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Response surface method optimization of rice straw-liquefaction using crude glycerol for rigid polyurethane foam application

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Statement of the Problem: Polyurethane is a versatile class of polymer produced from the condensation polymerization of isocyanates and polyol, a hydroxyl-rich compound. Its application can be found in adhesives, sealants, coatings, flexible and rigid foams. However, polyol is traditionally sourced from petroleum raw materials. With increasing environmental and sustainability problems, lignocellulosic biomass is a potential alternative source due to its abundance, biodegradability and its hydroxyl component. In the Philippines, 11.3 M tons of rice straw is produced annually which when burned, produces air pollutants such as carbon dioxide, nitrogen oxide and sulfur dioxide. Rice straw can be liquefied using an atmospheric liquefaction process with the use of a catalyst. Researchers reported that varying liquefaction parameters can significantly alter the properties of a polyol3. The purpose of the study is to produce rice straw-based polyol with a low acid number, high OH number, low viscosity and high liquefaction ratio which is suitable for rigid foam applications.

Methodology & Theoretical Orientation: A one-pot liquefaction process was used to liquefy rice straw with the use of sulfuric acid as catalyst and crude glycerol as liquefaction solvent. Response surface methodology was used to optimize four factors: acid loading, biomass loading, reaction time and reaction temperature based on four responses: acid number, OH number, liquefaction ratio, and viscosity.

Findings: Statistical analysis showed that all four factors have a significant effect on polyol properties. Increasing the acid loading was shown to significantly increase residual acid while higher reaction times lead to a decrease in liquefaction efficiency. Polyols with optimum properties were produced at a reaction time of 180-300 minutes, acid loading of 1-2%, reaction temperature of 170-180°C, and a biomass loading of 10-15%.

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