Preparation and Application of Amino-functionalized Magnetic Nanoparticles Composites

Xindang Bo[1], Fenglan Chai[1, *], Yuhao Xin[2], Fan Zhang[1]

[1]School of Chemical Engineering, Henan Technical Institution, Zhengzhou, China

[2]School of Chemical Engineering and Environment, Henan University of Technology, Zhengzhou, China

Email address:

553027275@qq.com (Xindang Bo), 965996899@qq.com (Fenglan Chai), 2336176909@qq.com (Yuhao Xin), 842460400@qq.com (Fan Zhang)

[*]Corresponding author

Abstract

The heavy metal pollution in water has become a major environmental problem. Adsorption methods by nanomaterials have been widely proved to be more economical and effective in removing heavy metals from wastewater. Magnetic nanoparticles have received extensive attention due to their excellent adsorption performance and particularly due to the simple magnetic separation process. $Fe_3O_4@SiO_2$ magnetic nanoparticles were prepared by co-precipitation method. Amino-functionalized magnetic nanoparticles adsorbent ($Fe_3O_4@SiO_2@NH_2$, AMNPs) was prepared with 3-aminotriethoxysilane as amination reagent, and characterized by Fourier transform infrared spectroscopy (FT-IR), scanning electron microscopy (SEM), X-ray diffraction (XRD) and vibrating sample magnetometer (VSM). The results show that the AMNPs have particle size about 40~70 nm, and exhibited superparamagnetic behavior and stronger magnetization. The adsorption properties of AMNPs for Cr(VI) in wastewater were investigated. The effects of different parameters such as AMNPs dosage (0.01-0.2 g/100 mL), initial Cr(VI) concentration (0.1-10 mg/L), initial pH (2-10), temperature (293-313 K) and contact time (5-30 min) on the adsorption process was examined. Kinetic data fitted very well to the pseudo-second-order kinetic. The adsorption of Cr(VI) onto AMNPs was feasible, and exothermic. The AMNPs adsorbent showed high adsorption capability for Cr(VI) in aqueous solutions via the chelation and reduction mechanisms. Under the optimum adsorption conditions, the adsorption capacity was as high as 563.3 mg/g for 30min. The chromium loaded AMNPs adsorbent can be easily recovered from solution with magnetic separation process. The AMNPs can be readily regenerated with NaOH by ultrasonic treatment. The recovery rate of Cr(VI) reached up to 96%. Moreover, the AMNPs have excellent bifunctional of adsorption and detoxification for Cr(VI) in wastewater. The Amino-functionalized magnetic particle adsorbents have great value for its industrial applications for the removal of Cr(VI) from aqueous solutions because of the advantage of their high adsorption and detoxification performance, easily recyclability and reusability.

Keywords

Heavy Metal, Magnetic Nanoparticles, Adsorbent, Amino-functionalization