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H₂ generation from NaBH₄ methanolysis via magnetic field sensitive ionic liquid coated silica particles as catalyst

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ABSTRACT

Upon the preparation of Magnetic (Fe₃O₄) nanoparticles (NPs), they were coated with amino-functionalized silica (SiO₂@NH₂) via the modified Stöber method. SiO₂ coated Fe₃O₄ (Fe₃O₄@SiO₂) particles and SiO₂@NH₂ coated Fe₃O₄ (Fe₃O₄@SiO₂@NH₂) particles were turned into ionic liquid (IL) colloids as Fe₃O₄@SiO₂@NH₃⁺Cl⁻, Fe₃O₄@SiO₂@NH₃⁺NO₃⁻ and Fe₃O₄@SiO₂@NH₃⁺HSO₄⁻ by the treatment of Fe₃O₄@SiO₂@NH₂ with hydrochloric acid (HCl), nitric acid (HNO₃) and sulfuric acid (H₂SO₄), respectively. The size of the prepared silica-based particles was approximately 500 nm by SEM images, and the zeta potential values varying between -59 and +26 mV. The catalytic activity performances of these silica-based particles as catalysts were investigated for H₂ generation from methanolysis of NaBH₄ in terms of the types of particles, reusability, recyclability, the concentration of NaBH₄, and the reaction temperature. Amongst the prepared IL colloids, Fe₃O₄@SiO₂@NH₃⁺Cl⁻ particles were found to be the most effective catalysts for the methanolysis reaction of NaBH₄. The maximum Hydrogen Generation Rate (HGR) value of 13188 ± 196 mL H₂ g⁻¹ min⁻¹ was attained at 500 mM NaBH₄ by using 50 mg Fe₃O₄@SiO₂@NH₃⁺Cl⁻ as catalyst at 25 °C. Additionally, turn over frequency (TOF) value was calculated as 43.1 ± 3.1 H₂ mol (mol of N.min)⁻¹ for Fe₃O₄@SiO₂@NH₃⁺Cl⁻ under the same reaction conditions. Moreover, activation energy (E_a) values for the methanolysis of NaBH₄ using Fe₃O₄@SiO₂@NH₃⁺Cl⁻ particles as catalyst were found as 32.5 ± 0.5, 39.9 ± 0.3 and 24.4 ± 0.7 kJ mol⁻¹ in the temperature range of -15–45, -30–0 and 15–45 °C, respectively, that are

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