
Abstract

Lignin-modified phenol formaldehyde resins have been synthesized by replacing the phenol with various quantities of purified lignin. Up to 50% of phenol was replaced by lignin. The synthesis was optimized by varying the molar ratios of phenol to formaldehyde and phenol to NaOH and also the reaction time. The thermal stability of the prepared resins were measured by DSC, TGA and isothermal analysis and it was found that the lignin-modified phenolic resin is thermally more stable than that of the pure phenolic resin. The adhesive strength of lignin-modified phenolic resin was determined by Lap-Shear method, which shows the adhesive strength of the lignin-modified resin gradually decreases with the increase in the lignin content. However, on replacement of 50% phenol by lignin, the resin retains 78% of adhesive strength for wood-wood joints and 86% adhesive strength for Al-Al joints.

Raw and dewaxed jute felt composites were prepared with lignin-modified phenolic resin containing 10 and 20% solid resin and compared their properties with that of the pure phenolic resin-jute felt composite. IR spectroscopy of lignin-modified resin, jute felt and jute felt-resin composite indicated the formation of bonding between jute felt and resin. TGA and DSC analyses of both types of composite indicate the improved thermal stability of the jute felt-lignin-modified phenolic resin composite than that of the jute felt-resol composite. Properties like tensile strength, water absorption and thickness swelling of dewaxed jute composites are better than those of raw jute composite. Jute felt-lignin modified resin composite retains 75% of the tensile strength of resol-jute felt composite. The water absorption and thickness swelling of lignin-modified phenolic resin-jute felt composites are comparable with those of the resol-jute felt composite.

Lignin-HTPB copolyurethanes have been synthesized from hydroxy-terminated polybutadiene (HTPB) and varied quantities of lignin and toluene diisocyanate. IR spectroscopy and estimation of isocyanate groups have established the formation of HTPB polyurethane and lignin-HTPB copolyurethane. The crosslink density, sol fraction, diffusion coefficient of solvents in the polyurethane matrix, mechanical properties and X-

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ray crystallinity of lignin-HTPB copolyurethane have been measured and compared with those of HTPB polyurethane. Although lignin has been found to form flexible copolyurethane with HTPB but its high hydroxyl value limits its higher loading in the polyurethane structure. With higher amount of lignin, crosslink density of the polyurethane becomes high and mechanical properties become poor. However, up to 3 % lignin incorporation the copolyurethane has shown better properties. Increase in lignin content in the copolyurethane has decreased both the swelling performance in toluene and activation energy of diffusion. Percent sol has also decreased with the increase in lignin content.

TGA, DSC and isothermal stability study of all the polyurethanes and copolyurethanes indicate that the thermal stability of lignin-HTPB copolyurethanes is higher than that of the HTPB polyurethanes and it increases with the increasing lignin content in lignin-HTPB copolyurethane having same NCO/OH ratio.

Chemical resistance, oil resistance and hydrolytic stability of the lignin-hydroxy terminated polybutadiene (HTPB) copolyurethane and HTPB polyurethane have been studied by measuring the changes in mechanical properties and weights of the samples after immersing the samples for various time periods. Mineral acids viz. HCl, H₂SO₄ and HNO₃ and various concentrations of NaOH were used for acid and alkali resistance study. Solvent resistance of the polyurethanes has been studied in organic polar solvents like dichloromethane (DCM), methyl ethyl ketone (MEK) and isopropanol (IP). Oil resistance of the polyurethanes has been studied using mobil and petrol. It has been found that the solvent and oil resistances depend on the polarity of the polyurethanes. Whereas the HTPB polyurethane and lignin-HTPB copolyurethane are highly stable in both dilute and concentrated aqueous alkali solution but their stability in dilute mineral acids is more than that in concentrated acids. These polyurethanes have also shown excellent hydrolytic stability compared to that of polyester or polyether polyurethanes.