Technical Brief

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Bio-derived polyols with varying hydroxylation levels for rigid PU foams and PU dispersions

Technology Summary

Polyols were synthesized using peracid oxidation and other routes starting from cardanol, a by-product of the cashew processing industry. The synthesized polyols were evaluated for their suitability in preparing rigid foams and PU dispersions. The resulting polyurethane foams exhibited good physical and mechanical properties. The dispersions exhibited better film formation ability, without the need for any VOC's.

Background

Industrial polyurethane (PU) foams are usually obtained from petroleum-based polyols; however, due to environmental concerns, there is much interest in the use of renewable sources for synthesizing polyols. Cashew Nut Shell Liquid (CNSL) contains a phenolic moiety with an unsaturated 15-carbon side chain, making it possible to synthesize a wide variety of polyols with better thermal, mechanical and chemical properties. Varoius type of cardanol based polyols are used in the manufacture of polyurethanes.

Technology Description

Cardanol was oxidized using performic acid, with the dropwise addition of hydrogen peroxide or reactions through the phenolic hydroxyl. The reaction was carried out with varying mole ratios of reactants. The molar ratio of cardanol: hydrogen peroxide: formic acid was found to influence the extent of conversion as well as the product viscosity. The half ester formed was subjected to saponification with 10% sodium acetate solution to yield the polyol, which was confirmed using IR and NMR analysis. The suitability of the synthesized polyols in preparing rigid polyurethane foams was tested using the standard cup foam method (ASTM D7487-08) and in the preparation of PU dispersion. Finally, foam properties such as density, morphology, and compressive strength were measured and compared with a petroleum-based polyol.

Market Potential

The polyols market size is estimated to be USD 26.2 billion in 2019 and is projected to reach USD 34.4 billion by 2024, at a CAGR of 5.6%. The increasing consumption of polyurethane foam in the construction and automotive industries is a major factor driving the global polyols demand during the forecast period.

Value Proposition

- Polyols with varying functionality (2 to 8) and hydroxyl value (~ 140 to 397 mg KOH/g), which is comparable to the best polyester polyols available
- Better hydrolytic stability compared to polyester polyols and plant oil based polyols
- Environment – friendly manufacturing
- Not subject to crude oil price fluctuation risk
- 100% bio-derived; renewable
- The resulting polyurethane foams exhibited good physical and mechanical properties, and good filming property of the PU dispersions

Applications

Depending upon the hydroxyl value and other characteristics of the polyol, it finds application in the development of adhesives, coatings, and flexible or rigid foams.

Technology Status

- Demonstrated at lab scale (500 g - 1 kg batch)
- Detailed molecular analysis and chemical characterization done
- PU synthesized and compared against commercial products for selected properties.

References

https://pubs.acs.org/doi/full/10.1021/sc300079z

https://www.marketsandmarkets.com/Market-Reports/polyols-market-725.html