ENVIRONMENTAL ASPECTS FOR LEATHER FROM A LIFE – CYCLE PERSPECTIVE. PART I: METHODOLOGY

DANA CORINA DESELNICU[1], MARIAN CRUDU[2], IOANNIS IOANNIDIS[3], FEDERICO BRUGNOLI[4]

[1] *University Politehnica of Bucharest, email: d_deselnicu@yahoo.com*

[2] *INCDTP- Division Leather and Footwear Research Institute, Bucharest, email: icpi@icpi.ro*

[3] *ME-MED Consultants for Leather Industry, email: ioannidisioa@gmail.com*

[4] *SPIN360, Italy, email: brugnoli@spin360.biz*

The goal of this paper is to quantify the environmental impact of new pre-tanning technology with Ti-Al tanning agents, developed during the execution phase of INNOVA-LEATHER project, as well as the thereof assertion of their improved environmental performance when compared against commercial chromium (III) tanning, currently applicable for the production of eighty five per cent of the total volume of finished leathers by the tanning industry worldwide. LCA study was performed using the GaBi 6.0. software and databases in accord with the ISO standard 14044:2006: Environmental management - Life cycle assessment - Requirements and guidelines. Part I of this paper presents the methodology and data collection activities.

Keywords: leather, LCA, chrome tanning, Ti-Al tanning, carbon footprint

INTRODUCTION

As a central objective of the Europe 2020 strategy, the EU as a whole aims to reduce GHG emissions (including emissions from international aviation) by 20 % compared to 1990 levels. By 2020, the national targets will collectively deliver a reduction of around 10 % in total EU emissions from the non-EU ETS sectors, and a 21 % reduction in emissions for the sectors covered by the EU ETS (both compared to 2005 levels). This will accomplish the overall emission reduction goal of a 20 % cut below 1990 levels by 2020, as stated by EUROSTAT in 2013.

Leather industry falls into the category of industries of medium polluting the environment. Over time, four main problems were identified, whose resolution has a significant impact on the economic efficiency of leather processing at industrial level and on the environment: (i) Industrial water consumption; (ii) Cumulative energy consumption (equivalent consumption of oil and/or coal); (iii) Pollution reduction; (iv) The necessary active chemical compounds used in the process *(*auxiliary chemical substances and their adjuvants).

In the last decade, the entire philosophy of development of leather processing and related sectors (especially the production of chemical auxiliaries) was centered on solving the third problem, namely the reduction of pollution.

Chrome tanning is the most common type of tanning in the world. Chrome waste from leather processing poses a significant disposal problem. It occurs in three forms: liquid waste, solid tanned waste and sludge. In most countries, regulations governing chrome discharge from tanneries are stringent. Today, all tanneries must thoroughly check their waste streams. Chrome discharge into those streams is one of the components that have to be strictly controlled.

Many researches were developed to find alternative free of chrome (FOC) tanning technologies. FOC tanning technologies include the use of tanning agents based of titanium-aluminum (Adiguzel Zengin *et al.*, 2012; Mutlu *et al.*, 2014, Crudu *et al.*, 2014; Deselnicu, V. *et al.*, 2012; 2014), which in combination with other retanning agents of vegetable or synthetic origin, allow obtaining quality leathers that may be used by footwear and upholstery industries.

Interest has been developed in estimating the total amount of GHG produced during the various stages in the life cycle of products. The outcome of these calculations, are referred to as Product Carbon Footprints (PCFs). The Carbon footprint of a product is defined as the "weighted sum of greenhouse gas emissions and greenhouse gas removals of a process, a system of processes or a product system, expressed in CO_2 equivalents" referred to a product system.

In case of finished leather, the carbon footprint is expressed as: Kg of CO2eq/m^2 of finished leather (Brugnoli *et. al*., 2012).

The goal of this paper is to quantify the environmental impact of new pre-tanning agents and technologies developed during the execution phase of INNOVA-LEATHER project, as well as the thereof assertion of their improved environmental performance when compared against commercial chromium (III) tanning.

