*Polish Journal of Chemical Technology, 13, **3**, 53 — 55, 2011, 10.2478/v10026-011-0037-2*

# Present and prospective leather industry waste disposal

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In this paper general characteristics of the main leather industry waste regarding its amount reduction by thermal treatment have been presented. Both the tannery solid wastes and the sludge contain organic substances. Their energy value is more than 50% higher in comparison to hard coal (nominally 20 MJ/kg as dry material). Up to now, the considerable amounts of energy are not recovered; leather wastes are predominantly on landfill. Implementation of a comprehensive thermal method for tannery solid waste and sludge utilization can permit to solve the waste disposal problem by effective neutralization of all of the waste. Moreover, it should bring economic benefits associated with steam or hot water production and landfill tax avoiding. The study is oriented towards the practical application.

**Keywords:** leather industry, tannery waste, sewage sludge, odor, waste treatment, thermal neutralization.

## INTRODUCTION

Leather industry has been categorized as one of the highly polluting industries because of the generation of huge amount of waste, both the solid waste from leather production processes and the sludge from tannery wastewater treatment as well as gas and odor pollutions emitted into the atmosphere. A comprehensive solution of such waste disposal problem is economically and socially very important not only for Poland but other EU countries where this problem still exists. Favorable investigation results obtained of the all tannery waste thermal treatment permit to reduce the adverse effects of the tanneries activities on the environment and human health by waste landfill avoiding and cheap and effective gas pollution neutralization.

Tannery process relies on hides and skins transformation to the leather. It involves a complex combination of mechanical and chemical processes which are divided into three fundamental sub-processes: preparatory stages, tanning and crusting. The first stage may include preservation, soaking, liming, unhairing, fleshing, splitting, bating, degreasing, bleaching and pickling. Next, the pre-treated raw material is tanned. Tanning is the process which converts the protein of the raw hide or skin into a stable material which will not putrefy and is suitable for a wide variety of end applications. Crusting takes place when the treated hide or skin is thinned, retanned and lubricated. Often, a coloring operation is also included in the crusting sub-process. Usually, the tanned leather needs additionally at least finishing step, which gives the leather the required pattern gloss or waterproof qualities. The finishing operations may include oiling, brushing, impregnation, polishing, embossing, glazing and tumbling.

Then hides and skins pass through many operations, which form solid waste and are a source of wastewater with a highly pollutant concentration. Moreover, tanning activities are also associated with disagreeable odors emission as an effect of protein decomposition and the presence of sulphides, ammonia and other volatile organic compounds.

The aim of this work was to characterize all types of leather industry waste, solid, liquid and gases for their thermal comprehensive disposal.

## GENERAL CHARACTERISTICS OF THE LEATHER INDUSTRY WASTE

Out of 1000 kg of raw hide, nearly 730 kg is generated as a solid waste in leather processing. Only 270 kg of the raw material is converted into a usable product. To solid wastes generated in leather industry contribute mainly skin trimmings, fleshings, shavings, buffing dust and keratin waste. The basic division of these wastes, generally known, has been shown in Fig. 1 and their characteristics are presented below in the text.

### Raw hide and skin waste

The chemical composition of untreated hide or skin waste (fleshings, trimmings, splits, scourings) depends mainly on the kind and the quality of raw material, treatment type and process conditions. It constitutes protein as the main component. High moisture, up to 80% of water is characteristic of these materials. The amounts of fat and protein are relatively high and require to 10.5%(w/w) and up 2.5 to 10.5%(w/w), respectively. These wastes contain small amounts of mineral substances, 2–6%(w/w). Chromium compounds are not present in the material.

### Tanned leather waste

The tanned leather wastes are mainly useless splits, chrome shavings and trimmings. The chemical compositions of the waste do not differ substantially among themselves, because they come from the same chemical processing. The size and shape of individual elements are different. Water content in the waste is in range of 30–60%(w/w). They contain 3–6%(w/w) of fat, about 15%(w/w) mineral components including 3.5–4.5%(w/w) chromium as a $Cr_2O_3$[1–4].

### Sludge from wastewater treatment

Leather production generates vast amounts of wastewater because most of the tanning processes occur in solutions. About 60 $m^3$ of water is requested for 1 tone of hides processing. The wastewater contains pollution, mainly such as: unused introduced to solution chemicals, leached proteins and the products of hide and skin degradation.

The wastewater mechanical treatment causes formation of sludge and sediments, the disposal of which is therefore

