بسم الله الرحمن الرحيم

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تم رفع هذه الرسالة بواسطة /صفاء محمود عبد الشافى

بقسم التوثيق الإلكتروني بمركز الشبكات وتكنولوجيا المعلومات دون أدنى مسئولية عن محتوى هذه الرسالة.

ملاحظات: لايوجد

ADSORPTION OF COPPER AND ZINC FROM AQUEOUS SOLUTIONS USING FULLER'S EARTH: KINETICS, EQUILIBRIUM, AND THERMODYNAMICS

By

Ahmed Ali Ibrahim Eita

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Civil Engineering - Public Works

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
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Title of Thesis:

Adsorption of Copper and Zinc from Aqueous Solutions Using Fuller's Earth: Kinetics, Equilibrium, and Thermodynamics

Key Words:
Adsorption; Fuller's Earth; Copper; Zinc; Wastewater.

Summary:
Heavy metals are non-biodegradable toxins that can accumulate in nature. Many of the most widespread heavy metals are copper and zinc. Adsorption is an effective method for the uptake of heavy metals from wastewater. Thus, this research aimed to study the adsorption of copper and zinc onto fuller's earth. The effects of the solution's pH and initial concentration were investigated. The results showed that the efficiency of removal increased with the initial pH value of the solution. The optimum initial concentration of either copper or zinc for maximum removal efficiency was found to be 100 mg/L. The adsorption kinetics and mechanism were studied using pseudo-first-order, pseudo-second-order, Elovich equation, intra-particle, and Boyd models. The data were best fitted with a pseudo-second-order kinetic model for either copper or zinc concentrations. The data were also fitted using several isotherms for equilibrium studies, such as Langmuir, Dubinin-Radushkevich, Freundlich, and Temkin. The adsorption of either copper or zinc using fuller's earth was best fitted with a Dubinin-Radushkevich and Temkin isotherm, respectively. Thermodynamics and desorption studies were also reported. The results indicate that the adsorption efficiency increased with temperature, while desorption studies showed that HCl was able to regenerate the used fuller's earth. Finally, the morphology of the fuller's earth before and after adsorption was examined and showed the difference between the surfaces of fuller's earth before and after adsorption process.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

Name: Ahmed Ali Ibrahim Eita Date: … /… /2022

Signature:

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Nomenclature

2,4-DCP	2,4- dichlorophenol
A_{ad}	surface area per gram of adsorbent
AC	activated carbon
A_T	Temkin isotherm equilibrium binding constant
B	Temkin constant related to heat of sorption
b_A	Langmuir adsorption constant
B_{DR}	Dubinin–Radushkevich constant
B_t	the function of F
b_T	Temkin isotherm constant
C	Constant in the isotherm models
$C_{desorbed}$	the metal concentration liquid phase present in the desorbing solution
CdS	Cadmium sulfide
C_e	adsorbate equilibrium concentration in aqueous solution
CeO_2	Ceric oxide
C_o	adsorbate initial concentration in aqueous solution
Conc.	Concentration
Cu	Copper
$CuSO_4$	Copper sulfate
Da	Dalton unit
D_i	effective diffusion coefficient
E	adsorption energy
e^-/h^+	Suppressed recombination of photogenerated electrons/holes
EC	electrocoagulation
EDX	Energy Dispersive X-Ray Analysis
EMRA	Egyptian Mineral Resources Authority
EO	electro-oxidation
EPA	Environmental Protection Agency
ER	electroreduction
F	fractional attainment of equilibrium at different time t
FE	Fuller's earth
HCl	hydrochloric acid
J/mol	Joule per mole
J/mol/K	Joule per mole kelvin
K.V.	kilovolt
K_1	constant for the Pseudo-first-order equation
K_2	rate constant for the Pseudo-second-order equation
K_{ad}	Langmuir adsorption equilibrium constant
K_F	Freundlich adsorption capacity parameter
K_{id}	expression rate
kJ/mol	kilojoule per mole
M	the reductant metal in cementation process
mol	Mole
m^2/g	square meter per gram
MW	molecular weight of adsorbate
N	the noble metal in cementation process
n	Freundlich adsorption intensity parameter