THE INVENTORY OF THE LIFE CYCLE FOR TEXTILE PROCESSES INVOLVED IN OBTAINING ANTISTATIC SURFACE

RALUCA MARIA AILENI, RĂZVAN RĂDULESCU, LAURA CHIRIAC, LILIOARA SURDU

National Research & Development Institute for Textiles and Leather (INCDTP), Lucretiu Patrascanu 16, Bucharest, 030508, raluca.aileni@certex.ro

This paper presents several aspects regarding life cycle inventory for processes involved in obtaining antistatic effect for textile surfaces made by synthetic fibers. The objective of use antistatic is to reduce or eliminate static electricity that is generated by triboelectric effect. The static electricity can be reduced if is used an antistatic agent for treatment in order to obtain a slightly conductive surface, a conductive surface or a hydrophilic surface in order to absorb moisture from air. For a long-term protection are used conductive agents such as carbon black, conductive fibers and conducting polymer nanofibers. The synthetic fibers in general have a very small electrical conductivity and electrostatic charges. In our paper, we present the comparative analyses (process trees and diagrams) of the inventory of the life cycle for finishing processes (classical and advanced) required in obtaining the textiles with antistatic effect. Synthetic fibers in general have a very small electrical conductivity and electrostatic charges. This fact is because they have a low hygroscopic/ hydrophilic character and the absence of water absorbed allows the build-up of static electricity. In our work, we present the process tree and several comparisons between classical process used for textile clean and plasma processes.

Keywords: antistatic, textile, life cycle inventory, conductive

INTRODUCTION

The inventory of the life cycle involves data collection about water, energy and chemical substances necessary to obtain textiles for antistatic effect. For the evaluation of the life cycle for textiles, products finished using traditional and advanced processes and technologies we consider the following inputs and outputs (figure 1):

- inputs: energy, water, chemical substances (acquisition→production→usage)
- outputs: waste, wastewater, emissions (recycling/reuse)

Figure 1. The inventory of the life cycle - the principle diagram

DATA PROCESSING BY INFORMATION TECHNOLOGY

For comparison, we consider two technological flows, the first one contains the advanced technology RF plasma and the second one was based on classical technologies. The technological flows are described in the following lines:

- **Technological flow 1:** Boiling → Bleaching → Drying → Thin film deposition (Tubicoat 41 + Tubivis DL 650 + Cu) → Drying → Crosslinking
- **Technological flow 2:** RF O₂ plasma treatment → Thin film deposition (Tubicoat 41 + Tubivis DL 650 + Cu) → Drying → Crosslinking

<https://doi.org/10.24264/icams-2018.XI.2>

For textile processes involved in obtaining textile surfaces with antistatic properties has been carried out the inventory of the life cycle (ICV) using the program SimaPro. The quantification of the environmental impact for the textile processes has been carried out using the method ECO-Indicator 99 (Curran, 2012; Sanfwon and Hupples, 2005; <http://www.ecoinvent.org>). Method ECO-Indicator 99 provides for the analysis of the impact several categories of distinct impact (<http://esu-services.ch/ourservices/lci/>), such as carcinogenic, inorganic and organic substances, climatic changes caused by the substances with the greenhouse effect, radiation protection, the changes that take place at the level of the ozone layer, ecotoxicity, acidification /Eutrophication, land-use, minerals and consume fossil fuels for power generation (<http://esu-services.ch/ourservices/lci/>; International Energy Agency, 2015).

Using SimaPro software, we used the following types of diagrams:

- Normalization diagram that allows the elimination of marginal impact that contribute to the pollution of the environment in the region concerned (Klopffer and Grahl, 2014; Werner, 2005; Steward and Weidema, 2004).

- Weighting diagram allows the results adjustment by multiplication (Steward and Weidema, 2004).

- Single Score diagram that require knowledge concerning the correlation between the emissions into the environment according in the environment and potential impact of such emissions and extractions (Suh, 2003; Nakamura and Kondo, 2009).

By comparing technological flow 1 and technological flow 2 (figures 2-5), it should be noted that the flow of technology 2 (classical processes) has the greatest impact on the environment (100% for all categories of impact), followed by the technological flow 2 that is influencing 75% by harmful substances through breathing and with 100% by ionized radiation resulting.

The energy consumption necessary to obtain textile surfaces with antistatic properties is presented by process tree method (Jolliet *et al.*, 2016).

In figure 6 is presented the process tree for the technological flow based on RF oxygen and in figure 7 is presented the process tree for the technological flow based on classical technologies. The process tree (figure 6), for the technological flow 2 –RF oxygen plasma, highlights the possibility of replacing the classic processes (cleaning, whitening) by RF plasma oxygen process and the reduction of the energy consumption with 4% and the duration of the process with 96%.

Figure 2. Characterization method - comparing technological flow 1 with technological flow 2

Figure 3. Normalization method - comparing technological flow 1 with technological flow 2

Figure 4. Single score method - comparing technological flow 1 with technological flow 2

Figure 5. Weighting method - comparing technological flow 1 with technological flow 2

The Inventory of the Life Cycle for Textile Processes Involved in Obtaining Antistatic Surface

Figure 6. Process Tree - Technological flow based on RF oxygen plasma

Figure 7. Process tree - Technological flow for classical technologies

<https://doi.org/10.24264/icams-2018.XI.2>

CONCLUSIONS

The investigation of the environmental impact by process trees and the diagrams (normalization, Single Score, Characterization, Weighting) on different categories of impact

(Eco-Indicator Method 99) is an important step in choosing the best technology flow (reduced time, tending to zero emissions and product quality), before final decision and industrial manufacturing.

In all diagrams, we can observe a significant impact of the classic technologies on fossil fuels consumption and on releasing the carcinogen and inorganics that are harmful if they enter into the respiratory system.

Acknowledgments

The research presented on this paper was prepared in the INCDTP laboratories.

This work is supported by funds from MCI, National Project "Optimizing the performance of the functional textile by advanced technologies", Contract PN 18 23 01 05.

REFERENCES

- Curran, M.A. (2012), *Life Cycle Assessment Handbook*, Wiley Publishing, USA.
- International Energy Agency (2015), *Life Cycle Inventories and Life Cycle Assessments of Photovoltaic Systems*, Report IEA-PVPS T12-04:2015.
- Joliet, O. *et al.* (2016), *Environmental life cycle assessment*, CRC Press.
- Klopffer, W. and Grahl, B. (2014), *Life Cycle Assessment (LCA)*, Wiley.
- Nakamura, S. and Kondo, Y. (2009), *Waste Input-Output Analysis*, Springer.
- Sanfwon, S. and Huppes, G. (2005), "Methods for Life Cycle Inventory of a product", *Journal of Cleaner Production*, 13(7), 687–697, <https://doi.org/10.1016/j.jclepro.2003.04.001>.
- Steward, M. and Weidema, B. (2004), "A consistent framework for assessing the impacts from resource use. A focus on resource functionality", *Int. J. Life Cycle Assess*, 10(4), 240–247, <https://doi.org/10.1065/lca2004.10.184>.
- Suh, S. (2003), "Input-output and hybrid life cycle assessment", *Int. J. Life Cycle Assess*, 8(5), 257.
- Werner, F. (2005), *Ambiguities in decision-oriented life cycle inventories*, Springer.
- ***, <http://esu-services.ch/ourservices/lci/>
- ***, <http://www.ecoinvent.org/>