

Effective Heteropolyacid-loaded Ionic Liquid Catalysts for the Synthesis of Benzaldehyde Glycol Acetal

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A series of environmental benign ionic liquid (IL) catalysts, synthesized by incorporating varied amounts of tungstophosphoric acid (TPA) and pyridinium propyl sulfobetaine (PPS) zwitterionic precursor, were exploited for homogeneous conversion of biomass. In particular, these water-soluble PPS-TPA IL ($[\text{PPSH}]_x\text{H}_{3-x}\text{PW}_{12}\text{O}_{40}$; $x = 1.0\text{--}3.0$) catalysts were evaluated for acetalization of benzaldehyde with glycol. The catalyst system revealed self-separation characteristics, which resulted in the formation of biphasic product/catalyst layers to render facile product separation and catalyst recycling. Among various PPS-TPA ILs examined, the $[\text{PPSH}]_2\text{HPW}_{12}\text{O}_{40}$ catalyst exhibited excellent durability and an optimal acetal yield over 85%, in good agreement with that predicted by factorial design of experiments and response surface methodology (RSM). The effects and correlations of different experimental variables such as reaction time, relative reactant concentration, amount of water-carrying agent, and amount of catalyst were addressed by the Box–Behnken design (BBD). The deduced optimal conditions lead to an acetal yield of 85.2 %, which is consistent with experimental results and that predicted by the BBD model. The superior acetalization activities observed for the novel PPS-TPA IL catalysts are attributed to their highly acidic nature and weak mass transport resistance.

Keywords: Heteropolyacid-based catalysts, Ionic liquid, Acetalization, Acidity, Reaction engineering, Process optimization, Biomass conversion

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