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Efficient catalytic reduction of nitroaromatics by recyclable 2-naphthalene sulfonic acid doped polyaniline nanotubes decorated with NiFe₂O₄ nanorods

Raju, Kumar

Council for Scientific and Industrial Research

Pretoria, 0001, South Africa

Email: KRaju@csir.co.za

Abstract

A hybrid nanostructure comprising NiFe₂O₄ nanorods and 2-naphthalene sulfonic acid (2-NSA) doped polyaniline nanotubes (NiFe₂O₄@PANI/NSA) has been explored as an efficient catalyst for the reduction of nitroaromatics in the aqueous medium. The obtained NiFe₂O₄@PANI/NSA nanocomposites (NCs) were characterized using XRD, FE-SEM, HR-TEM, TGA, FT-IR, BET, and XPS, and their catalytic efficiencies were investigated for the reduction of nitroarenes with 4-nitrophenol (4-NP) being used as a model nitroarene. NiFe₂O₄@PANI/NSA exhibited excellent catalytic activity with a rate constant of 0.00557 s⁻¹ and excellent recyclability, with the identical activity being retained after 15 successive runs. The mechanism of the reaction was proposed based on the kinetics results using the Langmuir-Hinshelwood model. The activation energy (E_a) was calculated to be 30 kJ/mol⁻¹ for 4-NP reduction.