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Mechanism and efficiency of metronidazole removal via adsorption and heterogeneous Fenton reaction using $FeNi_3$ nanoparticles

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ABSTRACT

Pharmaceutical wastewater is a source of many pollutants, the most important of which are antibiotics that can be toxic and carcinogenic to humans and animals. Therefore, finding a way to remove antibiotics from wastewater before discharging is of utmost importance by environmental researchers. In this study, the authors evaluated two widely used treatment methods which are adsorption and heterogeneous Fenton for metronidazole (MNZ) antibiotic removal. As an adsorbent and catalyst for the suggested processes, the $FeNi_3$ nanoparticles were applied. The application of $FeNi_3$ nanoparticles in the adsorption and heterogeneous Fenton processes achieved 45.09% and 100% MNZ antibiotic removal efficiencies, respectively. The effects study showed that the optimum conditions for removal are pH = 7 and 3 for adsorption and Fenton processes, respectively, reaction time = 180 min, MNZ antibiotic concentration = 10 mg/L, $FeNi_3$ nanoparticles dose = 0.005 g/L, and H_2O_2 concentration in Fenton process = 150 mg/L. The adsorption isotherm and kinetics data are consistent with the Langmuir isotherm and pseudo-second-order kinetic models, respectively. In addition, the kinetics data of MNZ antibiotic degradation using the heterogeneous Fenton process agreed with the pseudo-first-order reaction kinetics. It was found that the used $FeNi_3$ nanoparticles can be recycled five times in both processes with losses of less than 7% of MNZ antibiotic removal efficiencies from the first to fifth cycle.

Keywords: Adsorption; Heterogeneous Fenton; Metronidazole; Isotherm; Kinetics; Regeneration study

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