ASPECTS REGARDING VALORIZING THE NATURAL FIBROUS MATERIALS FROM TEXTILE AND LEATHER INDUSTRY FOR COMPOSITE MATERIALS

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Abstract. Technological aspects regarding sustainable development concept and considerations on creating textile products with high added value from recycled fibres as combed and carded yarns, woven fabric waste, hosiery and leather waste. The paper offers some ways to reuse wastes from leather industry and presents some physical characteristics of some composite materials based on PVC mixed with different concentrations of leather wastes, before and after forced ageing.

Keywords: leather industry, natural fibrous compounds

1. INTRODUCTION

Mainly, textile waste results from textile processing in spinning mill, weaving department, hosiery units, chemical recondition, manufacturing, other industrial departments (staple fibres processing or textile processing mill) [1-5].

The most important manufacturing processes of the textile wastes in the shape of threads, patches, hosiery, in order to reclaim fibres, are those of cutting or size reduction and de-fibre. Resulted fibres can be used to obtain unwoven threads and textiles [6, 7].

Fibres resulted from waste recovery, in order to obtain unwoven products, are used as fibrous layers. These constitute the textile base composed of fibrous aggregations oriented in various directions. Also, it can be obtained through manufacturing processes in dry state (carding, carding – folding, aerodynamic processes etc.) and in wet processes (from suspensions of water and short fibres) [5, 6].

Recommended technologies for manufacturing textile wastes as threads, patches, hosiery have in view [7]:
- to manufacture textile waste by cutting, tearing, de-fibre and compose fibrous mixes from fibrous wastes;
- to manufacture fibres that allow processing using classical technologies as spinning and weaving;
- to manufacture fibrous mixes using unconventional technologies with machineries that assure mechanical reinforcing by interweaving or sowing – knitting or by technologies of physic and chemical reinforcing using liquid and solid adhesives.

Using textile wastes for fibrous layers impose the following endowments [7, 8]:
- process lines with cutting and ravelling machineries and garnet type card;

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- aggregates to shape the fibrous layer through carding – folding and to reinforce it by interweaving or sowing – knitting;
- aggregates to aerodynamically form the fibrous layer and to reinforce by interweaving or using liquid adhesives.

These types of wastes can be processed by plants where the manufacture systems include the following stages: textile wastes processing and strands recovery; realisation of fibrous mixes; fibrous layers forming and its reinforcing [4, 5].

Reclaimed strands destined to be manufactured by classical or unconventional spinning system are used in 70 – 80 % of cases to obtain stands with a Nm 5 - 30 finesse of yarn [1-4].

The paper represents a review on waste recovery strategies, mainly of leather wastes from leather and shoes industry. The waste quantities resulted from leather processing and few physical characteristics of some composite materials based on PVC and leather wastes in different concentrations, for reuse purposes, are presented.

2. WASTE VALORIFICATION STRATEGIES

In general, waste minimization strategy is based on: encouraging the industry to minimise the waste; increase the awareness regarding the benefits of waste minimization; establish some clean production “cells” to promote waste minimization.

As tools, one can use promotional demonstration, news, promotion of know-how trades, organisation of environment day, developing a database containing the relevant clean technologies on economic domains/promotion of clean technologies, standards and regulations, trainings.

Database structured on public module, concern module, administrator module contains the identification data for 54 economic agents that constitute a starting point for centralization of textile waste collecting – processing activity.

Processing technology of the fibrous mix in strands includes the following operations: mixing, carding, lamination, classic spinning; the control characteristics of fibres being strand length, percentage content of strands and unravelling patches.

The technical specifications have been finalized for the following products: unwoven textile products/felts; strands that contain recovered fibres; PVC based polymeric compounds and protein waste used for manufacture shoes soles, fibrous coal activated from textile wastes.

2.1. Wastes resulted from leather and footwear production

Footwear and leather industry constitutes a relative large source of raw leather wastes (see Table 1). According to material balance from the basic tanning process, with base chromium salts, for a 1000 kg of raw leather, in order to obtain 300 – 400 kg of finite leather, results a quantity of approximately 600 – 700 kg solid wastes [1, 3], to which its added a volume of 40 – 50 m³ residual waters.

Specific technologies of exploitation of un-tanned leather wastes consist of obtaining soap, glue, additives for leather processing (colour paste and lubrication products) and pharmaceutical products or medical use. Cow leather wastes, mostly chromed (70 %), are used to obtain artificial soles in mixture with soft leather wastes and de-fibred hard leather.

