TECHNOLOGY FOR CUSHION PRODUCTION

Associate Professor **Costică SAVA**[1], Lecturer **Mariana ICHIM**[1], Eng. **Camelia Veronica VLĂŞAN**[2]

[1]"Gheorghe Asachi" Technical University of Iaşi, Romania,
[2]S.C. 4BRANDS S.R.L., Baia Mare, Romania

REZUMAT. Lucrarea prezintă o tehnologie de producere a pernelor pentru mobilier care garantează calitatea amestecului de umplere şi uniformitatea masei pernei. Ca material de umplere pentru perne tricamerale a fost utilizat un amestec format din 60% spumă poliuretanică şi 40% poliester siliconat. Determinarea masei componenţilor a pus în evidenţă menţinerea cotelor de participare la valori apropiate cu cele prestabilite. Variaţia masei umpluturii în fiecare compartiment şi în întreaga pernă se încadrează în limitele acceptate şi depinde de îndemânarea operatorului.

Cuvinte cheie: pernă pentru mobilier, umplutură, spumă poliuretanică, poliester siliconat.

ABSTRACT. The paper presents a technology for upholstery cushion production that guarantees the quality of filling blend and the uniformity of cushion mass. A blend consisting of 60% polyurethane foam and 40% siliconized polyester has been used as filling material for three-compartment cushions. Component mass measurement has revealed that the component percentages have been kept close to the established values. The filling mass variation in each compartment and in the whole cushion fits the acceptance limits and depends on the operator skills.

Keywords: upholstery cushion, filling, polyurethane foam, siliconized polyester.

1. INTRODUCTION

Cushions are soft pillows, which are a part of the sofa, couch, bed and chair, used for comfort and support while sitting. Cushions also function as decoration for the furniture they are part of providing an inexpensive way to change the feel of the room and to express the occupant personal style. Material cushion covers are available in a large variety of fabrics (cotton, linen, wool, silk, jute, leather, artificial and man-made nature), patterns, textures and colours and bring new life into the space they are used.

Even if for some buyers the cushion appearance is of prime importance, there is another element that requires equal consideration, cushion fillings. Fillings must be light and resilient and must preserve cushion comfort and shape for years. The common cushion filling options are polyester fibres, foam, feathers, recycled materials or mixtures of these [2,3].

The polyester fibres used as filling can be either virgin or regenerated (recycled), solid or hollow, siliconized or non-siliconized, crimped or smooth. Hollow conjugated polyester fibres are also extensively used for stuffing in furniture industry. The hollows gives the fibres low weight and thermal insulation, the silicone coating prevents the fibres to stick together because of the static charge accumulation, and the conjugated fibre, due to the three dimensional crimps, gives extra resiliency and bounce.

The foam filling comes in a wide range of densities, providing different comfort levels:

- High-density foam filling - cushions are firm in nature and feel hard.
- Low-density foam filling - cushions are soft in nature and moderately firm.
- Memory foam filling - cushions filled with memory foam softens in reaction to body heat and mold in different shapes, being recommended in particular for people with muscle and joint pain.

Cushions filled with duck or chicken feathers are soft and comfortable, but must be kept out from spills because feathers do not dry properly if they get wet. Also, the cushion casing must be feather-proof to prevent feathers to slip out.

Recycled polyester is made out of recycled plastic and it is a green and sustainable alternative to virgin fibres. As plastic waste do not degrade biologically, the use of recycled polyester as cushion filling is beneficial to the environment because it prevents the plastic waste from ending up in the ocean or landfills.

Foam waste is also recycled so that it can be placed back into the production system, as cushion filling for example. In order to become raw material for cushion stuffing, the foam waste is cut longitudinally and transversally in thin rectangular parallelepiped sticks.

According to Ferguson-Pell [1], there are a series of factors that determine cushion functionality, such as:

- stability provided
- weight of the cushion
- frictional properties of the cushion and cover
- cushion thickness
- durability and the need for user maintenance.

Besides the above mentioned factors, cushion appearance and cost may influence the buying decision of a consumer.

2. TECHNOLOGICAL LINE FOR CUSHION MANUFACTURING

The technological line for cushion manufacturing installed at S.C. 4BRANDS S.R.L Company in Baia Mare is schematically represented in Figure 1.

