



Heavy metal removal from water by magnetite nanorods



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HIGHLIGHTS

- ▶ Magnetite nanorods were synthesized by pulsed current electrochemical method.
- ▶ Magnetite nanorods were used for successful removal of Fe^{2+} , Pb^{2+} , Zn^{2+} , Ni^{2+} , Cd^{2+} and Cu^{2+} from water.
- ▶ Adsorption capacity of the synthesized magnetite nanorods were calculated by kinetic method.

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ABSTRACT

In this paper, a new effective adsorbent for removal of some heavy metal ions such as Fe, Pb, Zn, Ni, Cd and Cu from aqueous solution is synthesized by pulsed current electrochemical method. Scanning Electron Microscopy (SEM) imaging and X-ray diffraction shows the synthesized sample including pure magnetite nanorods (MNR) with 60 nm average diameters and 1000 nm average lengths. The adsorbed ions can easily eluted by small volume of nitric acid solution. The adsorption equilibrium study exhibited that the heavy metal ions adsorption of magnetite nanorods followed a Langmuir isotherm model. The experimental kinetic data for adsorption of heavy metal ions on the surface of the synthesized nanorods were described by a pseudo-second-order equation. From the Langmuir isotherms, the maximum adsorption capacities of magnetite nano-adsorbents towards Fe^{2+} , Pb^{2+} , Zn^{2+} , Ni^{2+} , Cd^{2+} and Cu^{2+} were 127.01, 112.86, 107.27, 95.42, 88.39 and 79.10 mg g^{-1} , respectively. The experimental data shows the synthesized MNRs can quantitatively remove heavy metal ions from water.

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1. Introduction

Water pollution by heavy metal ions such as Pb, As and Cd occur globally [1]. Environmental regulations on the discharge of heavy metal ions and rising demand for clean water with extremely low level of heavy metal ions make it greatly important to develop different efficient methods for heavy metal ions removal from waters. The conventional methods for heavy metal ions removal from water include electrochemical and chemical precipitations, ion exchange, reverse osmosis and adsorption [2]. Among the above mentioned different methods, adsorption of heavy metal ions on the surface of solid materials is one of the most recommended physicochemical methods is commonly used for heavy metal ions removal from water samples and aqueous solutions. Adsorption is attractive due to its merits of efficiency, cheap and simple operation [3]. The common adsorbents include zeolites, clays, biomass, activated carbon and polymeric materials [4].

However, the mentioned adsorbents have low adsorption capacities. Therefore, finding of new promising adsorbents is interest and very important research. Adsorption can be carried out based on the utilization of solid adsorbents from either organic, inorganic, biological or minerals [5,6].

Nano-adsorbents can be one of the promising ways for a novel environmental purification technique because of producing little or no flocculants and having capability of treating large amount of wastewater within a short time. Only limited researches on application of nanomaterials without surface modification in the environmental area were reported. Among of nanomaterials, iron oxide nanoparticles specially magnetite [7], hematite [8] and maghemite [9–11] nanoparticles have been applied to the removal of different heavy metal ions. The small size of Fe_3O_4 nanosorbents was favorable for the diffusion of metal ions from solution onto the active sites of the adsorbents surface. It recommended that Fe_3O_4 nanosorbents were effective and economical adsorbents for rapid removal and recovery of metal ions from wastewater effluents. Ngomsik et al. [12] gave a mini review on the application of magnetic nano and microparticles in the removal of metal ions in wastewaters. Recently, monodisperse Fe_3O_4 nanocrystals were

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