NCHEM / Novel chemistry

● Free formaldehyde adhesive based on lignin-phenol-glyoxal resins for wood particleboards

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Abstract content

Statement of the problem: Phenol-Formaldehyde (PF) resins are typically used as a highly cross-linked wood adhesive with good, desired properties; however, PF adhesives are generally synthesised from non-renewable petroleum derived raw materials which include formaldehyde, highly volatile and toxic compound classified as carcinogenic, mutagenic and reprotoxic for reproduction substance. Due to the sustainability and health concerns, sustainable and low toxicity resins show a possibility to replace the petroleum-derived ones and one way to solve this challenge is the use of less volatile and toxic alternative raw materials and phenolic biopolymers with the aim of replacing as much as possible the non-renewable components to achieve more sustainable resins without toxic emissions. The purpose of this study is to develop and analyse alternative adhesives to PF resins through lignin glyoxilation. Methodology and Materials: To develop alternative resins, Kraft Lignin was used as a partial substitute of phenol content of the resins, and to replace formaldehyde, glyoxal was used. The lignin load in the adhesives was up to 30% of the hydroxylated compounds so, the phenol percentage was reduced. Reaction time and experimental conditions (temperature, time, molar relationship) for the synthesis of lignin-phenol-glyoxal resins were analysed to reach the most optimal results. Resins obtained were molecularly analysed by Transmission FTIR, 1H-NMR, and 13C-NMR; physical and chemical properties were determined by TGA and DSC analysis, Brookfield Viscosity and %Solid Content measurements. To evaluate the capacity as binder of each synthesised adhesive, small particleboards (e.c. 80bar, 195ºC) were prepared at laboratory scale. In addition, the particleboards were tested for formaldehyde emissions and biodegradation tests of adhesives were performed. Findings: Resins from the lignin-phenol-glyoxal reaction were synthetized with a 30% lignin content with a solid content average above 40 % and low viscosity (166 mPa·s at 23ºC) with an averaged curing temperature of 190ºC. Structural chemical analysis showed the modification of lignin and phenol units through glyoxilation at different degrees. No formaldehyde emissions, from adhesive, were detected through UNE EN-ISO 12460-5 test of the wood particleboards. Conclusions & Significance: The synthesis of alternative PF resins with a 30% lignin content shows a chance to use a renewable resource such as lignin to develop new adhesive resins for wood panels avoiding formaldehyde use and, therefore, its derived emissions.

References

El Mansouri et al. (2011). “Glyoxalated alkaline lignin,” BioResources 6(4), 4523-4536.