ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

RESEARCH ON THE BEHAVIOUR OF ECOLOGIC FURS OBTAINED BY TUFTING

OANA Ioan – Pavel[1], OANA Dorina[1]

[1] University of Oradea, Department of Textiles-Leather and Industrial Management, Faculty of Energy Engineering and Industrial Management, B.St.Delavrancea str. No. 4, 410058, Oradea, Bihor, Romania,
E-mail: textile@uoradea.ro

Corresponding author: Oana Ioan-Pavel, E-mail: oanaioanpavel@yahoo.com

Abstract: *Unconventional textiles are goods obtained by methods other than the classic spinning, weaving and knitting. They are manufactured by mechanically or chemically reinforcing a fabric consisting of fiber layers or a combination of fiber, weavings, yarn or textile layers. Also, unconventional textiles can be obtained by mechanically or chemically reinforcing a yarn pattern or multiple yarn patterns. The tendency of the industry to increase production of synthetic fibers în comparison to natural fibers is also visible în the field of unconventional textiles. Additionally, there is more and more emphasis on using fibers recovered from recycled materials and products which resulted from a classic textile manufacturing process.*
A TUFTING product is made from a backing fabric, usually cloth, reinforced with yarn introduced through the fabric in loops spaced equally relative to the stitches, and raised at the ends.
The fur substitutes can also be obtained with unconventional TUFTING technologies, by reinforcing a backing cloth and then undergoing a final reinforcement by raising and felting on one side.
The TUFTING product obtained by reinforcing and weaving can be used în the manufacturing process because it is predisposed to unraveling and has an inadequate aspect.
For an optimal uniformity în Tufting fur substitutes, it is recommended that the backing cloth has a mean apparent density of 300Kg/m^3 with a 5% irregularity. It is recommended to use the goods for manufacturing childen's clothing, coat linings and children's hats.

Key words: *knitting, raising, breaking strength, tensile strength, apparent density*

1. INTRODUCTION

For TUFTING products, the technological process consists of all the operations that the yarn for the tuft loops and the backing fabric have to undergo to become the final product [1],[2]. For TUFTING products, the raw material comes on bobbins, and the backing cloth is bundled în rolls. The diagram of the technological process for manufacturing TUFTING fur substitutes is shown în figure 1. In the paper there are also instructions on how to use TUFTING fur substitutes for manufacturing clothing.

2. CHARACTERISTICS OF TUFTING GOODS FOR FUR SUBSTITUTES

The characteristics of TUFTING goods for fur substitutes are:

2.1. Finding the thickness, mass per square meter and apparent density.

To determine these characteristics, 10 samples were manufactured, each in the shape of a 100x100 mm square.

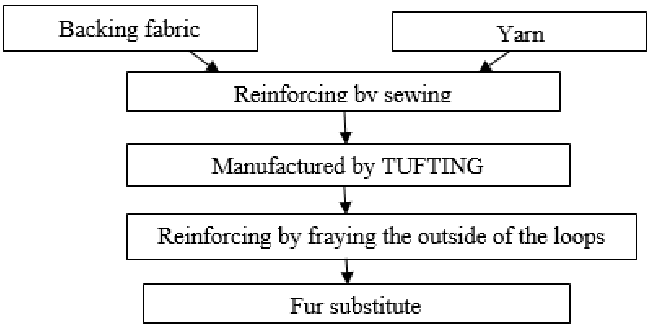

Fig. 1: *The diagram of the technological process for obtaining TUFTING fur substitutes*

The samples were weathered for 25 hours. The thickness was found by using a DM-100 disk micrometer, and mass was determined with the help of an analytical balance with 0,1 mg readability. Mass per square meter can be calculated based on the mass of each sample, using the relationship [3]:

$$Mmp = \frac{m_i}{0,01}, \ [g/m^2] \tag{1}$$

Apparent density is the mass per unit of volume of weaved textiles, which include capillary pores and air in the fabric. The relationship is as follows:

$$\gamma = \frac{Mmp}{d}, \ [kg/m^3] \tag{2}$$

- Yarn usage for reinforcing one square meter of backing fabric

After weighing the ten 100x100m samples, the quantity of yarn used to reinforce one square meter of backing cloth can be calculated:

