https://doi.org/10.7250/CONECT.2025.096

FROM WASTE TO POLYURETHANES: ENVIRONMENTAL ASSESSMENT OF BIO-POLYOLS BASED ON USED COOKING OIL

Anda FRIDRIHSONE[1*], Arnis ABOLINS[2]

[1,2] *Polymer laboratory, Latvian State Institute of Wood Chemistry, Dzerbenes str. 27, Riga, LV-1006, Latvia*

[*] ***Corresponding author.*** *Email address: anda.fridrihsone@kki.lv*

Abstract – Used cooking oil (UCO) is a valuable resource that can be utilized in different ways, from animal feed and biodiesel production to bio-based feedstock for polymeric materials. UCO is a cheap, renewable resource that can be utilized as an input to produce polymer precursors like polyols, the starting material for polyurethane. Due to the fact that the European Union has recognized the bio-based industrial sector as a priority area for sustainability, it is crucial to evaluate the environmental performance of bio-based products. UCO was successfully employed to synthesize bio-polyols that will be used to produce a two-component polyurethane system. Experimental results at the laboratory showed that UCO, a biogenic waste stream, can be successfully used as a renewable feedstock for polyurethane production. The aim of the study was to evaluate the environmental impact of UCO-based bio-polyols developed at the Latvian State Institute of Wood Chemistry suitable for development of flexible polyurethane foams. The chosen system boundary was cradle-to-(laboratory) gate and the functional unit was 1 kg UCO-based bio-polyol. The production system for bio-polyols included feedstock production, required energy, and other chemicals needed for the synthesis process. The LCA model was built according to the ISO 14040/44:2006 series. LCA analysis was performed using SimaPro 9.6 software by Pré Consultants. Potential environmental impacts were assessed according to ReCiPe's (2016) v1.1 midpoint method and global warming potential (GWP) was assessed using the Intergovernmental Panel on Climate Change (IPCC), 2021 GWP 100a' method. Results show that GWP for UCO-based bio-polyols was more than 40 % lower than petrochemical polyols. ReCiPe results indicate that chemicals besides the UCO used in bio-polyol synthesis contribute around 70 % to the environmental impact, electricity consumption 20 % and 10 % contributes waste generated. LCA results can provide guidance on the improvement options of the UCO-based bio-polyol synthesis process. The results show the importance of life cycle assessment integration in the early-stage development of new bio-based precursors and polymers.

Keywords – Bio-polyols; circular economy; environmental assessment; life cycle assessment; polyurethanes

ACKNOWLEDGEMENT

This research was funded by the European Partnership Innovative SMEs project BIODESIGN4INSULATION.