LCA of a coated textile: conventional production and new process developments

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Introduction

The objective is to determine how changes in production process influence the environmental performances of coated textiles. This study is part of a GreenWin project, funded by the Walloon region in partnership with SionFabrics, Interco, Centexbel and the University of Liège. Traditionally, the textile coated with polyurethane (PU) are made using an N,N-dimethylformamide (DMF) solvent to dissolve the PU before its application on the textile. During the curing, the solvent is evaporated and the PU is coated. Nevertheless, small amount of DMF can remain in the product. As the DMF is toxic, to avoid problem of indoor air quality, a process without DMF is studied.

There are several possible substitutes to DMF that will be tested. All these possibilities will be compared from a technical point of view but also from an environmental point of view for those that obtain sufficient technical properties. In a first step, the LCA helps get a better understanding of the conventional product.

LCA of the conventional product

functional unit = 1 m^2 of coated textile - ReCiPe 2016 (v1.1) method (midpoint)

Cradle-to-gate : Raw materials production and transport and production process.

Several difficulties:

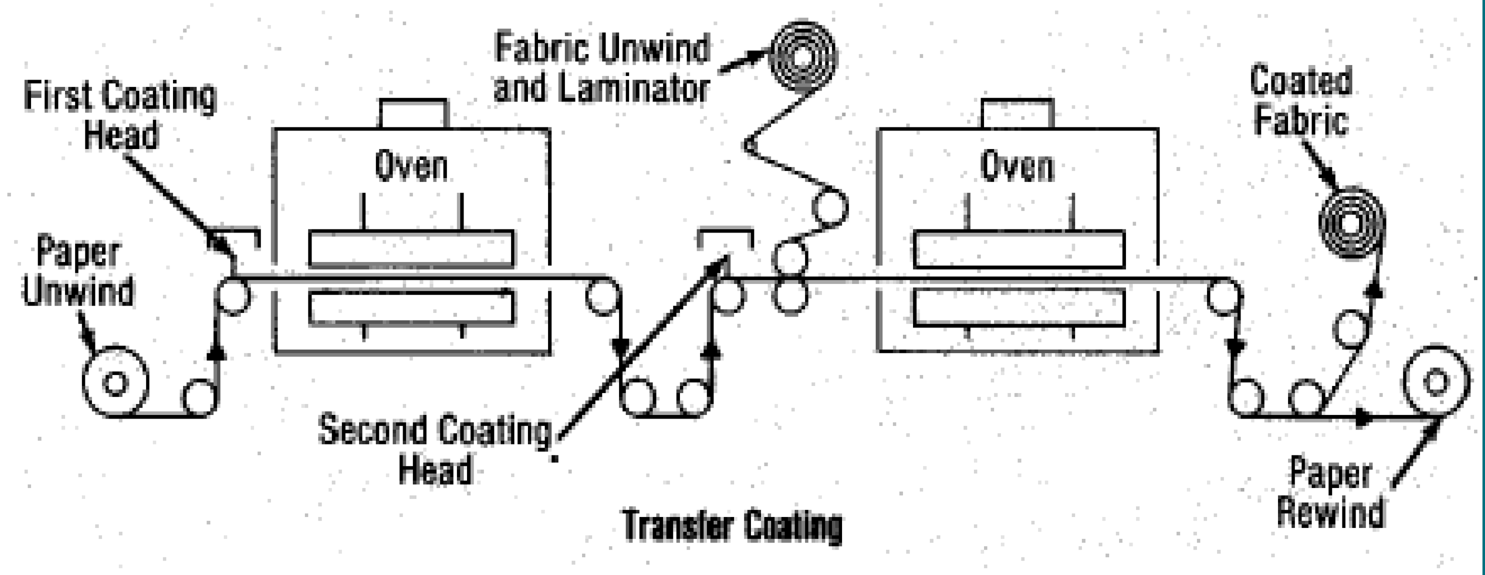
- The plant has several parts and several interconnected lines (impossible to get enough data for allocation)➔ Data collection = a challenge!
- Characterization factor for DMF for impact in toxicity categories

Inventory

Process: transfer coating process

1. PU is dissolved in DMF (+/- 25 % of PU for +/- 75 % of DMF) + additives (pigments, etc.)
2. Induction: coating of the textile.
   2.1. Drop the PU mixture on paper
   2.2. Curing of the paper (evaporation of DMF)
   2.3. Pasting of the textile on the laminated PU
   2.4. Removing of the paper + cutting of the textile

The DMF that is evaporated in the curing oven could be reused thanks to a scrubber that allow its recovery (after distillation). A part of the solvent is not recovered but go through an RTO (regenerative thermal oxidizer) for thermal valorization. The recovered heat allows to heat the oven and therefore to reduce the natural gas consumption.



