**Stability of polyurethane adhesives and rigid foams produced with industrial biomass by-products**

Lukas Jasiunas*\**, Linas Miknius

*Department of Organic Chemistry, Kaunas University of Technology, Kaunas, Lithuania*

*\*Corresponding author: lukas.jasiunas@ktu.edu*

**Highlights**

* Polyurethane products were synthesized at significant levels of renewable content
* Comparable physical properties to commercial analogues were achieved
* Biopolyol blending shows promise at lowering isocyanate demands
* The products will be evaluated in terms of their stability, flammability and fire toxicity

**1. Introduction**

Multiple hydroxyl functional group containing compounds, commonly known as polyols, are currently produced from fossil resources, food competing or virgin feedstocks. Representing a significant portion of the polyol-isocyanate system in polyurethane production, their synthesis has to improve in order for humanity to advance into a more sustainable production of value added polymers. Previously produced renewable biopolyols are studied in the production of polyurethane wood adhesives and rigid foams [1].

Sugar beet pulp (residue from sugar production), hemp stalk hurds (residue from cannabidiol and hemp fibre production) and digested sewage sludge (waste water treatment residue) are the studied biomass feedstocks. The three represent by-products of well-established and upcoming industries. Crude glycerol (biodiesel production residue) is incorporated directly as the renewable low cost solvent for the liquefaction process. Finally, commercially available isocyanates are used as the second major component in the polyurethane product synthesis.

**2. Methods**

A two-step thermochemical liquefaction process, carried out at mild temperatures (110-170 C) and atmospheric pressure, was chosen to investigate the cumulative effects offered by homogeneous base and acid catalysis in batch biomass liquefaction. The stability of the produced wood adhesives (renewable content of 82-87%) and rigid foams (renewable content of 28-39 %) will be assessed in terms of thermal degradation (DTG, TGA-FTIR), fire properties and fire toxicity (Micro Combustion Calorimetry, Cone Calorimetry and Steady-State Tube Furnace), chemical resistance (water uptake and dimensional stability) and biodegradability (via soil burial tests).

**3. Results and discussion**

The objective of this work is to study the possibility of producing polyurethane products of high renewable content suitable for commercial applications by incorporating locally available biomass by-products. Furthermore, the effect of initial feedstock moisture (ranging from dry to as received) and particle size (from <0.2 mm to 0.5-1 mm fractions), parameters not studied extensively in previous research, are analysed in order to contribute to the knowledge base of direct and industry-friendly polyurethane synthesis. Finally, biopolyol blending is studied as an alternative mode of improving product properties at low isocyanate levels.

The novel findings on such product performance will aid in determining their feasibility. Thermal stability and pyrolytic-oxidative decomposition analyses will add clarity to how such composites compare in terms of fire safety and toxicity with their fossil-derived analogues. Finally, biodegradation adds yet another aspect to how sustainable future materials will have to be handled.

**4. Conclusions**

Polyurethane wood adhesives and rigid filler foams were successfully synthesized including various amounts of biopolyols. The products show comparable mechanical properties to their commercial counterparts. Meanwhile, the utilisation of biopolyol blending may have significant industrial benefits due to lower isocyanate demands. The products will also be evaluated in terms of their thermal and bio-stability, flammability and fire toxicity.

**References**

1. Jasiūnas, L., Skvorčinskienė, R. and Miknius, L., 2018. Wet and Coarse: The Robustness of Two-Stage Crude Glycerol Mediated Solvothermal Liquefaction of Residual Biomass. *Waste and Biomass Valorization*, pp.1-11.