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Fabrication and characterization of magnetic cobalt ferrite nanoparticles for efficient removal of humic acid from aqueous solutions

Mohammad Kamranifar[a], Fatemehsadat Masoudi[b], Ali Naghizadeh[a,*], Majid Asri[c]

[a]*Medical Toxicology and Drug Abuse Research Center (MTDRC), Birjand University of Medical Sciences (BUMS), Birjand, Iran, Tel. +985632381665; Fax: +985632395346; emails: al.naghizadeh@yahoo.com (A. Naghizadeh), mo.kamrani@yahoo.com (M. Kamranifar)*
[b]*Department of Environment Health Engineering, Student Research Committee, Birjand University of Medical Sciences, Birjand, Iran, email: Ftmmasoudi71@yahoo.com*
[c]*Department of Environmental Health Engineering, Faculty of Medicine Sciences, Islamic Azad University, Birjand Branch, Birjand, Iran, email: majid.asri@yahoo.com*

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ABSTRACT

In the present study, magnetic cobalt ferrite nanoparticles were synthesized and its efficiency in removing humic acid from aqueous solutions was investigated. Structural characteristics of magnetic cobalt ferrite nanoparticles by scanning electron microscopy, transmission electron microscopy, Fourier transform infrared spectroscopy, X-ray diffraction and vibrating-sample magnetometerwere described. In addition, the effects of various parameters such as pH (3–11), adsorption dose (0.2–0.8 g/L), contact time (5–90 min), humic acid concentration (5–40 mg/L) and temperature (283–313 K) on the adsorption of humic acid by magnetic cobalt ferrite nanoparticles were studied. The adsorption parameters were determined with Langmuir, Freundlich, Temkin, BET and Dubinin–Radushkevich isotherms as well as pseudo-first and pseudo-second-order kinetics. Finally, the thermodynamic parameters (ΔH, ΔS and ΔG) were investigated. The results of this study showed that in optimum conditions, the maximum adsorption capacity of magnetic cobalt ferrite nanoparticles was 146 mg/g (optimal conditions: pH = 3, adsorbent dose = 0.2 g/L, initial concentration of humic acid = 40 mg/L, contact time = 20 min, temperature = 283 K). The adsorption isotherm data well match with Langmuir and Freundlich models. The kinetics of the process was described well with the pseudo-second-order model. The results of the thermodynamic analysis showed that the values of ΔS and ΔH are positive and ΔG is negative.

Keywords: Magnetic nanoparticles; Cobalt ferrite; Humic acid; Isotherm; Kinetics; Thermodynamics

* Corresponding author.