For a complete exploitation and efficiency of solid wastes from the dressing and manufacture process of natural leather, the actions must be aimed to:
- extend the existing production capacity for artificial soles inside or near the large tanneries, in order to eliminate shipping expenses;
- finding new areas to exploit these wastes:
a) by physic and mechanical processing to obtain construction materials or in mixes with synthetic polymers for various uses;

b) by physic and chemical processing to obtain chemical additives; cremation with heat retrieval, a more efficient method from the viewpoint of environmental protection than their ground depositing.

Table 1. Leather wastes resulted from manufacture process (thousands tone), [1].

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<td>- recyclable</td>
<td>35.2</td>
<td>15.0</td>
<td>9.36</td>
<td>4.56</td>
<td>3.87</td>
<td>5.72</td>
<td>4.34</td>
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<tr>
<td>- unrecyclable</td>
<td>24.64</td>
<td>10.5</td>
<td>6.56</td>
<td>3.19</td>
<td>2.69</td>
<td>4.77</td>
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<td>- recyclable</td>
<td>6.92</td>
<td>2.92</td>
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<td>1.12</td>
<td>1.28</td>
<td>2.35</td>
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<td>- unrecyclable</td>
<td>5.19</td>
<td>2.19</td>
<td>1.29</td>
<td>0.84</td>
<td>1.12</td>
<td>2.81</td>
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<td><strong>Raw sheep-goat skins:</strong></td>
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<td>- recyclable</td>
<td>1.73</td>
<td>0.73</td>
<td>0.43</td>
<td>0.28</td>
<td>0.44</td>
<td>1.21</td>
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<td>- unrecyclable</td>
<td>1.60</td>
<td>1.04</td>
<td>0.83</td>
<td>0.92</td>
<td>1.23</td>
<td>1.23</td>
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<td><strong>Finite leather from ready-made clothes industry:</strong></td>
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<td>- recyclable</td>
<td>0.53</td>
<td>0.34</td>
<td>0.28</td>
<td>0.31</td>
<td>0.92</td>
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<td>- unrecyclable</td>
<td>0.38</td>
<td>0.17</td>
<td>0.14</td>
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<td>0.73</td>
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<td><strong>Total, from which:</strong></td>
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<td>5.47</td>
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<td>1.22</td>
<td>1.37</td>
<td>2.34</td>
<td>1.33</td>
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<td>- unrecyclable</td>
<td>3.83</td>
<td>1.78</td>
<td>1.17</td>
<td>0.85</td>
<td>1.22</td>
<td>1.44</td>
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Finite leather wastes can be used to create polymeric composites as superficially treated filling for the optimum compatibility between polymers and protein wastes. The composite utilisation represents the main technique to obtain new plastic materials with special proprieties. The variety of materials used for filling is very large, some fillings are used for several classes of polymers and others for specific polymers.

Superficial alteration opens up new possibilities for recycling of finite leather wastes as products with high added value that lead to environmental and economic benefits. This technique consists in chemical treatment of the exterior surface of the finite leather wastes, transforming it from an inert filling agent to a reactive agent for the efficient mixing with polymeric materials or primary rubber.

In comparison to the untreated wastes, the superficially treated ones are compatible with rubber or continuous phase polymers and form weak Van der Walls like bounds, thus realising the compatibility between two completely different phases in structure and composition. Therefore, it can be used a higher percentage of finite leather waste, superficially treated, without reducing the technical quality of the product [1-3, 8].

2.2. Polymeric compounds based on finite leather wastes

Finite leather wastes can be processed thus:

1. Collecting, depositing and drying of finite leather wastes. The most adequate form for processing finite leather wastes is as fibrous mass. Obtaining the fibrous mass, in which the leather fibre size has to be as uniform and smaller as possible (µm figure), can be done only through a dry process [1, 3].

2. Milling of finite leather wastes was realised through several processes:
   - cryogenic milling;
   - grinding in a mill equipped with knives and sieves;

3. The superficial treatment of the grinding was made in encapsulated mixers, in presence of some chemical agents in order to modify (methyl methacrylate) and homogenize (EVA – ethylene vinyl acetate), inserted in various proportions, that changed the mixing and homogeneity propriety of finite leather wastes. The grinding treatment technique was done in accordance with the waste type and the changing agent percentage.
4. The mixes were done on a laboratory rolling machine with electrical heating system from a mixer with heated jacket. The compounds were made in a PVC matrix with different breakdown and by superficial treatment with metal material of the leather waste surface [1].