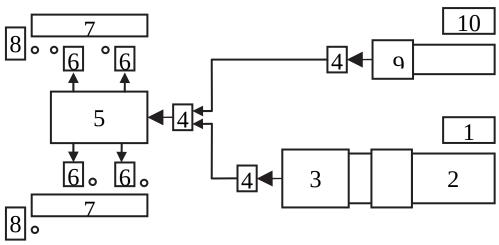

Fig. 1. Technological line for cushion manufacturing:
1 – bale of siliconized polyester; 2 – blending opener for siliconized polyester ; 3 – opener;4 – fan;5 – blending chamber(silo); 6 – table provided with a fan for stuffing the cushion casing; 7 – conveyor belt for stuffed cushion casings; 8 – sewing machine for cushion casing closure;9 – blending opener for foam sticks;
10 – bag with foam sticks.

After the first opening of the siliconized polyester fibres that takes place between the inclined lattice and the evener roller of the blending opener (Figure 2), a second more intensive opening, takes place in clamped state between the feed roller pair and the opening drum of the opener (Figure 3) [4, 5]. A fan blows the fibres to another fan situated above the blending chamber.

The foam sticks are fed manually onto the feed apron of the blending opener that pushes the material toward the inclined lattice. The spikes on the inclined lattice have been replaced with L profile metallic sheets and the evener roller has been removed because of the particularity of the foam sticks. A frequency converter is used to modify the speed of the inclined lattice of both blending openers. The speeds of the inclined lattices are correlated to each other in order to adjust the percentage of each component in the blend.

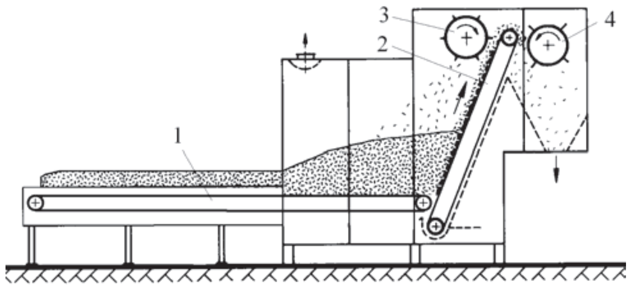

Fig. 2. Blending opener:
1 – conveyor belt; 2 – inclined lattice; 3 – evener roller; 4 – detaching roller.

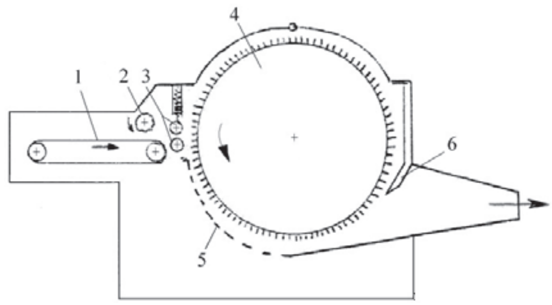

Fig. 3. Opener:
1 – feed apron; 2 – pressing roller; 3 – feed rollers; 4 – opening drum; 5 – grid; 6 – drlivery duct.

The fan mounted in the upper part of the blending chamber blows both components into the silo where their intimate mixing takes place. The silo storage capacity allows a constant and continuous running of the cushion stuffing line. From the lower part of the blending chamber, through 4 suction holes and ducts, the filling is aspired by the fans placed on the each working table (Figure 4).

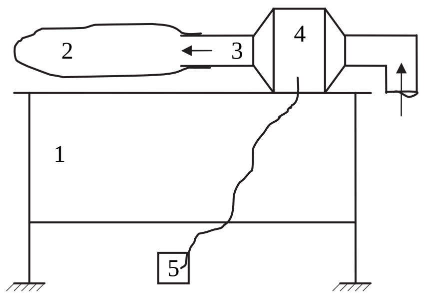

Fig. 4. Schematic representation of a table provided with a fan for stuffing the cushion casing:
1 – table; 2 – cushion casing; 3 – duct; 4 – fan; 5 – foot pedal for fun drive .

The operator introduces the opening of the cushion casing into the stuffing duct and presses the foot pedal that starts the fan. The fan aspire the filling blend from the silo as time as the foot pedal is kept pressed. After the cushion casing is stuffed, the operator weighs it so that the mass of the cushion is kept between the acceptance limits. The closure of the cushion casing is done on a sewing machine.

3. MATERIALS AND METHODS

In order to avoid the static charge accumulation that prevents an homogenous blend, the foam sticks have previously been treated with an antistatic agent, RUCO STAT APF.

