ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

SC CORA TRADING & SERVICE SRL - GOOD PRACTICE MODEL IN THE FIELD OF SUSTAINABLE DEVELOPMENT OF THE TEXTILE SECTOR

GROSU Marian-Cătălin[1], ALEXAN Alexandru[2]

[1]National R&D Institute for Textiles and Leather, 16th Lucrețiu Pătrășcanu Street, 030508, Bucharest, Romania, E-mail: catalin.grosu@certex.ro

[2] S.C. Cora Trading & Service S.R.L.,43rd Mehadiei street, Bucharest, Romania, E-mail: a.alexan@romfelt.ro

Corresponding author: Grosu Marian-Catalin, E-mail: catalin.grosu@certex.ro

Abstract: *Awareness of the importance of reducing / slowing down, by any means, the level of pollution is steadily increasing and meeting this goal is an important objective at the level of the European Union. The use of natural resources is a measure that fits into this objective. SC Cora Trading & Service SRL is an example of a Romanian company focusing on the use of small and medium fineness sheared, tannery and recovered / recycled wool fibers in high value added products. The paper presents experimental results regarding the processing, on the existing technology at SC Cora Trading & Service SRL, of a 100% fibrous fiber mixture for obtaining 4 unconventional textile structures for thermal and sound insulation in the constructions area. The technological flow adopted consists of preliminary operations (sorting, cutting opening, willowing and blending), formation carded webs, cross lapped batts, 2 types of bonding operations (using steam and needle punching) and final finishing operations. The steam bonded structures are bulky: (density: 36 kg/m3 to 54 kg/m3), while the needle punching bonded ones are compact (density: 133 kg/m3 - 97kg/m3). The thermal conductivity of the obtained structures ranged from (0.0332 W/mK to 0.0392 W/mK), comparable to thermal insulation materials from basaltic fibers and does not support burning.*

Key words: *non-conventional textile structures, tanning wool, sheared wool, thermal conductivity, valorization*

1. INTRODUCTION

In Europe, each person generates annually about half a ton of waste, of which less than 40% is recovered. According to Eurostat, in some countries more than 80% of the generated waste is discarded [1]. The concern of mankind about the unprecedented environmental pollution (soil, water, air) with negative effects on climate change has convinced the authorities to take concrete measures according to the principles of the circular economy (industrial production, consumption, waste, etc.). This concern for our health and the generations to come is the desideratum of sustainable development, one of the measures being the transition to the development of ecological materials from renewable resources [2].

For millions of years, mankind has been using natural (animal and vegetable) textile fibers for current protection and comfort activities, food, health, energy, construction, art, and so on. In some industrial sectors, natural fibers are an alternative to synthetic ones, in addition have a low impact on the environment [3], they are human-friendly, the toxicity is very low (it does not generate hazardous wastes) are biodegradable and their responsible valorisation leads to a sustainable life [4].

Wool fibers are a natural source of raw material, whose local capitalization is quantitatively reduced. The wool can come from 4 major sources: sheep shearing (wool on first use with high quality fiber, not degraded); tanning of hides obtained from slaughtered animals (wool with degraded areas due to chemical and mechanical treatments applied for its extraction) [5]; reclaimed wool (obtained from pre-consumer textile waste resulting from technological processes), regenerated wool (obtained from post-consumer textiles, identified as finished products)[6]. The regenerated and recovered tanning wool shows less mechanical resistance compared to the sheared wool, under the conditions of mechanical operations.

The paper follows the technological presentation of non-conventional textile structures (NTS), designed for thermal insulation and obtained on the existing technology at company Cora Trading & Service SRL.

2. CONTEXT

2.1. SC Cora Trading & Service SRL

Among the Romanian companies that process the wool is SC Cora Trading & Service SRL, a company with Romanian capital, which has as its object the production of unconventional non-woven products (e.g. technical felts) with industrial applications. The company processed more than 50 tons of wool fiber in 2016. A significant part of the company's products are destined for export. The national competition environment and its policy required investment in high performance machines to improve the quality and productivity of products and services offered. These investments focused directly on the production of nonwoven and felts by offering both products with technical characteristics that are superior to competition and respecting dimensional characteristics through fieldwork in many sites and workplaces in the country. The company has implemented and maintains a quality management system in accordance with SR EN ISO 9000 families of standards for all product categories [7]. The company’s activity is based mainly on sheared wool fibers, thick tannery wool (considered waste of tanneries) and wool fibers recovered from the textile technological waste to develop the products with high added value. The use of natural resources and waste is a key factor in the circular economy, which stimulates innovation and recycling of waste and reduces the amount of waste dumped to landfills, fully understood by the company's management. The use of indigenous and wool textile waste by SC Cora Trading & Service SRL has environmental implications (reduction of soil, water and air pollution in areas where wool is usually burned in the field) and human health implications [7].

