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Heavy metal adsorption efficiency magnetic porous composites Fe_3O_4–SiO_2–APTES

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ABSTRACT

Heavy metals such as Cd^{2+} and Ni^{2+} in water have been a major issue for many years. This study presented heavy metal adsorption efficiency by Fe_3O_4–SiO_2 and Fe_3O_4–SiO_2–APTES. Fe_3O_4–SiO_2 synthesized by sol-gel method and was modified with APTES. Characteristics of adsorbents, including particle structure, composition and size were determined using analytical devices such as XRD, scanning electron microscopy, Fourier transform infrared spectra. In order to design experiments and analyse the results, the Software Design-Expert 7 and Taguchi method was used. Physical and chemical parameters such as pH, contact time, and adsorbent dosage under various conditions were studied. The result shows that in pH ≥ 5.5–6.5, initial Cd^{2+} and Ni^{2+} with 10 mg/L concentration, 20 mg adsorbent dosage, and 20 min contact time, resulted in 75.5% cadmium and 70.5% nickel removal by Fe_3O_4–SiO_2. Moreover, the maximum capacity of cadmium and nickel adsorption was achieved 18.88 and 17.63 mg/g of adsorbent, respectively. In optimal condition (pH ≥ 6.5–7, 10 mg/L initial cadmium and nickel concentrations, 20 mg adsorbent dosage, 10 min contact time), 95.5% of cadmium and 83.5% of nickel were removed from solutions, respectively. In addition, the maximum adsorption capacity of Fe_3O_4–SiO_2–APTES for cadmium and nickel adsorption was 22.63 and 20.88 mg/g, respectively. While, Fe_3O_4@SiO_2 shows the maximum adsorption capacity of 18.88 and 17.63 mg/g for cadmium and nickel, respectively. The adsorption isotherm follows both of the Langmuir and Freundlich models (R^2 > 0.97). Finally, Fe_3O_4–SiO_2–APTES have more ability than Fe_3O_4–SiO_2 to quickly and efficiently adsorb nickel and cadmium ions. In addition, modified magnetic silicon nanoparticle can be industrially used as reusable and environment friendly adsorbent.

Keywords: Adsorption; Cadmium; Nickel; $FeSO_4$@SiO_2; Ligand

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