



Ain Shams University
Faculty of Science
Chemistry Department

Utilization of Some Solid Wastes in the Field of Water Treatment

A Thesis

Submitted for Ph.D Degree in Chemistry

By

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M.Sc. Chemistry, (2008)

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Sayed Ahmed Othman Abo El-Dahab

List of Abbreviation

Symbol	Description
WHO	World health organization
TDS	Total dissolved salts
TSS	Total suspended solids
WTS	Water treatment sludge
PCB	Powder calcined brick
WBD	Waste brick dust
COD	Chemical oxygen demand
SMWW	Standard methods for the examination of water and wastewater
FA	Fly ash
DWTS	Drinking water treatment sludge
LWBW	Light white brick waste
HOMRA	Red brick waste
ICP	Inductive coupled plasma
XRD	X-ray diffraction
XRF	X-ray florescence
EDX	Energy Dispersive X-ray
SEM	Scanning electron microscope
CSH	Calcium silicate hydrates
CS	Calcium silicate



Research paper

Drinking water treatment sludge as an efficient adsorbent for heavy metals removal

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ABSTRACT

Green chemists paid much more attention towards the alternative ways to reutilize waste materials instead of its disposal in a non-ecofriendly manner. In this study, drinking-water treatment sludge (DWTS), which is a by-product resulted from drinking water treatment plants, was successfully applied as an adsorbent for Pb(II), Cd(II) and Ni(II) removal from wastewater. The physicochemical characteristics of DWTS were investigated using X-ray diffraction (XRD), X-ray fluorescence (XRF), scanning electron microscopy (SEM) and N₂ adsorption-desorption isotherms.

The XRD analysis revealed that the DWTS under study consists of quartz and illite phases which had been reported for their adsorption efficiency. Firing of DWTS at 500 °C causes the appearance of albite phase in addition to previous ones which enhances the adsorption capacity of these materials. The influence of different parameters such as firing temperature of DWTS, contact time, pH, DWTS dose and initial metal ions concentration on the adsorption of heavy metal ions and, consequently, on their removal were investigated. DWTS exhibit an adsorption efficiency towards Pb(II) > Cd(II) > Ni(II). The extremely high efficiency of DWTS towards Pb(II) adsorption can nominate it as a specific low-cost adsorbent for Pb ions.

1. Introduction

Drinking-water treatment sludge (DWTS) is a by-product from the coagulation-flocculation process using aluminum or iron based salts to precipitate clay, colloidal particles, algae and humic substances from water resources. Due to its high production rate and its environmentally unfavored disposal to landfill, several researchers paid a considerable attention for using this waste material in different applications especially those of low cost. The chemical composition of DWTS varies depending on the source of water under treatment as well as the type of coagulant used. These applications include utilization of DWTS for ceramic products (Zamora et al., 2008; Kizinievic et al., 2013; Mymrin et al., 2017), cement and concrete production (Rodríguez et al., 2010; Sales et al., 2011; Hwang et al., 2017) as well as wastewater treatment as an adsorbent for the removal of phenolic compounds (Fragoso and Duarte, 2012), phosphates (Razali et al., 2007; Piaskowski, 2013), dyes from textile industry discharge (Chu, 1999) and heavy metals (Ippolito et al., 2011; Siswoyo et al., 2014).

Pollution of water resources by heavy metals such as lead, cadmium and nickel which are continuously discharged in huge amounts from different growing industrial activities has been recognized (Ribeiro

et al., 2012; Yang and Cui, 2013; Keränen et al., 2015). These heavy metals are considered as hazardous materials where their toxicity to living organisms comes from their tendency to accumulate in living tissues since they are not biodegradable causing several health hazards like kidney problems, anemia, lung cancer and dyspnoea (Ahmaruzzaman, 2011; Visa et al., 2012). Therefore, a tremendous number of researches deals with the removal of such heavy metals especially via adsorption process (Bailey et al., 1999; Babel and Kurniawan, 2003; Ngah and Hanafiah, 2008; Tofighy and Mohammadi, 2015; Castaldi et al., 2015; Isaac et al., 2015; Dobrowolski et al., 2017; Azimi et al., 2017).

The aim of this study is to get a beneficial use of DWTS as a low cost adsorbent for the removal of lead, cadmium and nickel metal ions from wastewater.

2. Experimental

2.1. Starting materials

The material used in this investigation is DWTS waste produced during 4 months from El-Fustat drinking water treatment plant (Egypt).

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ABSTRACT

The objective of this study is to investigate the efficiency of using drinking water treatment sludge (DWTS), light white brick (LWBW) and red brick (HOMRA) wastes as solid adsorbents for the removal of heavy metal ions like lead, cadmium and nickel from their aqueous solution. The physicochemical characteristics of each solid waste were investigated using X-ray diffraction (XRD), X-ray fluorescence (XRF), scanning electron microscopy (SEM) and N_2 adsorption-desorption isotherms. Besides, the effect of different parameters such as contact time, initial pH, initial metal ion concentrations, adsorbent dose and competition of metal ions on the adsorption of heavy metal ions was studied by using batch experiments. In addition, the effect of firing temperatures on the removal efficiency of these heavy metal ions from their solutions was investigated in case of DWTS. The removal efficiency at optimum conditions was approximately 100% for Pb^{+2} , Cd^{+2} and Ni^{+2} using DWTS and LWBW and 100, 20 and 9.7%, respectively using HOMRA. The adsorption kinetics of ions was followed the pseudo-second-order model based on the amounts of metal sorbed at various time intervals.

Keywords: Solid waste, heavy metals, wastewater, sludge, brick waste, low cost adsorbent.

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