2.2. Wool fiber – valorization potential in construction area

The wool (natural textile fiber, which represents about 95-97% of the animal hair) has a significant potential for valorisation in technical fields due to the unique structure and properties. Wool fiber has the most complex chemical structure and is obtained by proliferation of new cells in the root (nontextile part) and subsequent migration of these cells to the stem (the textile part). The major component of the wool, which contains about 97%, is the protein (minerals with functional groups - α-amino acids) [8]. Structurally, wool fiber is made up of the cuticle (outer fiber coat, about 2-10% of its mass, which covers the fiber in its entirety, having a protective role), cortex (the basic fiber component of about 90% its mass, which determines almost all physico-mechanical and chemical properties), a medullary channel present on thick fibers with a role in the mechanical properties of it [9]. The wool fiber properties are unique, being influenced by the chemical structure, the supramolecular structure, and the morphological particularities. Among the physical-mechanical properties of wool fibers are: fineness within wide limits: 15 µm - 65 µm, length in wide limits: 30 mm - 350mm, number of crimps / cm: 1-13, hygroscopicity: <40%, etc [11, 13]. The wool exhibits good thermal insulation properties / thermal resistivity / thermal conductivity, both at low and high temperatures [10], due to the amount of stationary air between wool fibers [11]. Wool has amphoteric character, resistance to dilute mineral acids, <5% [12], good felting ability depending on fiber position relative to other fiber, heat, unity, pH, mechanical action; great spinning capacity etc.

Thanks to these characteristics, wool fibers have attracted the attention of manufacturers of thermal insulation materials at European level, which have produced fibrous products in the form of panels or rollers containing wool fibers. At national level, SC Cora Trading & Service SRL is an example of an innovation-oriented enterprise whose existing infrastructure allows the design and development of 100% wool NTSs with valorisation potential or thermal and sound insulation properties.

3. MATERIALS AND METHODS

For testing of NTSs, at Cora Trading & Service SRL, a blend of 100% fibers: 50% sheared wool, 50 % tannery wool with medium and low finesse has been established. The fiber blend was analyzed for average fineness (µm), average length (mm), breaking force and elongation at break (cN, %), content of impurities (%). Samples were taken from the impact technological flow operations (opening - sample A, willowing-mixing - sample B, carding - sample C). The NTSs were analyzed in terms of physical characteristics: thickness (mm), specific mass (g/m^2), density (kg/m^3) and thermal conductivity (W/mK).

4. EXPERIMENTAL PART

The technological flow adopted for the NTSs is shown in Figure 1. The cutting wool requires several preliminary operations (sorting, cutting + mechanical cleaning, opening) than tanned wool due to a high level of impurities. As a result of these operations, more than 50% of the vegetal and mineral impurities were removed.

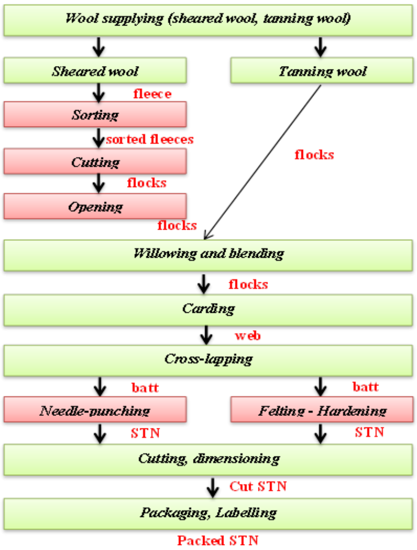

Fig. 1: *Fiber processing flow*

In the willowing operation, the two components are intensively blend, and this blend is fed to the card, where complete oppening takes place, deep cleaning, removal of a percentage of short fibers; blending, straightening, parallelizing and uniformizing and web forming of the fibers, conferring an advanced degree of individualization of the fibers. The crosslapping operation involves the overlapping of card webs under a folding angle in order to obtain semi-fabrics (fibrous layers) that can be consolidated/ bonded. Consolidation involves mechanical bonding between fibers, in order to increase the resistance of the fiber layer to the textile structure due to the progressive frictional forces between the fibers. For this research, two types of consolidation (using steam and needle punching) were used. The final operations are to prepare NTSs for use.