Backing cloth M_{mp1}=118,8 [g/m^2]

Tufting good M_{mp2}=396,32 [g/m^2]

The quantity of yarn needed for reinforcing one square meter of backing cloth:

$$M_F = M_{mp2} - M_{mp1} = 396,32 - 118,8 \tag{3}$$

M_F=277,52[g/m^2]

2.2 The final reinforcement by raising is done by using certain machines configured with well-determined parameters.

Raising the goods is extremely important, the plush is set exclusively by sewing. The process takes place in order to prevent the unraveling of the loops. Raising is done on a Lamperti raising machine with needle rollers [3,4].

- Technological losses derived from raising

After weighing the ten 100x100m samples, the yarn used to reinforce one square meter of backing cloth and the losses derived from raising can be calculated.

M_F=277,52[g/m^2]

Reinforced product: M_{mp3}= 322,19[g/m^2]

Mass of yarn in the reinforced product: M_F=203,39[g/m^2]

Losses derived from raising:

$$Ps = Mf - MF, \ [g/m^2] \tag{4}$$

Ps= 277,52-203,39

Ps= 74,13[g/m^2]

Table 1: *The values obtained by calculating apparent density*:

No.	Thickness d [mm]	Mass m [g]	Mass per sqm [g/m^2]	Apparent density [kg/m^3]
1	2,45	4,109	410,9	167,714
2	2,45	4,182	418,2	170,693
3	2,47	4,184	418,4	169,392
4	2,4	4,160	416,0	173,333
5	2,36	4,124	412,4	174,745
6	2,4	3,810	381,0	158,75
7	2,41	3,731	373,1	154,813
8	2,4	3,783	378,3	157,625
9	2,38	3,802	380,2	159,747
10	2,41	3,747	374,7	255,477
Σ	24,13			1642,289

Table 2 shows the irregularity in the thickness of the TUFTING goods. Table 3 shows the irregularity in the apparent density of TUFTING goods

Table 2: *Irregularity in the thickness of the goods*

No.	di	di-d	(d1-d)^2
1	2,45	0,037	0,0013
2	2,45	0,037	0,0013
3	2,47	0,057	0,0032
4	2,4	0,013	0,00016
5	2,36	0,053	0,0028
6	2,4	0,013	0,00016
7	2,41	0,003	0,00009
8	2,4	0,013	0,00016
9	2,38	0,033	0,0010
10	2,41	0,003	0,00009
Σ	24,13		0,01

Table 3: *Irregularity in the apparent density of the goods*

No.	mi	mi-m	(m1-m)^2
1	167,714	3,485	12,145
2	170,693	6,464	41,784
3	169,392	5,163	26,657
4	173,333	9,104	82,884
5	174,745	10,516	110,588
6	158,75	5,478	30,018
7	154,813	9,415	88,659
8	157,625	6,603	43,611
9	159,747	4,481	20,087
10	155,477	8,751	76,595
Σ	1642,289		533,028

2.3. Calculating the yarn length for one stitch

The length of a stitch can be determined practically or by using a formula for calculating it. In the first approach, 30 yarns were unraveled from one 100x100m sample, not before counting the stitches corresponding to each yarn [5]. Each yarn was measured and after the calculations, the values in table 4 were found:

Table 4: *Computation of the yarn length*

No.	Yarn length per 100 mm L[mm]	No. of stitches per 100mm	Yarn length for one stitch	li-l	(li-l)^2
1	277	30	9,233	0,141	0,019
2	280	30	9,333	0,041	0,0016
3	283	30	9,4	0,026	0,0067
4	281	30	9,266	0,008	0,000064
5	284	30	9,466	0,092	0,0084
6	283	30	9,433	0,059	0,0034
7	287	30	9,566	0,192	0,0036
8	284	30	9,466	0,092	0,0084
9	282	30	9,4	0,026	0,00067