Siliconized polyester fibres used as cushion filling have had the length of 32 mm and the linear density of 7.8 dtex. The silicone coating reduces the fibre-fibre friction coefficient, the electrostatic charge and the fibre tendency to lump after a period of cushion use.

The cushion casing has had three compartments and has been made of spunbond nonwoven fabric (TNT). The three-compartments casing offers the advantage of better preservation of cushion volume and shape over the years. The pores of the casing material allow air to get out, but in the same time prevents fibres to slip out.

A blend consisting of 60% polyurethane foam and 40% siliconized polyester has been used as filling material. At regular time interval, blend samples of different mass (100 g, 200 g, 300g, 400 g, and 500 g) have been taken from the silo. Each component has been separated manually from the blend and it has been weighed. The variation in time of component mass and percentage has been determined.

Also, an analysis of filling mass distribution in each compartment of the cushion casing has been done. In this regard, successive weightings of the filling mass have been done after the stuffing of each compartment of the cushion casing. The measurements have been conducted for each of the four working tables.

4. RESULTS AND DISCUSSIONS

The values of each component mass and percentage corresponding to different sample sizes are presented in Table 1 and the values of mass of filling blend corresponding to each of three compartments of the cushion casing obtained on every working table are presented in Table 2.

Table 1. **Values of mass and percentages of filling blend components**

Sample size	**100g**		**200g**		**300g**		**400g**		**500g**	
Component	**PES**	**Foam**	**PES**	**Foam**	**PES**	**Foam**	**PES**	**Foam**	**PES**	**Foam**
Mass (g)	39.6	60.3	79.2	122.0	124.0	188.8	160	244	188.8	307.1
	39.2	61.5	77.5	123.5	116.5	190.7	157.3	249	190.4	306
	39.7	60.0	80.0	121.4	117.4	190.2	155.2	245	210.4	308.8
	40.4	58.1	77.7	120	119.2	189.8	155	230	211	300.4
	41.0	59.3	78.9	121.7	118.7	180	159.4	238.5	203.7	312.2
	38.4	62.8	79.7	117	118.4	180.4	160.3	240.5	200.8	290.5
	40.4	62.4	83.0	118.8	120	180.7	167.7	248.0	191.3	288.8
	41.5	60.1	81.1	118.0	115.5	175.9	168.9	250.5	190.7	290.7
	38,1	58.2	78.4	119.9	118	176.5	162	245	188.1	299.4
	39.7	62.3	80.2	123.3	117.1	174.2	155.3	244.5	188	314.2
Average mass (g)	39.8	60.5	79.5	120.5	118.4	182.7	160.1	243.5	196.3	301.8
CV (%)	2.69	2.81	2.07	1.81	1.97	3.56	3.08	2.45	4.72	3.09
Mass percentage (%)	39.68	60.32	39.75	60.25	39.33	60.66	39.66	60.33	39.41	60.59

Table 2. **Mass of filling blend in each compartment of the cushion casing**

Working table	**1**				**2**				**3**				**4**			
Compartment	**C1**	**C2**	**C3**	**All**	**C1**	**C2**	**C3**	**All**	**C1**	**C2**	**C3**	**All**	**C1**	**C2**	**C3**	**All**
Mass (g)	488	495	513	1496	505	490	510	1505	480	490	505	1475	503	500	508	1511
	495	500	502	1497	485	490	495	1470	510	495	510	1515	500	505	505	1510
	503	485	498	1486	470	495	490	1455	490	465	480	1435	490	495	515	1500
	492	498	495	1485	498	510	505	1513	495	485	495	1475	475	495	515	1485
	505	495	500	1500	510	505	508	1523	498	500	494	1492	480	490	510	1480
	507	497	503	1507	505	503	490	1498	465	505	515	1485	510	500	495	1505
	485	495	505	1485	515	510	505	1530	485	465	520	1470	490	510	510	1510
	502	500	484	1486	500	490	475	1465	510	495	510	1515	485	475	520	1480
	497	503	490	1490	503	480	480	1463	485	505	510	1500	510	510	510	1530
	498	506	496	1500	475	475	495	1445	470	480	495	1445	485	500	490	1475
Average mass (g)	497.2	497.4	498.6	1493.2	496.6	494.8	495.3	1486.7	488.8	488.5	503.4	1480.7	492.8	498	507.8	1498.6
CV (%)	1.46	1.14	1.62	0.52	3.02	2.44	2.40	2.05	3.08	3.02	2.41	1.8	2.49	2.07	1.80	1.19

As can be seen in Table 1, regardless of sample size, the percentages of components in the blend have close values to the set percentages, therefore the adjustment of the speeds of the inclined lattices of both blending openers allows the obtaining of established composition of the filling blend. However, keeping constant the percentages of components in the filling blend also depends on the proper functioning of the two blending openers and fans, and on the quantity per metre of the fed material. If a blending opener stops, then the operator must stop the other blending opener as soon as possible because the installation does not have an automation equipment.