5. RESULTS AND DISCUSSIONS

The results of the physico-mechanical analyze of the fiber blend used for obtaining of NTS within SC Cora Trading & Service are presented in Table 1.

Table 1: *Fiber blend characteristics*

Characteristics	Reference document	Sample		
		A	B	C
Average fiber diameter (μm); CV (%)	SR ISO 137/2016	38,836; 40,162	34,693; 37,469	32,986; 36,855
Average fiber lenght (μm); CV (%)	SR ISO 6989:1998	116,65; 65,91	77,13, 90,87	64,33; 74,97
Average elongation to brerak (%); CV (%)	SR EN ISO 5079:2000	38,584; 0,227	33,266; 0,369	29,675; 0,460
Average breaking force (cN); CV (%)		56,272; 0,450	40,827; 0,612	0,637
Impurities content % -Vegetable; Dirt; Both	STAS 6710:1988	2,8; 2,7; 5,5	0,8; 3,1; 3,9	-; -; 0,8

After the fibrous processing and consolidation through the two processes (fig.1) 4 unconventional textile structures with specific masses and different thicknesses were obtained. Steam consolidation technology causes the agglomeration/bonding of the fibers from the closslaped layers as a result of simultaneous action of vibrational movement at high velocity in the presence of steam and under variable mechanical pressure. After consolidation, the thickness of the structure can be calibrated using buffers over which the oscillating plate will act. In this way, NTSs with low density (bulky) and high thickness, designed for thermal insulation are obtained. Mechanical consolidation by needlepunching involves entrainment of the fibers through the interstices of the fibrous layer. Consolidation is accomplished by reorienting / changing the direction of the fibers, which come in direct contact with the barbed needles. This type of consolidation has the effect of increasing the mechanical strength and decreasing the thickness of the fibrous layer (increasing the density). Thus, compact, higher density STNs are provided for thermal and acoustic insulation.

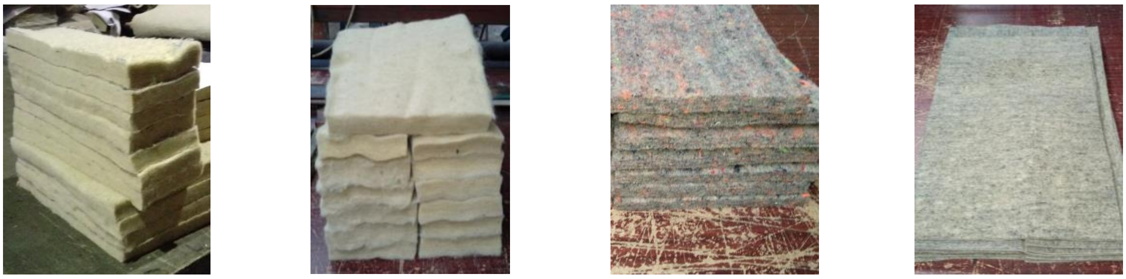

Fig. 2: *Obtained NTS*

a) S1 *b) S2* *c) S3* *d) S4*

The results of the physico-mechanical characterization of the structures obtained, encoded S1 - NTS1 steam bonded (Fig. 2); S2 - STN2 steam bonded, (Fig. 2b); S2 - STN1 needlepunching bonded (see Fig. 2c); S4 - STN2 needlepunching bonded (see Fig. 2d) are shown in Table 2.

***Table 2:** Obtained NTS characteristics*

Characteristic	NTS			
	S1	S2	S3	S4
Mass/unit area, g/m^2	2100 ± 5%	1700± 5%	2700± 5%	900± 5%
Thickness, mm	40 ± 5%	50± 5%	20± 5%	10± 5%
Density, kg/m^3	54 ± 5%	35 ± 5%	130± 5%	95± 5%
Thermal conductivity, W/mK	0.0378	0.0362	0.0392	0.0332

In terms of specific mass, S2 has a specific mass 17.29% lower than S1, this being the minimum specific mass that can be obtained through this bonding technology. Below this value, keeping the bonding conditions constant, the mechanical bonds between the fibers are not assured, so the structure does not acquire mechanical resistance. In the case of S3 and S4, the bonding technology allows obtaining large specific masses at smaller thicknesses than the S1 and S2 structures. S3 has a specific mass greater than 203.15% compared to S4. The thickness of S2 is 22% greater than S1. The S3 and S4 structures are more compact, with smaller thicknesses than the S1 and S2 structures, as the needlepunching technology trains the fibers, for bonding, through the interstices of the fiber layer (rendering compactness). Structure S4 has a thickness 55% smaller than structure S3. The value of λ for structure S2 is 4.07% smaller than S1, which means that structure S2 is better isolated than structure S1 (it has a volume of air, which is larger in structure S2, which allows a higher convective transfer than the S1 structure). Structure S4 shows an λ value of 15.34% less than structure S3. In terms of fire behavior, it can be mentioned that the 4 structures obtained do not burn or remove dangerous substances