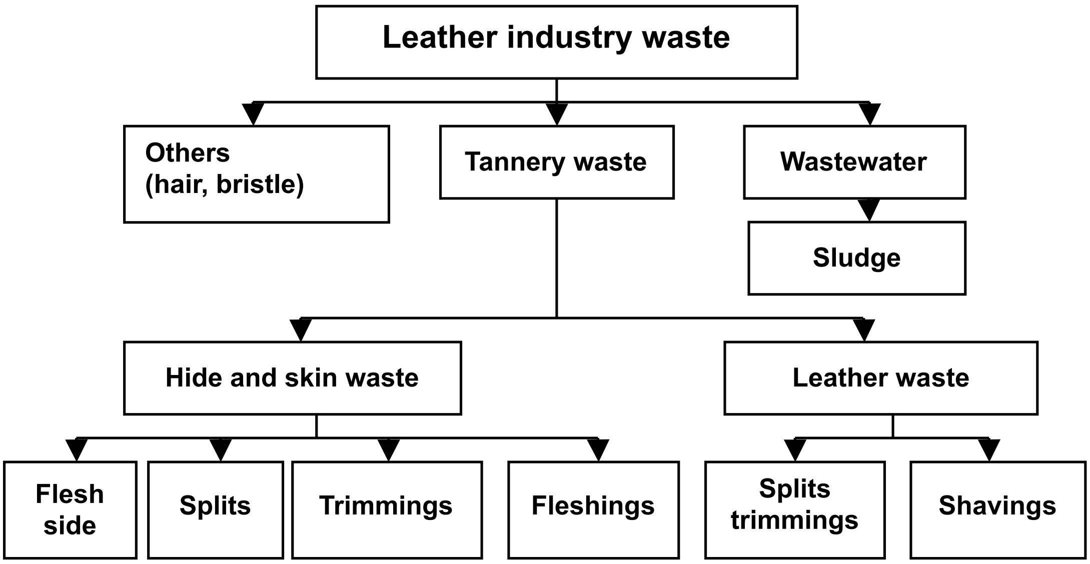


**Figure 1.** The scheme of basic tannery waste division[1]

a serious and difficult problem. Their moisture is 45– 65%(w/w), they contain about 30%(w/w) of organic substances and to 2.5%(w/w) of Cr(III) compounds. Currently, these wastes are stored on proper landfill sites[5].

**Gases and odors**

Processes and operations of hides and skins processing are proverbially known for generating malodor. Tanneries emit odor of volatile compounds of hides and skins biological decomposition and are a source of other gaseous chemicals. The type and quantity of these pollutants depends on the performed operation and applied technology. The provided studies[3] have shown the presence of ammonia, hydrogen sulphide and volatile organic compounds such as hydrocarbons, amines, aldehydes in the air. Currently, all these gaseous pollutions are emitted into the atmosphere.

## LEATHER INDUSTRY WASTE MANAGEMENT

Heretofore leather industry waste management has involved only partial utilization of the waste and mainly their storage. The non-tanned waste was used as a raw material for glue, gelatin, technical fats, protein sheaths and even feed and fertilizers. At present these wastes are not utilized. Since for fleshing all BSE-related restrictions imposed on slaughterhouse waste were applied, it became unusable. Other wastes are not treated for various, mostly economic, reasons.

The tanned leather waste used for secondary leather production as a result of Western companies competition became unprofitable in Poland[6].

In Poland leather industry converts on average several thousand tones of raw hides and skins each year while the world consumption of various types of hides is about 6.3 mln tones annually. According to research data over 55% of the processed material constitutes the waste. Thus, comprehensive waste disposal technology developing is very important.

Both the hides, skins and leather waste and biological sludge contain organic substances and thus their energy values are relatively high. They range from 50 to 60% of hard coal energy value (nominally 20 MJ/kg as dry material). The considerable amounts of heat are not yet utilized. The leather wastes are predominantly stored on landfill and pose hazardous pollution problem to environment. In Table 1 the general physicochemical characteristic of selected tannery waste is presented.

The leather dust briquettes have the highest energy value, comparable to hard coal. Finished and semi-finished leather

**Table 1.** Characteristics of some leather industry waste

| No | Kind of waste | Total organic substances content*, %(w/w) | Fat content*, %(w/w) | Moisture, %(w/w) | Combustion residue (ash), %(w/w) | Lower heating value, kJ/kg |
|---|---|---|---|---|---|---|
| 1 | Pig hide fleshing | 87.8 | 82.5 | 35.6 | 12.2 | 8 797 |
| 2 | Fleshings of cattle lime pelt | 91.4 | 70.2 | 68.3 | 8.6 | 3 824 |
| 3 | Solid waste from mechanical treatment of chromic wastewater | 65.5 | 36.1 | 49.2 | 34.5 | 7 020 |
| 4 | Trimmings of wet-blue grain leather | 86.9 | 9.0 | 63.8 | 11.9 | 4 263 |
| 5 | Trimmings of wet-blue leather semi-product split | 87.9 | 9.3 | 62.6 | 12.1 | 4 989 |
| 6 | Chrome shavings of cattle hide | 87.5 | 9.1 | 62.0 | 11.1 | 5 206 |
| 7 | Trimmings of cattle hide semi-product in crust state | 87.7 | 5.2 | 13.4 | 12.2 | 13 106 |
| 8 | Buffing dust (briquettes) | 87.4 | 5.3 | 9.8 | 10.3 | 18 349 |
| 9 | Cattle leather trimmings | 93.0 | 5.1 | 13.1 | 5.1 | 15 231 |
| 10 | Hard coal | | | 10 | 20 | 20 000 |

* in dry matter

trimmings possess also advantageous energy parameters. Definitely worse parameters characterize the strongly hydrated waste, such as fleshings, shavings, wet-blue trimmings. Definitely, the initial dehydration of these kind materials can facilitate their combustion. In order to allow wet waste dehydration, all waste combustion and flu gases burnt-out the furnace of peculiar construction is required. A tunnel furnace seems to be applicable for thermal utilization of comprehensive treatment of all types leather industry waste.

## RECAPITULATION AND CONCLUSION

Global leather industry generates 4 million tones of solid waste per year. As the economic and environmental costs of the waste disposal and the costs associated with the use of fossil fuels to generate energy continue to rise, the search for viable alternative waste solutions and sources of energy becomes increasingly critical.

Implementation of comprehensive utilization method for all types of solid tannery waste and sludge permits to obviate waste deposition and to solve the existing waste heap problem. Additionally, by a reduction of gas pollution and odors effect on the atmosphere the quality of life for people living near the tannery will improve. The thermal treatment of these wastes should cause not only the reduction in environmental burden but also it should bring the economic benefits through heat and hot water or stem production and landfill tax avoiding. Furthermore, the combustion ash containing chromium(III) compounds can be used as a chromic ore substitute in sodium chromate(VI) production technology[8,9].

## ACKNOWLEDGEMENT

The research is supported by the Ministry of Science and Higher Education (Poland) Project No N R14 0028 06/2009.

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