The values in Table 2 show that the coefficients of variation of filling mass in each compartment and in the whole cushion casing depend on the professional training, conscientiousness and skills of the operator. Skill formation is a time consuming process and is decisive for the yield of the employee and for the filling dosage precision in the cushion casing compartments.

Cushion mass variations fit the acceptance limits of ±5% of the cushion nominal mass (1500 g), between 1425 g – the minimum accepted value and 1575 g – the maximum accepted value, respectivelly.

5. CONCLUSIONS

The paper presents a technology for cushion production installed at S.C. 4BRANDS S.R.L Company in Baia Mare. The entire upholstery cushion production process is based on continuously obtaining of a good filling blend and on finding the best and precise system of casing stuffing. The presented technology of cushion production guarantees the quality of filling blend and the uniformity of cushion mass. A blend consisting of 60% polyurethane foam and 40% siliconized polyester has been used as filling material for three-compartments cushions.

Component mass measurements at regular time intervals have revealed that the percentages of the blend components have been kept close to the established values. Also, it has been concluded that the filling mass variation in each compartment and in the whole cushion fits the acceptance limits and depends on the operator skills.

REFERENCES

[1] Ferguson-Pell, M., *Seat cushion selection.* https://www.rehab.research.va.gov/mono/wheelchair/ferguson-pell.pdf, Accessed at 20.09.2019.
[2] https://snydersolutions.com/cushion-manufacturing, Accessed at 15.10.2019.
[3] https://masiasmaquinaria.com/en/industrial-solutions/home-textiles/pillow-filling-machine/, Accessed at 21.10.2019.
[4] Sava, C., Ichim, M., 2005. *Filatura de bumbac. Tehnologii si utilaje in preparatie*. Performantica. Iasi.
[5] Sava, C., Ichim, M., 2008. *Procese şi maşini în filatura de bumbac. Îndrumar pentru lucrări de laborator*, Editura Performantica, Iaşi.

About the authors

Associate Professor PhD Eng. **Costică SAVA**
"Gheorghe Asachi" Technical University of Iaşi, Romania

In 1983, Associate Professor PhD Eng. Costică SAVA has graduated the Faculty of Textile and Chemical Technology from "Gh. Asachi" Polytechnic Institute of Iasi. From 1983 to 1985 he has worked as engineer in a worsted spinning mill from Buhuşi. Since 1985 he teaches and does research at the Faculty of Textiles, Leather and Industrial Management, Department of Engineering and Design of Textile Products. In 1998 he has earned a doctoral degree in Textile Mechanical Technologies. His main fields of research are: optimization of technological parameters of spinning mill machinery, new technologies for unconventional blend spinning, manufacturing technologies for thermally consolidated nonwoven materials, manufacturing technologies for decorative cushions.

Lecturer PhD Eng. **Mariana ICHIM**
"Gheorghe Asachi" Technical University of Iași, Romania

Lecturer PhD Eng. Mariana ICHIM has graduated the Faculty of Textiles and Leather Engineering from "Gh. Asachi" Polytechnic Institute of Iasi in 1991. Currently, she is a Lecturer at the Faculty of Textiles, Leather and Industrial Management, Department of Engineering and Design of Textile Products. In 2003 she has earned a doctoral degree in Industrial Engineering. The areas of specialization and research interests are: yarn manufacture, yarn structure and properties, optimization of technological parameters of spinning mill machinery, development and characterization of innovative textiles.

Eng**. Camelia Veronica VLĂŞAN**
S.C. 4BRANDS S.R.L. Baia Mare, Romania

Eng. Camelia Veronica VLĂŞAN has earned a Master's Degree in Quality Assurance in the Textiles and Leather Area in 2017 at the Faculty of Textiles, Leather and Industrial Management from "Gheorghe Asachi" Technical University of Iasi.