5. CONCLUSIONS

The study reveals the potential for the use of wool fibers in unconventional textile structures for thermal insulation in construction. The proposed fibrous blend to be experimented contains the tanning wool, as considered tanneries waste and sheared wool. Two technological flows for the processing of the fibrous blend were selected for the experiments, which included preliminary processing operations, web forming operations, bonding operations and final operations.
Due to the high content of impurities of mineral, animal and vegetal origin, it was insisted on the preliminal processing operations, where the own (invented) equipment of the beneficiary was used, or with specific technological adaptations for the processed fiber blend. There were 4 NTSs experimental models, formed by two bonding ways, which were analyzed from the point of view of

the specific functionalities. The steam bonderd textile structures are bulky: S1 (~density: 36 kg/m^3), S2 (~density: 54 kg/m^3), while the needlepunching bonded ones are compact S3 (~density: 133 kg/m^3), S4 (~density: 97kg/m^3). From the point of view of thermal conductivity, the values obtained (0.0378 W/mK - S1, 0.0362 W/mK - S2, 0.0392 W/mK - S3, 0.0332 W/mK - S4) are comparable to thermal insulation materials from basaltic fibers. The obtained textile structured does not support burning.

ACKNOWLEDGEMENTS

This work was carried out under the PNIII, Programe 2: P2– Increasing the Romanian economic competitiveness, through RDI, Subprograme 2.1. Research, development and inovation, Innovation Checks 2018, Program implemented with the support of the Executive Agency for Higher Education, Research, Development and Innovation Funding, project no. PN-III-P2-2.1-CI-2018-0870 and the publication is funded by the Minister of Research and Innovation through the Program 1 – Development of the National Research and Development System, Subprogram 1.2 – Institutional Performance – RDI excellence funding projects, Contract no. 6PFE/ 16.10.2018.

REFERENCES

[1] Eurostat, Eurostat-your key to European statistics. Retrieved from Waste-related Indicators, [Online]. Available: https://ec.europa.eu/eurostat/web/waste/indicators

[2] National Academies of Sciences. (2017). Sustainable Materials and Manufacturing for Renewable Energy Technology Development to 2030 - Proceedings of a Workshop in Brief. Washinghton DC: The National Academies Press.

[3] F. D'Alessandro and G. Pispola, "*Sound absorption properties of sustainable fibrous materials in an enhanced reverberation room"*. The 2005 Congress and Exposition on Noise Control Engineering. Rio de Janeiro, 2005.

[4] M. Adnan Ali, M., and M. Imran Sarwar, (2010). "*Sustainable and Environmental Friendly Fibers in Textile Fashion - Master thesis*", Hogskolan Boras.

[5] J. R. Stevens & Co. Inc. (1970). Wool Handbook - Third Enlarged Edition (Vol. 2 (2)). London: Interscience.

[6] E. Carpus, E. Visileanu, V. Gribincea and A. Popa, (2010). Managementul deseurilor textile. Bucuresti: Certex.

[7] CORA TRADING & SERVICE SRL deținător al mărcii inregistrate Romfelt. Retrieved from Romfelt: http://www.romfelt.ro/

[8] N. Johnson, E. Wood, P. Ingham, S. McNeil, & I. McFarlane, *"Wool as a technical fibre",* The Journal of The Textile Institute, 94 (part3: Technical Textiles), 2003.

[9] D. Rama Rao and S. K. Chopra, "*The Effect of the Medulla on the Stress/Strain Properties of Wool Fibres"*. The Journal of The Textile Institute, 4, 2008, 306-308.

[10] E. Mansour, C. Loxton, R. M. Elias, and G. A. Ormondroyd, Assessment of health implications related to processing and use of natural wool insulation products. Environment International, 73, 402-412, 2014.

[11] Ionescu-Muscel, I. (1978). Fibrele textile. Bucuresti: Editura Tehnica.

[12] N. Asandei and A. Grigoriu, (1983). Chimia si structura fibrelor. Bucuresti: Editura Academiei Republicii Socialiste Romania.

[13] M. Caraiman, M. Netea, I. Taras, (1998). Filatura de lana - Fire - Materii prime - Amestecuri. Iasi: BIT.