One-pot synthesis of a magnetic metal mixed oxide: an efficient and reusable catalyst for the reduction of 4-nitrophenol

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The compound 4-nitrophenol (4-NP) is an anthropogenic pollutant. Thereby, the efficient and fast degradation of 4-NP is a critical concern considering its environmental and health hazards[1]. One way to eliminate this pollutant from wastewater is to reduce it in order to produce 4-aminophenol (4-AP), which is less toxic and considered an essential intermediate for the pharmaceutical industry[2]. The reduction of 4-NP to 4-AP can be achieved in an aqueous medium under mild conditions using a reducing agent, sodium borohydride ($NaBH_4$), in the presence of a catalyst[3]. Bismuth-based catalysts possess several advantages over noble metals-containing systems. The present work reports the preparation of a novel magnetic material by depositing bismuth oxide onto iron oxide (Mag-Bi_xO_y) by the co-precipitation method. The material was characterized by powder X-ray diffraction, scanning electron microscope, Fourier-transform infrared spectroscopy (FT-IR), the Brunauer-Emmett-Teller surface areas, thermogravimetric analysis, Vibrating-sample magnetometry (VSM), and X-ray photoelectron spectroscopy (XPS). Bismuth oxide in Mag-MMO was converted to semimetallic bismuth in the presence of $NaBH_4$(0.05 $mol.L^{-1}$) for 2 hours, which after washing and drying, was applied to reduce 4-NP into 4-AP using $NaBH_4$0.01 $mol.L^{-1}$. The catalyst exhibited high catalytic activity, converting 4-NP into 4-AP within 8 minutes at 15 °C, with a first-order kinetic constant of 0.41 min^{-1}. Additionally, after the reaction, the catalyst could be easily removed from the reaction system by a magnet and reused in subsequent cycles. The obtained results suggest that Mag-Bi is a promising catalyst for the 4-NP removal process.

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References:

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