



Enhancement of adsorption efficiency of methylene blue on $\text{Co}_3\text{O}_4/\text{SiO}_2$ nanocomposite

Hany H. Abdel Ghafar^{a,b,*}, Gomaa A.M. Ali^{c,d}, Osama A. Fouad^e, Salah A. Makhlof^{f,g}

^aFaculty of Science and Arts, Department of Chemistry, King Abdulaziz University, Khulais, Saudi Arabia

Tel. +996 533645049; email: hany_ghafar@hotmail.com

^bWater Pollution Research Department, National Research Center, Cairo 12311, Egypt

^cFaculty of Science, Chemistry Department, Al-Azhar University, Assiut branch, Assiut 71524, Egypt

^dFaculty of Industrial Science and Technology, University Malaysia Pahang (UMP), Kuantan 26300, Pahang, Malaysia

^eCentral Metallurgical Research and Development Institute, CMRDI, P.O. Box 87, Helwan 11421, Egypt

^fFaculty of Science, Physics Department, Assiut University, Assiut 71516, Egypt

^gDeanship of Scientific Research, Al Imam Mohammad Ibn Saud Islamic University (IMSIU), Riyadh 11463, Saudi Arabia

Received 24 July 2013; Accepted 21 November 2013

ABSTRACT

Single and well-crystalline Co_3O_4 phase imbedded in an amorphous SiO_2 matrix has been obtained by novel aqueous solution method. The structural and morphological properties are investigated using X-ray diffraction, Fourier transform infrared spectrometer, and N_2 adsorption-desorption techniques. The apparent crystallite size for Co_3O_4 was found to be about 13.5 nm, which elucidates the role of poly ethylene glycol in preventing particle's agglomeration; moreover, the porous structure of the composite enhances its adsorption ability. $\text{Co}_3\text{O}_4/\text{SiO}_2$ has a high ability to absorb methylene blue from an aqueous solution. The removal percent of Methylene blue (MB) by $\text{Co}_3\text{O}_4/\text{SiO}_2$ has reached 95.7%. The effect of various experimental parameters, such as initial dye concentration, contact time, and dose were investigated. $\text{Co}_3\text{O}_4/\text{SiO}_2$ nanocomposite shows high adsorption capacity of 53.87 mg g^{-1} , which is larger than the adsorption capacity of MB on other materials. Both of Langmuir and Freundlich models were used to analyze the equilibrium adsorption data. The pseudo-second-order model was found to be the most appropriate model to represent the present data. $\text{Co}_3\text{O}_4/\text{SiO}_2$ nanocomposite material is proposed as a potential adsorbent for water treatment.

Keywords: Cobalt Oxide/Silica; Nanocomposite; Adsorption; Methylene blue

1. Introduction

One of the important applications of metal oxide/silica nanocomposites is employing them in the field of catalysis. For instance, silica-supported cobalt has been reported as an excellent catalyst [1–3]. Moreover,

these nanocomposites have excellent surface properties making them potential humidity sensor materials [4]. Silica is commonly used as a supporting material because of its ability to prevent the core nanoparticles from leaching in an acid environment [5], inhibit the growth of the core nanoparticles, and stabilize their crystalline structure [6], increase their thermal stability [7,8], and enhance the void fraction [4,9].

*Corresponding author.