Kinetic modeling of wastewater treatment that polluted with organic dyes, by synthesized CTO-Fe^0 nanoparticles

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Abstract:

Zero-valent iron nanoparticle (NZVI) technology is becoming an increasingly popular choice for treatment of hazardous and toxic wastes and remediation of contaminated sites. NZVI tends to accumulate and adhere to nature materials like soil. In this project chitosan is used in order to prevent accumulation and higher their efficiencies. Chitosan- Fe^0 (CTO-Fe^0) nano particles are prepared by $NaBH_4$ reduction method. Characteristics of synthesized nanoparticles were studied through TEM, FT-IR and XRD analysis. Mean crystallite size of nanoparticles is calculated using Debye-Sherrer formula and was approximately equal to 23 nm. Acid red 14 (AR14) was used as a model pollutant in order to study water pollutants decolorization efficiency of CTO-Fe^0 nanoparticles. The kinetic data were analyzed using the pseudo-first-order and pseudo-second-order adsorption kinetic models. According to these models, the rate constants were calculated for different initial dye concentrations, pH and initial CTO-Fe^0 concentrations. It can be concluded that the experimental data are well defined with pseudo-second-order kinetic model. Predicted values of rate constants were found to be in good agreement with experimental values (R^2=0.987).

Keywords: nano zero valent iron; chitosan; kinetic model; Acid Red 14

Introduction

Normally, Fe^0 nanoparticles are prepared by borohydride reduction of Fe(II) or Fe(III) in aqueous solution (Zhang, 2003). Fe^0 nanoparticles prepared in this way tend to agglomerate in water through direct interparticle interactions such as van der Waals forces and magnetic interactions leading to poor particle size suitable for any reactions (He et al., 2007). A stabilizer can reduce agglomeration of Fe^0 nanoparticles through (a) electrostatic repulsion (Coulombic repulsion caused by the accumulation of charged) and (b) steric hindrance (existence of sterically bulky groups) (Chen et al., 2004; He and Zhao, 2005, 2007; He et al., 2007). He et al. (2007) observed that carboxymethyl cellulose can be used as an efficient stabilizer to prepare Fe^0 nanoparticles to yield stable dispersions with sizes smaller than 17 nm. The efficiency of stabilized Fe^0 nanoparticles in degrading TCE is almost 17 times higher than those of non-stabilized counterparts judged by the initial pseudo-first-order rate constant (He et al., 2007). Thus, a proper stabilizer must be cheap, widely available and can well disperse the metals to form right particle size and, at the same time, can stimulate the reaction on its surface. Chitosan (b-[1-4]-2-amino- 2-deoxy-D-glucopyranose) is one of the important natural polymers composed by layers of crustaceans and cell walls of many fungi. Chitosan has also been widely used in the green synthesis for the nanoscale materials due to its excellent biocompatibility, biodegradability, and lack of toxicity. Previous studies have