

One-Pot Synthesis of 5-Hydroxymethylfurfural from Hexose Sugar over Chromium Impregnated Zeolite Based Catalyst, Cr/H-ZSM-5

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Abstract : The world's population and industrialization of countries continued to grow in an alarming rate irrespective of the security for food, energy supply, and pure water availability. As a result, the global energy consumption is observed to increase significantly. Fossil energy resources that mainly comprised of crude oil, coal, and natural gas have been used by mankind as the main energy source for almost two centuries. However, sufficient evidences are revealing that the consumption of fossil resource as transportation fuel emits environmental pollutants such as CO₂, NO_x, and SO_x. These resources are dwindling rapidly besides enormous amount of problems associated such as fluctuation of oil price and instability of oil-rich regions. Biomass is a promising renewable energy candidate to replace fossil-based transportation fuel and chemical production. The present study aims at valorization of hexose sugars (glucose and fructose) using zeolite based catalysts in imidazolium based ionic liquid (1-butyl-3-methylimidazolium chloride, [BMIM] Cl) reaction media. The catalytic effect chromium impregnated H-ZSM-5 (Cr/H-ZSM-5) was studied for dehydration of hexose sugars. The wet impregnation method was used to prepare Cr/H-ZSM-5 catalyst. The characterization of the prepared catalyst was performed using techniques such as Fourier transform infrared spectroscopy (FT-IR), X-ray diffraction analysis (XRD), Temperature-programmed desorption of ammonia (NH₃-TPD) and BET-surface area analysis. The dehydration product, 5-hydroxymethylfurfural (5-HMF), was analyzed using high-performance liquid chromatography (HPLC). Cr/H-ZSM-5 was effective in dehydrating fructose with 87% conversion and 55% yield 5-HMF at 180 °C for 30 min of reaction time compared with H-ZSM-5 catalyst which yielded only 31% of 5-HMF at identical reaction condition.

Keywords : chromium, hexose, ionic liquid,, zeolite

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