

## ADSORPTION OF CADMIUM IONS FROM WATER ON DOUBLE-WALLED CARBON NANOTUBES/IRON OXIDE COMPOSITE

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**Abstract.** A new material (DWCNT/iron oxide) for heavy metals removal was developed by combining the adsorption features of double-walled carbon nanotubes with the magnetic properties of iron oxides. Batch experiments were applied in order to evaluate adsorption capacity of the DWCNT/iron oxide composite for cadmium ions. The influence of operating parameters such as pH value, amount of adsorbent, initial adsorbate concentration and agitation speed was studied. The adsorption capacity of the DWCNT/iron oxide adsorbent for Cd<sup>2+</sup> ions was 20.8 mg g<sup>-1</sup>, which is at the state of the art. The obtained results revealed that DWCNT/iron oxide composite is a very promising adsorbent for removal of Cd<sup>2+</sup> ions from water under natural conditions. The advantage of the magnetic composite is that it can be used as adsorbent for contaminants in water and can be subsequently controlled and removed from the medium by a simple magnetic process.

**Keywords:** double-walled carbon nanotubes, iron oxide, adsorption, cadmium ion.

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### Introduction

Carbon nanotubes (CNTs) have attracted much attention worldwide since their discovery in 1991 [1]. CNTs are relatively new materials that due to their unique electrical, mechanical, optical and chemical properties [1], are used in an increasing number of applications, such as hydrogen storage [2,3] catalyst supports [4], chemical sensors [3,5] nanoelectronic devices [6], and even as tools for daily use, including water purification process [3].

Due to their high specific surface area as well as their layer structure, CNTs seem hold an important place in several fields of application, among those, they have been used as adsorbents for various organic contaminants and metal ions. CNTs can be easily modified by a chemical treatment to increase their adsorption properties [7]. Oxidation of CNTs has been widely reported [8] and different type of metals and oxides have been successfully supported on CNTs such as Ni, Cu, Pt, Fe, Co, SiO<sub>2</sub> [9], SnO<sub>2</sub> [10], Al<sub>2</sub>O<sub>3</sub> [6] and TiO<sub>2</sub> [11].

Metal ions are harmful pollutants on ecosystems; their presence in the environment can affect aquatic bodies with serious consequences to biological systems. Water contamination by heavy

metal ions had become much more serious with a rapid development of industries and competitive use of fresh water in many parts of the world. Therefore, heavy metal ions removal from water has become an important issue [11,12,13].

Cadmium, a non-essential and highly toxic metal, is used in the production of alloys, batteries, metal plating, ceramics, dyes and pigments [14,15]. It can be easily routed to drinking water and even at very low concentrations can affect health by causing serious diseases mainly affecting the bones, lungs and kidneys and can even cause some cancers [15,16]. In the field of water treatment, several ways to remove heavy metals from water are known, such as adsorption, coagulation, precipitation, electro dialysis, membrane separation and oxidation processes. However, adsorption process seems to be one of the most effective methods and presents several advantages due to its low-cost and easy usage.

In this work we report the synthesis of a new material (DWCNT/iron oxide) with magnetic properties, composed by double-walled carbon nanotubes and iron oxides. Magnetic nanoparticles of iron oxide are gaining importance as they can be used as highly efficient and