The difficulties:

- Natural gas consumption unknown: only the total natural gas consumption of the plant is known (plant that produces different products – production quantities unknown. Thermodynamic calculations allow to estimate the energy consumption (validated by comparing with daily consumption/ related to specific product). Nevertheless, a lot of hypotheses (example: what is the air evaporation during the curing, etc.)
- The energy consumption for distillation is not known: use of Aspen
- The electricity consumption is not known: only the total energy consumption of the plant is known: use of power from technical datasets of the equipment

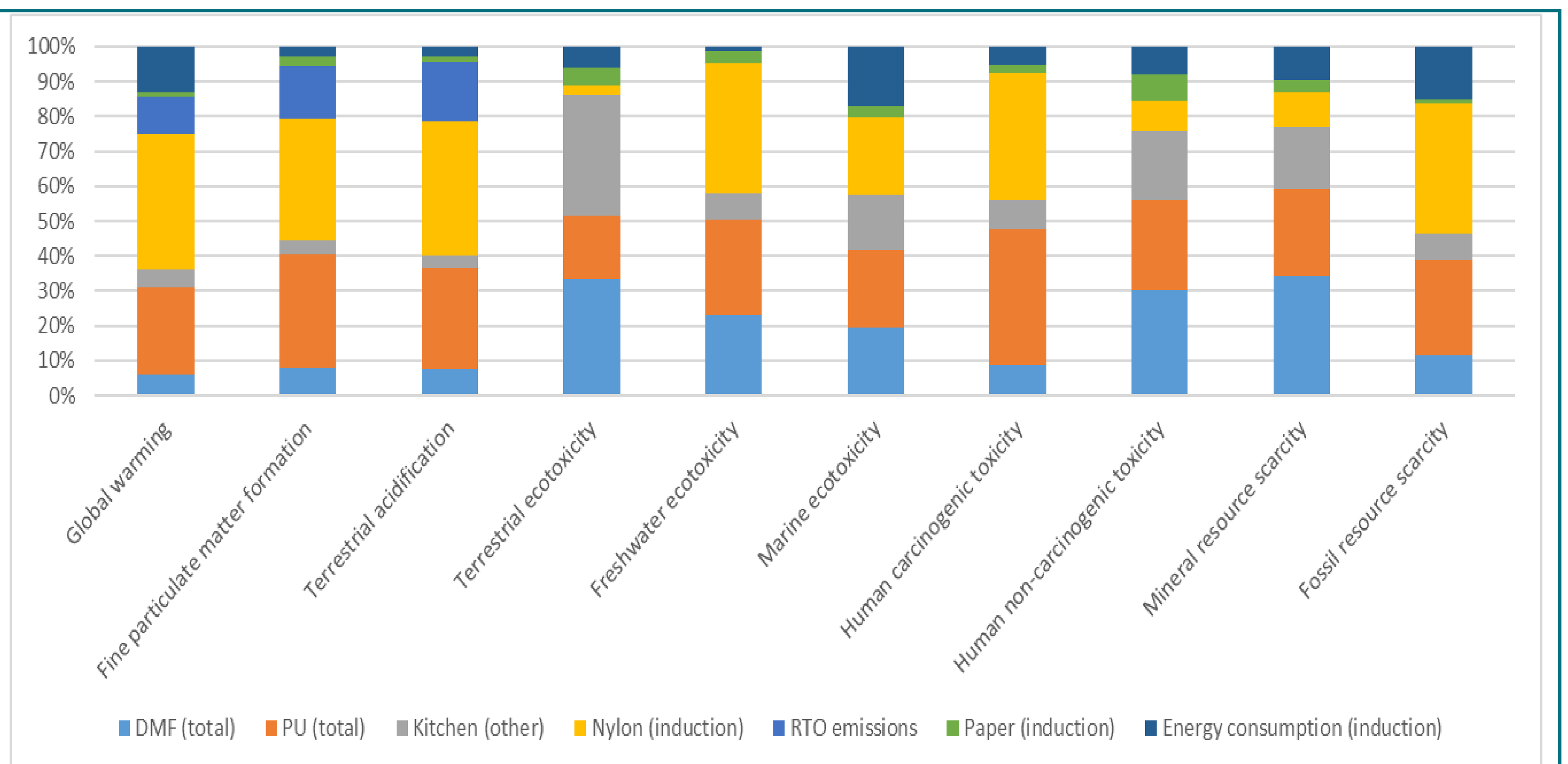
➔ Low quality data but a first step to identify hotspots where improvements are needed.

Results

This results should be used with caution because the energy consumption still needs to be determined more accurately. The distillation for DMF recovery still needs to be added.

The induction step has a large contribution in global warming potential, particulate matter formation, acidification and fossil resource scarcity, with contributions larger than 55 %. Its contribution is close to 40 % in marine ecotoxicity and in human toxicity categories. The other categories are mostly related to the raw materials for the induction layers.

The large influence of nylon production has an important contribution in global warming potential, particulate matter formation, acidification, freshwater ecotoxicity, human carcinogenic toxicity and fossil resource scarcity, and, in less extent, in marine ecotoxicity. The PU impact is at least 20 % in all the categories. The DMF contribution if especially high in terrestrial ecotoxicity, mineral resources scarcity, human non-carcinogenic toxicity, and, in less extent in freshwater and marine ecotoxicity, fossil resource scarcity and human carcinogenic toxicity.



What is important to notice, is that there are no contribution of DMF in itself in the toxicity categories. Only the dimethylamine, the main raw material used for producing DMF, has a characterization factor in toxicities categories, the DMF is not included (nor as a characterization factor, but also no emissions flow in Simapro).

Conclusions

- Data quality: a challenge!
- Large contribution of the materials (nylon, PU and DMF)
- Energy consumption data: could be a real challenge – need of engineering tools for data collection and validation. Still need to validate the distillation data.
- The comparison with no DMF products still needs to be done: same technical properties so comparison possible BUT the products are only developed in the lab or at the pilot scale so data collection is even more challenging.