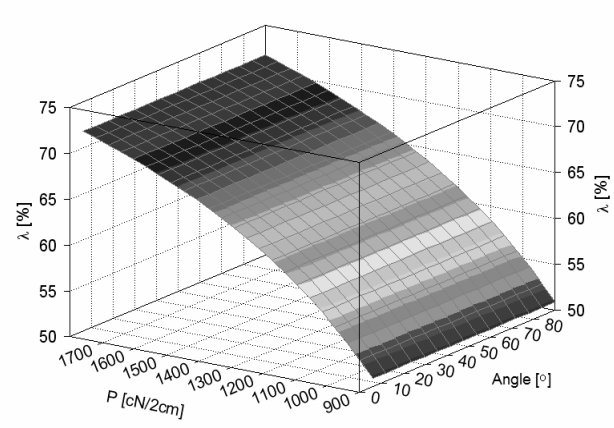
a = -9328.71

b=-0.014

c=2575.21

The value of the determination coefficient (r^2) is 0.99.

Fig 8. The dependence of the detachment capacity on the wrinkling recurrence and on the direction of the layers



The mathematical model is:

z=a+blnx+c/y, where

z –the wrinkling recurrence(λ)

y –the direction of the reinforcement material (A)

x – the detachment resistance (P)

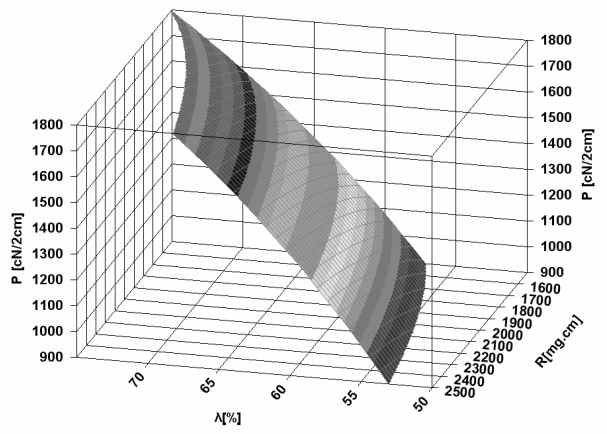
a = 92.745

b=-0.0046

c=-37684.57

The value of the determination coefficient (r^2) is 0.959

Fig 9. The dependence of the wrinkling recurrence on the detachment capacity and on the direction of the layers



The mathematical model is:

z=a+b/x+c/y, where

z – the detachment resistance (P)

y – rigidity (R)

x –the wrinkling recurrence (λ)

a = 5382.50

b=-1089807.3

c=-214680.38

The value of the determination coefficient (r^2) is 0.997

Fig 10. The dependence of the detachment capacity on the wrinkling recurrence and on rigidity

Between the heat- sealed indicators (the detachment capacity, rigidity, the wrinkling recurrence and the direction of the reinforcing material) the connections are real and not accidental (4, 7, 11). We can also say that there is a strong connection between all of these indicators, because the values of the determination (r^2) / correlation coefficient (r) are big and significant from a statistical point of view. The assembling detachment capacity reaches its highest level when the angle value is set at 0° or 90° and the wrinkling recurrence is big (see Figure 8). The wrinkling recurrence has got the same tendency (see Figure 9). The detachment resistance increases until it reaches a maximum and it will remain at this level, even if the values of the wrinkling recurrence and rigidity are still modifying.

4. THEORETICAL ASPECTS

For the materials which shrink or suffer great changes when the temperature increases, the heat- sealed treatment must be done for a long time at a low temperature. For the materials with lower contraction, it is necessary to apply a higher temperature with a lower value of pressure adapted to the properties of the material: porosity, composition and chemical treatment finishing. Using a high pressing temperature, the pressing time is reduced, because the adhesive is easily formed (the adhesive has a relatively low strength and pressure). An uniform pressure is as important as the temperature because both have equal influence on the adhesive power. The pressed power facilitates the transfer of heat from the press to the material and it kneads

the adhesive agent with the base material for an uniform adhesive power. The inner temperature represents the melting temperature of the adhesive granules. The contact temperature refers to the temperature of the heating strip or plate. It is recommended to lay the base material on the bottom plate and to place the adhesive material above it. The heat- sealed treatment runs in the sandwich. For a good treatment, the inner temperature must be around 125-130°C and the temperature which actions on the base material must be higher by about 20-25°C than the former one (7, 8, 9, 10). Sometimes, undesirable phenomena occur, not only because of the lack of correlation between the heat-sealed parameters and the properties of the material, but also because of the arrangement of the reinforcing material on the base one.

The reinforcing material is attached to the base one on different directions (measured by angle). If the value of the attachment angle is changed, some modifications may appear in the main features of the double ensemble, such as: the shrinkage of dimensional stability, rolling edges, alterations in the detachment capacity, in the wrinkling recurrence, in stiffness, flexibility, etc. (3, 5, 9).

5. CONCLUSIONS

The study about the influence of the heat-sealed process direction (expressed by angle) on the detachment capacity, on the wrinkling recurrence and on rigidity led to the following conclusions:

- The lowest value of the detachment capacity is achieved when the reinforcing material is oriented at a 45° angle with respect to the warp base material;
- If the direction of the reinforcing material is changed, the wrinkling recurrence is not changed. A 45° value of the direction of the reinforcing material will ensure a good quality of the garment;
- The reinforced ensemble will have a good rigidity and stability on both directions (warp and weft);
- The rigidity value is higher when the angle of the reinforcement material direction is about 45° (the product will have a good dimensional stability);
- The values of the wrinkling recurrence are not significantly different one from another; it is also obvious that the value registered in the polar chart for the 45° angle (the direction of the reinforcing material with respect to the base one) is lower than the ones registered for 0° and 90°;
- In the same manner it is possible to study the specific indicators of the double ensembles in which new types of reinforcing materials (non-woven, woven or padding) are used.

The appropriate choice of the treatment parameters helps avoiding undesirable phenomena, such as: surface destructions, structural changes, different contractions, modifications of the comfort properties, etc. The standard conditions are those in which the heat-sealed agent provides the necessary power for the reinforcing material to join with the base one.

In conclusion, it is important to know and use the optimal values of pressure and time in order to reach the gelatinization point for a good heat-sealed process.

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