The developed LCA study is a cradle-to-gate approach, evaluating the environmental impact of the finished leather starting with the slaughtering of the cattle, preservation of the raw cattle hides (by treatment with salt), and tanning of the raw salted hides through all core processes until finished leather, taking into consideration the impact of electricity production, water, chemical substances, natural gas production etc., as well as wastes and waste water treatment, water pollutants and air emissions. The agricultural phase is not included in the system boundaries, and cattle husbandry phases are taken into consideration as bringing a zero impact.

METHODOLOGY

The study has been conducted in Romania, since raw material resourced only from Romanian cattle livestock, slaughtered and flayed in Romania, whereas the establishment of the slaughterhouse, tannery and the investigating Institute - ICPI is in Bucharest (Romania). All core processes operations (mechanical, chemical) took place in the tannery.

The study follows the indications of Standard ISO 14044:2006: *Environmental management - Life cycle assessment - Requirements and guidelines.* The GaBi software 6.0. and databases were used in this study.

Product Systems and Boundaries of the LCA Study

Two product systems (technologies) were studied and compared, namely:

S1: Chrome tanned finished box calf upper full grain embossed upper leather sides (1.2 / 1.4 mm), destined for the manufacture of classic men's footwear.

S2: Ti-Al tanned finished box calf upper full grain embossed upper leather sides (1.2/ 1.4 mm), destined for the manufacture of classic men's footwear.

The methodological approach adapted comprises in a step-by-step approach for the identification and quantification of all consumptions and emissions of all core tannery processes for the two product systems. Upstream and downstream processes specific and background data were collected, but the environmental impacts generated were considered to be outside the boundaries of the systems.

The Functional Unit chosen as the reference for all quantified environmental impact values were one square meter (m^2) of surface area of the finished leather.

In turn, the reference flows selected for both systems were the functional unit defined as above mass equivalents of the wet salted skins, intermediate products (pelts, wet stabilized, crust, semi-finished leathers) and finished leathers, respectively.

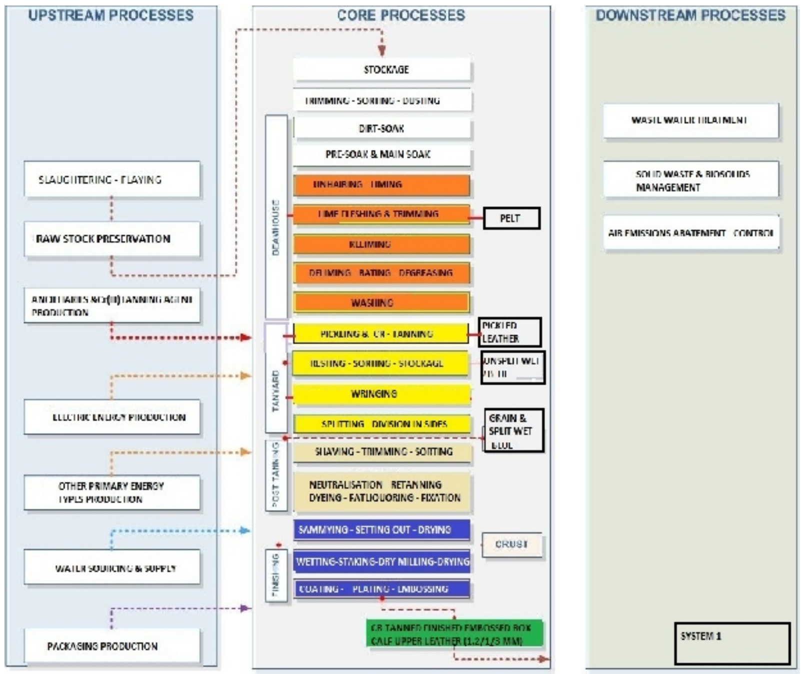

Figure 1. SYSTEM 1 (Chrome Tanning Technology) – Boundaries and outline of processes

System boundaries serve to identify the processes to include in the LCA study, as well as which data can be excluded. The system boundaries for the two technologies under study are described in Figure 1. The boundaries include Upstream processes, which take place before the tanning phases (Core processes), and Downstream processes, including phases taking place after the tanning phases.

