Faculty of Science
Chemistry Department

Assessment of Some Nanomaterials for Heavy Metals Removal from Water

A DISSERTATION

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Chemistry Department
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By

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B.Sc.(2003); M. Sc.(2008) (Al-Azhar University)
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PhD Thesis

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ABSTRACT

Name: Shaimaa Taha Elsaid El-Wakeel

Title: **Assessment of Some Nanomaterials for Heavy Metals Removal from Water**

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Nanotechnology holds great potential in advancing water and wastewater treatment to improve treatment efficiency by the development of innovative methods to produce new products, substitute existing production equipment and reformulate new materials and chemicals with improved performance resulting in less consumption of energy and materials and reduced harm to the environment as well as environmental remediation

The thesis has been focused on the application of nanotechnology for heavy metals removal from water.

Magnetite nanoparticles were prepared by chemical co-precipitation, characterized and have been investigated for the removal of chromium, nickel, copper, cadmium and lead ions from aqueous solutions.

Structural characterization of the prepared nanoparticles showed an average particle size of 2 and 7 nm confirmed by transmission electron microscopy image. The surface area was determined to be 125 m^2/g.

Batch experiments were carried out to determine the adsorption equilibrium of metals on magnetite nanoparticles as a function of contact time, initial pH, initial metal concentration, and adsorbent dose.

Adsorption equilibrium was reached within 60 min independent of initial metal concentration using 2 g/L of nano magnetite. The affinity order of the metal ions towards nano magnetite was: Cu^{2+}>Pb^{2+} > Cr (VI) >Cd^{2+}>Ni^{2+}

In order to increase the magnetite capacity for adsorption and get useful from its magnetic properties, magnetite composites with clay (kaolinite) and ion exchange resin (Dowex 50WX4) were prepared ,characterized and tested for heavy metals removal.

The magnetite kaolinite nanocomposite (Mag-KL) showed a less metals removal percentages compared to that obtained from nano magnetite.

Adsorption reached equilibrium at 30 min with the use of magnetite- Dowex 50WX4 resin (Mag-Dow) nanocomposite and metals adsorped in the order Cu^{2+} > Cr (VI) >Cd^{2+} > Ni^{+2} > Pb^{2+}

Nano magnetite composited with chitosan to form a sheet film (NMag-CS) and was tested for heavy metals removal.

Surface area for the prepared nano magnetite and its composites followed the order: NMag-CS films > Mag-Dow nanocomposite > nano magnetite > Mag-KL nanocomposite.

Adsorption by Mag-Dow nanocomposite was the highest for all metals compared to nano magnetite and its composites.

Adsorption isotherms and Kinetics adopted by different prepared adsorpents were investigated.

Oxidation of MWCNTs (MWCNTs-ox) with nitric acid solution had improved the sorption capacity of MWCNTs for metal ions.

Adsorption using both MWCNTs and MWCNTs-ox attained equilibrium at 120 min and was highly dependent on the solution pH and adsorbent dose.

In this study nano zero valent iron (NZVI) was prepared by liquid phase reduction method , characterized and was tested for heavy metals removal .

The prepared NZVI showed a high adsorption capacity over the prepared nano magnetite and the effects of contact time, initial metals concentration , pH and adsorbent dose on the adsorption were investigated .

Zero valent iron - Dowex 50 WX4 resin (NZVI-Dow) nanocomposite was prepared and showed high adsorption capacity compared to NZVI.

NZVI was also stabilized with chitosan to form a film (NZVI-CS) which subjected to heavy metals adsorption under the different tested conditions.

CONTENTS

Chapter III
Results and Discussion

Abbreviations

BCM	Billion Cubic Meter
BET	Brunauer-Emmett- Teller
CNTs	Carbon Nanotubes
CS	Chitosan
EPA	Environmental Protection Agency
FTIR	Fourier Transform Infrared spectroscopy
Mag –Dow	Magnetite –Dowex 50 WX4 Resin Nanocomposite
Mag-KL	Magnetite – Kaolinite Nanocomposite
MWCNT	Multiwalled Carbon Nanotubes
NMag-CS	Nano Magnetite –Chitosan
NZVI	Nano Zero Valent Iron
NZVI-CS	Nano Zero Valent Iron –Chitosan
NZVI-Dow	Nano Zero Valent Iron-Dowex 50 WX4 Resin Nanocomposite
pH_{pzc}	Point of Zero Charge
SWCNT	Single Walled Carbon Nanotubes
TEM	Transmission Electron Microscopy
VSM	Vibrating Sample Magnetometry
XRD	X-ray Diffraction (XRD)