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SCREENING LIFE CYCLE ASSESSMENT OF BIOBASED VITRIMER COMPONENT SYNTHESIS

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Abstract – The development of polymers from renewable raw materials while ensuring that the material is recyclable after the end of its life cycle is essential for Europe to achieve the goals set by the Green Deal and to approach climate neutrality in 2050. The goal of the TReResin project is to develop a new type of thermosetting resin with almost 100 % renewable raw material content, which can be recycled by changing the chemical conformation of the polymer due to the thermally reversible reactions of β amino polyesters. Within the project, Aza-Michael components, donor and acceptor, will be synthesized from used cooking oil (UCO). UCO is a waste without nutritional value generated in food processing industries, restaurants, and households. UCO is a combination of triglycerides and free fatty acids that have undergone physicochemical changes during food preparation (high temperature, moisture). Life cycle assessment (LCA) can be helpful early in the development phase, particularly for chemical processes, in identifying hotspots, comparing alternatives, assessing possible environmental implications, selecting production routes, and improving the processes themselves. The aim of the study was to evaluate the environmental impact of UCO-based AzaMichael donors and acceptors developed at the Latvian State Institute of Wood Chemistry suitable for the development of bio-based vitrimer resins. The synthesis technology currently is at TRL 2. The chosen system boundary was cradle-to-(laboratory) gate, and the functional unit was 10 g UCO-based Aza-Michael donor or acceptor. The production system for Aza-Michael components 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. For the first time, the environmental impact of a lab-scale bio-based vitrimer component synthesis is investigated, hot spots are identified, and routes for improvement are explored. Primary data for the life cycle inventory were gathered from the experiments in the laboratory which is an advantage and best-case scenario. However, the LCA also highlighted the challenges of performing LCA on new types of chemical synthesis pathways, as background data availability and quality are limiting.

Keywords – *Circular economy; environmental assessment; life cycle assessment; used cooking oil; vitrimers.*

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