5. The chemical, physical and mechanical characterisation of the resulted compounds was done according to the valid standard. These general working steps were adapted in accordance with the experimental results, working conditions, starting materials and the quality of the protein wastes. Experiments were oriented in order to realise a series of polymeric compounds with a finite leather waste percentage between 0 – 60 %, thus:

   - Series A1 - polymeric compounds based on 40 % plasticized PVC and protein waste (finite leather);
   - Series A2 - polymeric compounds based on 60 % plasticized PVC and protein waste (finite leather);
   - Series B1 - polymeric compounds based on 40 % plasticized PVC and protein waste (finite leather) superficially treated with methyl methacrylate;
   - Series B2 - polymeric compounds based on 60 % plasticized PVC and protein waste (finite leather) superficially treated with methyl methacrylate;
   - Series C1 - polymeric compounds based on 60 % plasticized PVC and protein waste (finite leather) treated with 10 % EVA for compatibility;
   - Series C2 - polymeric compounds based on 40 % plasticized PVC and protein waste (finite leather) treated with 20 % EVA for compatibility [1].

The hardness and elasticity variations of type A1 polymeric compounds with 10 – 60 % concentrations of finite leather wastes, for fresh, as well as artificially aged material, are presented in Figures 1 and 2.

For the polymeric compounds based on plasticized PVC and protein waste (finite leather), it can be observed the increase of hardness (Figure 1), elasticity (Figure 2) and wear (Figure 3), in all the leather waste mixes with various properties, especially for mix A1 which demonstrate that the introduction of the protein compounds have a negative influence on the physic and mechanical proprieties.

From the charts result that the leather wastes lead to a minor increase in the hardness, elasticity and wear, as well as a decrease of the breaking elongation for all studied polymeric compounds. The found changes are minimal and do not influence in a negative manner the technical characteristics of the products realised with the new materials [1].

These findings are also valid for the series of polymeric compounds based on 60 % plasticized PVC and different percentages of protein waste. It comes out that the obtained percentages of elastomeric waste used in mixing are those of 10, 20, 30 %. As well, it can be observed that the physic and mechanical characteristics change directly proportional to the quantity of protein waste inserted in compound and, after accelerated ageing, the characteristics values do not modify, thus the compounds resist in time [1].
The superficial changing and compatibility were realised by treatment of the finite leather waste under slow mixing with an active chemical agent, respectively methyl methacrylate for 24h in the presence of accelerator lucidol at room temperature. By superficial chemical treatment, it was also realised the compatibility between elastomers with the finite leather waste inserted into the mixes. In series C1 and C2 was experimented the compatibility between PVC and protein waste by inserting another polyether EVA – ethyl vinyl acetate, polymer frequently used for elastomeric compatibility [1].

In our country, are well known the issues created by the huge quantities of wastes resulted from footwear and leather industry, and also the possibilities to reduce and reuse of those wastes. Taking into consideration the high costs that involve the treatment and recovery of these wastes thus their impact on the environment to be minimal, few economic agents can afford to invest or supplementary expenses for this.

The resistance to wear variation of freshly obtained compound A1 (with concentrations from 10 to 10 percentage of leather wastes) is presented in Figure 1. Mainly, it shows an increase of wear with the increase of the leather waste percentage from the polymeric compound, over a quantity of 10 %.
3. CONCLUSIONS

Polymeric mixes based on PVC and finite leather wastes can be obtained if the leather waste is superficially chemically treated with methyl methacrylate; for compatibility, is used EVA – ethyl vinyl acetate.

The physic and mechanical characteristics are comparable with compounds without protein waste; the treated waste do not influence in a negative manner the material proprieties, mainly for percentages under 20% of leather wastes. Thus, the hardness of 40% plasticized PVC with leather wastes additions significantly increase over 20% of leather addition, on the other hand, the elasticity continuously increases with the increase of leather waste addition, both for the fresh and accelerated aging materials. In these circumstances, the reuse of the obtained composite is very important.

The technical machinability of the new material is optimal, and the classic equipment used in polymers manufacturing processes can be utilised.

The new materials can be used to manufacture soles, fittings, technical plates, the manufacturing technology is ecological because it uses wastes and no wastes are obtained from the manufacture of the finite products from this material (Figure 4).

Fig. 4. Products obtained from the protein waste manufacture.

A future solution applied in developed countries consists in the realisation of new industrial parks that include and use in common water treatment plants and pilot plant of the waste reclaim. Thus, the investment costs are smaller and easier to sustain by the economic agents.

Transposing into practice the “zero waste” desiderate by efficiently reclaiming of the textile and leather waste into products with high added value through competitive technologies requires:

- strategic facilities through public – private partnerships to realise the investments in infrastructure and technological grid of waste processing;
- efforts in development and important researches with a starting point from a new approach based on the products' life cycle, on the environmental impact of waste generating, on the introduction of new standards, as well on actions to prevent waste production.

REFERENCES

