Liquid-Liquid Phase Behavior of Kraft Lignin Biopolymer with a Tunable, Renewable Solvent System: Purification and Fractionation

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Lignin is unique among biopolymers in having significant aromatic character, which makes it potentially attractive for a wide range of uses, including resins, coatings, and even carbon fibers. Unfortunately, most of the commercial-grade lignins available today (i.e., Kraft lignins) are severely limited in their applications because of their high metals (primarily sodium) content. We have discovered a powerful, versatile, and renewable mixed-solvent system that forms liquid-liquid phase behavior when contacted with lignin, such that the metals content of the lignin can be reduced 10-fold with each successive phase split. For example, lignin fractions containing 25ppm Na have been obtained from only two successive phase splits. Furthermore, this phase separation separates the lignin itself into lignin fractions of significantly different molecular weights, chemical compositions, and solvent content. The effect of processing temperatures and solvent feed composition on the solid-liquid to liquid-liquid phase transition, metals content, solvent content, and molecular properties of the lignin fractions isolated by our so-called ALPHA process have been measured. Implications of these results for the development of a commercially viable purification and fractionation process for lignin are also discussed.