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Communication

Preparation of core-shell magnetic $Fe_3O_4@SiO_2$-dithiocarbamate nanoparticle and its application for the Ni^{2+}, Cu^{2+} removal

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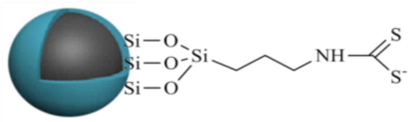
Graphical abstract



$Fe_3O_4@SiO_2$-DTC

A typical superparamagnetic nanoparticles-based dithiocarbamate absorbent ($Fe_3O_4@SiO_2$-DTC) with core-shell structure was applied for aqueous solution heavy metal ions Ni^{2+}, Cu^{2+} removal.

ABSTRACT

A novel magnetic nanoparticles-based dithiocarbamate absorbent ($Fe_3O_4@SiO_2$-DTC) with core-shell structure was synthesized under mild conditions and used in aqueous solution Ni^{2+} and Cu^{2+} ions treatment. The structure, morphology and magnetic properties of the adsorbent were characterized by X-ray diffraction (XRD), fourier transformed infrared spectroscopy (FTIR), scanning electron microscopy (SEM), transmission electron microscopy (TEM), and vibrating sample magnetometer (VSM). $Fe_3O_4@SiO_2$-DTC exhibited a typical superparamagnetic with a saturation magnetization value of 52.7 emu/g, which could be rapidly separated from aqueous solution under external magnetic field. We investigated the effects of solution pH, adsorption time, and the initial concentration of heavy metal ions on the adsorption of Ni^{2+} and Cu^{2+}. The adsorption equilibrium times of Ni^{2+} and Cu^{2+} on $Fe_3O_4@SiO_2$-DTC were reached at 15 and 90 min, respectively. The adsorption kinetic data were fitted to the pseudo-second-order model, and the adsorption data were consistent with the Frenudlich isotherm model. When the initial concentration of heavy metal ions was 250 mg/L, the maximum adsorption capacity of Ni^{2+} and Cu^{2+} at room temperature was 235.23 and 230.49 mg/g, respectively. In addition, we discussed the plausible adsorption mechanism. The results indicated that the adsorption was mainly dominated by chelation.

Keywords:Core-shell Magnetic nanoparticle Dithiocarbamate Adsorption Heavy metals removal

With the development of industry and agriculture, environmental pollution has become more and more serious, and heavy metal pollution has attracted widespread attention. Metallurgy, machinery manufacturing, electronic instruments and other industries produce a large number of heavy metal ionic pollutants [1,2]. These contaminants had seriously affected human health and ecological environment due to their carcinogenicity, mutagenicity, and teratogenic properties in the biological system [3-5]. Hence, looking for cost-effective, green environmental heavy metal removal treatments had attracted considerable attention.

There are many methods to remove heavy metal ions from wastewater, such as electrolysis method, ion exchange method, adsorption method, membrane separation method, *etc.* [6-8]. In these methods, the adsorption method is widely used due to its high efficiency and economy [9,10]. Various adsorbent materials have been used to remove heavy metals from wastewater, such as activated carbon, biopolymers, *etc.* [11-13]. However, most of the adsorbent materials are prone to secondary contamination, and it is difficult to separate and regenerate from the wastewater [14]. Currently, magnetic Fe_3O_4 materials have attracted wide attention due to their easy