10	288	30	9,6	0,226	0,0051
11	284	30	9,466	0,092	0,0084
12	276	30	9,2	0,174	0,03
13	282	30	9,4	0,026	0,00067
14	285	30	9,5	0,126	0,015
15	270	30	9	0,374	0,0139
16	280	30	9,5	0,126	0,015
17	275	30	9,466	0,092	0,0084
18	284	30	9	0,374	0,139
19	275	30	9,333	0,041	0,0016
20	274	30	9,166	0,208	0,043
21	276	30	9,466	0,092	0,0084
22	275	30	9,166	0,208	0,043
23	287	30	9,133	0,241	0,058
24	283	30	9,2	0,174	0,03
25	285	30	9,5	0,126	0,015
26	287	30	9,966	0,192	0,036
27	283	30	9,433	0,059	0,0034
28	288	30	9,6	0,226	0,051
29	282	30	9,4	0,026	0,00067
30	284	30	9,466	0,092	0,0084
Σ		30	281,244		0,783

Next, the following will be calculated:

- Average length

$$L = \frac{\sum li}{30} \tag{5}$$

$L = \frac{281{,}224}{30} = 9{,}374$ mm

- Standard deviation

$$S = \frac{\sum(li - l)x^2}{n-1} \tag{6}$$

S=0,164

- Variation coefficient

$$Cv = \frac{S}{L} \cdot 100[\%] \tag{7}$$

$CV = 1{,}74\ \%$

Using the second approach, the yarn length for one stitch can be found with the following formula:

$$lc = 2d - 2{,}875F + 3{,}15S + \sqrt{P^2} + 2{,}25F^2 + \sqrt{S(25 - 44 - 5F + 6{,}25F^2 + 44^2)} \tag{8}$$

Lc=14,12 mm

The values of the parameters used in the formula are determined based on the product sample, and are as follows:

- Loop height: h= 3 mm
- Row size s=1,923 mm
- Stitch size p=3,125 mm
- Yarn thickness F=0,37 mm
- Backing cloth thickness d=0,399 mm
- Correlation coefficient Cv=0,66

Next we will describe the characteristics of the finished products:

- Fabric length 190±5 m
- Mass per surface unit 322,19 g/m^2

- Needle density 50±2 ace/10cm
- Number of stitches 30 stitches/10cm
- Raw material PNA 100%

To determine these characteristics, 10 samples were manufactured, each in the shape of a 100x100 mm square. The samples were weathered for 25 hours. The thickness was found by using a DM-100 disk micrometer, and mass was determined with the help of an analytical balance with 0,1 mg readability. The data obtained is shown in table 5.

Table 5: *Computation of apparent density*

No.	Thickness d [mm]	Mass m [g]	Mass per m^2[g/m^2]	Apparent density [kg/m^3]
1	4,84	3,410	341	70,454
2	4,65	3,298	329,8	70,924
3	4,46	3,315	331,5	74,327
4	4,83	3,143	314,3	65,072
5	4,93	3,207	320,7	65,05
6	4,28	3,129	319,2	74,579
7	4,35	3,188	318,8	73,287
8	4,36	3,069	306,9	70,389
9	4,36	3,154	315,4	72,339
10	4,6	3,243	324,3	70,5
Σ	45,66	32,219		706,921

Tensile strength is determined with the help of the dynamometer. The value of the load upon breaking P can be read directly off the scale shown on the gauge [6]. The elongation upon breaking can also be read on a drawn scale, its value expressed in mm. Table 6 shows the values of the load upon breaking and resistance to tear.

Table 6: *Values of the load upon breaking, elongation and resistance to tear*.

