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Lignin Phenol Formaldehyde Resole Resin: Synthesis and Characteristics

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Abstract : Phenol formaldehyde (PF) resins are widely used as wood adhesives for variety of industrial products such as plywood, laminated veneer lumber and others. Lignin as a main constituent of wood has become well-known as a potential substitute for phenol in PF adhesives because of their structural similarity. During the last decades numerous research approaches have been carried out to substitute phenol with pulping-derived lignin, whereby the lower reactivity of resins synthesized with shares of lignin seem to be one of the major challenges. This work reports about a systematic screening of different types of lignin (plant origin and pulping process) for their suitability to replace phenol in phenolic resins. Lignin from different plant sources (softwood, hardwood and grass) were used, as these should differ significantly in their reactivity towards formaldehyde of their reactive phenolic core units. Additionally a possible influence of the pulping process was addressed by using the different types of lignin from soda, kraft, and organosolv process and various lignosulfonates (sodium, ammonium, calcium, magnesium). To determine the influence of lignin on the adhesive performance beside others the rate of viscosity development, bond strength development of varying hot pressing time and other thermal properties were investigated. To evaluate the performance of the cured end product, a few selected properties were studied at the example of solid wood-adhesive bond joints, compact panels and plywood. As main results it was found that lignin significantly accelerates the viscosity development in adhesive synthesis. Bonding strength development during curing of adhesives decelerated for all lignin types, while this trend was least for pine kraft lignin and spruce sodium lignosulfonate. However, the overall performance of the products prepared with the latter adhesives was able to fulfill main standard requirements, even after exposing the products to harsh environmental conditions. Thus, a potential application can be considered for processes where reactivity is less critical but adhesive cost and product performance is essential.

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