بسم الله الرحمن الرحيم

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REMEDIATION OF SOIL CONTAMINATION CAUSED BY BRICK INDUSTRY USING ELECTROKINETIC TECHNIQUE: A CASE STUDY OF A BRICK FACTORY IN AL-NAHRAWAN AREA IN IRAQ

By

Sarah Duraid Ahmed Zangana

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
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Title of Thesis:

Remediation of Soil Contamination Caused By Brick Industry Using Electrokinetic Technique: A Case Study of the Brick Factory In Al- Nahrawan Area In Iraq.

Key Words:
Brick; Soil; Pollution; Electrokinetic; Heavy Metals.

Summary:

In this thesis, polluted soil with heavy metals (Pb, Cd, V, Ni, Cu, Zn, Cr) and S is being treated to remove the pollutants from it by the electrokinetic methods. The experimental setup consisted of electrodes placed in the soil and connected to electric power source. Twelve experiments were conducted. The following parameters were studied: the type of electrode, voltage, distance between the electrodes, and the use of electrolytes. The removal rates of heavy elements by electrokinetic method differed from one experiment to another, but they proved to be effective in removing pollutants from the soil. The electrokinetic process was found to be a successful process to reduce the concentration of soil contaminants including heavy metals (Pb, Cd, V, Ni, Cu, Zn, Cr) and S, when using stainless steel and graphite electrodes. The best electrode for removing Pb, Cd, Cr and S was found to be the graphite electrode, while the best electrode to remove V, Zn, Cu and Ni was stainless steel.

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: Sarah Duraid Ahmed Date: / / 2022

Signature:

Dedication

To from the first drop of water I drank from his river

To from the first atom of air I inhaled from him

... My beloved country, **Iraq**

To my support, my hope and my life

... my **father** and **mother**

To whom do I draw my energy and strength

... my **sister** and my **brothers**

With my love...

Sarah

2022

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Thank You

Sarah

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Nomenclature

Abb.	INTERPRETATION
As	Arsenic
AC	Alternating current
BS	Body mill sludge
Cd	Cadmium
Cu	Copper
Cr	Chromium
CO	Carbon monoxide
CO_2	Carbon dioxide
DBS	Dry bed sewage sludge
DOC	Dissolved organic carbon
DC	Direct current
EC	Electrical conductivity
EDTA	Ethylene diamine tetra acetic acid
EKPR	Electrokinetic assisted phytoremediation
EKR	Electrokinetic remediation
ECC	Energy consumption cost
EEP	Electric energy price
Gr	Graphite
Hg	Mercury
HA	Humic acid
H	High
H_2S	Hydrogen sulfide
Ir	Iridium
i	Current density
KW	Kilo Watt
LCA	Life cycle analysis
LBS	Lead bearers sewage sludge
MCBP	Milted clay brick powder
mA	Milli amber
Ni	Nickel
NA	Natural attenuation
NO_2	Nitrogen dioxide
Pb	Lead
PS	Polishing sludge
pH	Negative logarithm of hydrogen ion concentration
ppm	parts per million
PM	Particulate Matter (contain a proportionately larger amount of water and acid forming chemicals such as sulphate and nitrate and carbon material) [67].
PM_{10}	Particulate Matter with size 10 µm
PM_{25}	Particulate Matter with size 25 µm
PHC	Polycyclic hydrocarbons
RHA	Rice husk ash
RH	Relative humidity