Load upon breaking	U	55	52	50	47	50	50,8
	B	38	37	38	43	37	38, 6
Elongation	U	32	33	30	35	30	32
	B	29	30	32	30	27	29,6
Resistance to tear	U	4	6	7	7	7	6,2
	B	3	3	3	3	3	3
							AVERAGE

Table 7 shows the irregularity in the thickness of the reinforced product. Table 8 shows the irregularity in mass per surface unit

Table 7: *The irregularity in the thickness of the goods*

No.	di	di-d	(d1-d)^2
1	4,84	0,274	0,075
2	4,65	0,084	0,007
3	4,46	0,106	0,011
4	4,83	0,265	0,069
5	4,93	0,364	0,132
6	4,28	0,286	0,081
7	4,35	0,216	0,046
8	4,36	0,206	0,042
9	4,36	0,206	0,042

Table 8: *The irregularity in mass per surface unit*

No.	mi	mi-m	(m1-m)^2
1	341	18,81	353,816
2	329,8	7,61	57,912
3	331,5	9,31	86,676
4	314,3	7,89	62,252
5	320,7	1,49	2,22
6	319,2	2,99	8,94
7	318,8	3,39	11,492
8	306,9	15,29	233,78
9	315,4	6,79	46,104

10	4,6	0,034	0,001
Σ	45,66		0,506

10	324,3	2,11	4,452
Σ	3221,9		867,642

Table 9 It holds the values found for resistance to tear by abrasion.

Table 9*: The values for resistance to tear by abrasion*.

Direction	Test	Initial mass	Time t	No. of cycles	Mass of sample		Time until raised layer is destroyed	No. of cycles until destuction	Final mass
longitudinal	1	11,803	30	1800	10,951	7,21	69,5	4170	9,003
	2	13,101	30	1800	12,488	4,67	88	5280	12,111
	3	12,543	30	1800	11,893	5,18	60	3600	10,545
	average	12,482	30	1800	11,777	5,68	72,55		10,553
transversal	1	12,057	30	1800	11,025	8,55	86	5160	10,649
	2	11,999	30	1800	10,997	8,35	93,5	5160	10,737
	3	11,663	30	1800	11,061	6,02	93,5	5160	10,447
	average	11,906	30	1800	11,027	7,64	91		10,611

2.4. Susceptibility to Pilling

Susceptibility to Pilling is determined by counting the number of balls of fluff on the cloth. The sample is cut in the shape of a circle with a diameter of 60 mm. On this surface, the number of balls is counted. A Pill tester device is used to calculate the Pilling effect.

3. CONCLUSIONS

Fur substitutes can also be obtained by means of unconventional technologies such as TUFTING, which involve firstly reinforcing a backing cloth and then a final reinforcement by raising on one side. The TUFTING semi-finished goods obtained through the process of reinforcing by sewing can be used in the manufacturing process because it is predisposed to unraveling and has inadequate aspect. For an optimal uniformity in Tufting fur substitutes, it is recommended that the backing cloth has a mean apparent density of 300Kg/m^3 with a 5% irregularity.

In the final reinforcing by raising, the mass decreases by 26,7%. Raising can be done on a Lamperti raising machine. For a finished product with an average mass of 322,19g/m^2 the backing cloth represents 37% and the yarn is 62%. For the Tufting semi-product with a mass of 396,32g/m^2 the backing cloth represents 30% and the yarn is 70%.By analyzing the product its susceptibility to Pilling increases. On the transversal direction the following results were recorded: a drop in average mass from 1,906 g to 11,026 g in 30 minutes. It is recommended to use the semi-product goods for manufacturing children's clothing, coat linings and children's hats.

REFERENCES

[1] C. Preda, ”*Tehnologia textilelor neconvenţionale*” Editura Performantica, Iaşi, 2004

[2]C. Preda, „*Ştiinţa şi ingineria proceselor textile neconvenţionale*” Editura Performantica, Iaşi, 2003

[3] C. Preda, C.Preda, „*Metode şi aparate pentru controlul calităţii materialelor textile destinate confecţionării produselor de îmbrăcăminte*” Editura BIT, Iaşi,1996

[4] C. Preda, “*Structuri şi tehnologii de obţinere a materialelor textile neconvenţionale*”, Ed. BIT, Iaşi, 1997

[5] C. Preda, A.L. Leon, C. Racu, “*Textile neconvenţionale cu conţinut de fibre recuperate din materiale refolosibile*”,Editura Performantica, Iaşi, 2004

[6] S. Mitu “*Bazele tehnologiei confecţiilor textile,* ” Editura Performantica Iaşi,2005