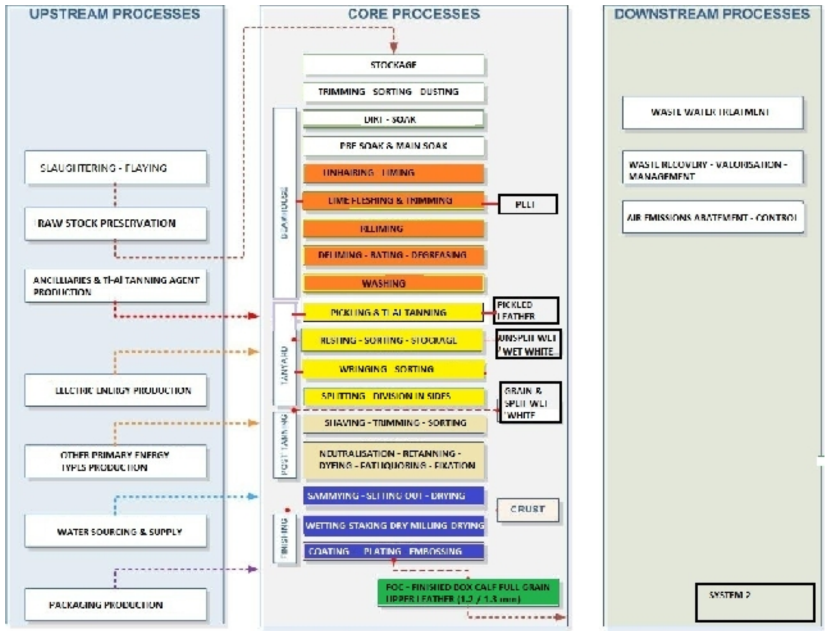

Figure 2. SYSTEM 2 (Ti-Al Tanning Technology) – Boundaries and outline of processes

Data Quality

(1) Upstream processes: Site specific data from the Slaughterhouse; GaBi databases data for the Electricity, natural gas production, water, chemical substances.

(2) Core Processes: Site specific data, GaBi databases data for the Electricity, natural gas production, water, chemical substances.

Chemical substances core inventory and cut off criteria: All chemical technologies used for the production of the two technologies have been listed, together with their specific consumption in kg.

Downstream processes: Site specific data, GaBi databases data for the Electricity, natural gas production, water, chemical substances etc. Pollutant parameters for waste water were established and measured in the final mixed waste waters: chlorides, sulphates.

Air emissions were measured over 24 hours and allocation employed for the objects of the study.

Allocation Principles

Allocation permits the attribution of a correct quantity value to an input, output and concomitantly related impact to the quantity of the specific products defined with the functional unit.

For every phase allocation coefficients have been calculated from the total produced using each of the surveyed and compared technologies). Consumptions of process water, effluent and solid waste generated, chemicals were measured directly for each aggregated phase and process per mass or surface area unit.

The machines, equipment and buildings used for the production of the two articles were not taken into consideration for the calculation of the environmental footprint and other LCA impact categories.

The data used for the LCA impact evaluation was taken from GaBi software databases, representing Romanian (or European average data where applicable) for the inputs and outputs (water, chemical substances, transportation, waste treatment, etc).

CONCLUSIONS

In the first part of the study was presented the objective, the methodology and the data collection for the LCA study in order to quantify the environmental impact of new pre-tanning agents and technologies developed during the execution phase of INNOVA-LEATHER project, as well as the thereof assertion of their improved environmental performance when compared against commercial chromium (III) tanning.

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