Applied Catalysis B: Environmental

Silver decorated magnetic nanocomposite (Fe3O4@PPy-MAA/Ag) as highly active catalyst towards reduction of 4-nitrophenol and toxic organic dyes

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Abstract

Developing innovative technologies for the efficient treatment of wastewater containing toxic organic pollutants is of particular importance worldwide. Removal of organic contaminants from aqueous media through chemical reduction using noble metal-based nanocatalysts, and in the presence of NaBH4, as a reducing agent, has become an established approach in the last few years. Herein, we describe a simple method for the synthesis of a magnetic conducting polymer modified with mercaptoacetic acid (MAA) and silver nanoparticles (Ag NPs) as a promising catalyst for the reduction of organic pollutants. Ag NPs were deposited on the magnetic conducting polymer by the reduction of a silver salt precursor (AgNO3) without the need for a reducing agent or stabilizer. The developed Fe3O4@PPy-MAA/Ag nanocomposite was characterised using FE-SEM, TEM, XRD, XPS, BET and ATR-FTIR. The catalytic performance of the nanocatalyst during the reduction of 4-nitrophenol (4-NP) and organic dyes, namely, methylene blue (MB) and methyl orange (MO) was assessed in aqueous medium at 25 °C. The catalyst exhibited excellent catalytic activity for the reduction of all three targeted organic pollutants (4-NP, MO and MB). The pseudo-first-order rate constants were estimated as 0.5–14.3×10−2 min-1, 0.52–24.2×10−2 s−1 and 10.1–46.8×10−3 s−1 for the reduction of 4-NP, MO and MB, respectively. The magnetic catalyst was separated easily from the reaction medium and recycled without significant loss of catalytic activity up to eight successive cycles. In addition to its green synthesis and reusability, findings from this study show that Fe3O4@ PPy-MAA/Ag nanocomposite has the potential efficiency and stability to make it an ideal catalyst in environmental applications via chemical reduction of toxic contaminants from wastewater.