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Adsorptive removal of toxic Methylene Blue and Acid Orange 7 dyes from aqueous medium using cobalt-zinc ferrite nanoadsorbents

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ABSTRACT

Cobalt-zinc ferrite nanoparticles of general formula $Co_{1-x}Zn_xFe_2O_4$ ($0.0 \leqslant x \leqslant 1.0$) were synthesized by means of chemical co-precipitation method. Impedance analysis was used to study the grain and inter-grain conductivities. The changing of complex conductivity with composition confirmed the semiconducting behavior. A significant influence of Zn concentration on dielectric properties was observed. The obtained Co-Zn ferrites were examined as magnetic adsorbents using both cationic and anionic dyes as model pollutants. Substitution of zinc ions with cobalt ones resulted in changes in sorption characteristics. The efficiency of Methylene Blue (MB) dye removal was increased with increasing Co content. On contrary, efficiency of Acid Orange 7 dye removal was increased with increasing Zn content. The adsorption of the both anionic and cationic dyes onto ferrite nanoparticles agreed well with the Langmuir isotherms. The maximum adsorption capacity for the Acid Orange 7 dye was reached up to 31 mg/g using $ZnFe_2O_4$, while the maximum adsorption capacity for the cationic Methylene Blue dye was found to be 3.4 mg/g on $Co_{0.9}Zn_{0.1}Fe_2O_4$. The relation of adsorption efficiency with ionic-covalent and acid-base parameters of the ferrite surface was also discussed.

Keywords: Ferrite nanoparticles; Magnetic sorbents; Dyes; Surface

1. Introduction

Adsorption is well known as affordable and efficient method of water purification. A huge number of sorbents based on diverse materials such as activated carbon, clay minerals, waste biomass, agricultural by-products etc. have been proposed for the removal of various types of pollutants from aqueous medium [1–4]. In the recent decades, literature reports the information about the sorbents with magnetic properties possessing the advantage of after-use separation by means of external magnetic field. Among the magnetic sorbents, the most promising materials are ferrite spinels possessing adjustable crystalline structure [5,6]. Year-to year, spinel ferrite sorbents attract ever increasing attention of

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