INVESTIGATION OF ZINC REMOVAL CAPACITIES OF DIFFERENT SORBENT MATERIALS TO BE USED IN CONSTRUCTED WETLANDS

MASTER OF SCIENCE

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SRI LANKA

DECEMBER 2010

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(08/8018)

Thesis submitted in partial fulfilment of the requirements for the degree Master of Science

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December 2010

Declaration

I hereby declare that this submission is my own work and that to the best of my knowledge and belief, it contains neither materials previously published or written by another person, nor material, which to a substantial extent has been accepted for the award of any other degree or diploma of an university or other institute of higher studies, except where an acknowledgement is made in the text.

W.A.U. Witharana
Date:

This is to certify that this thesis submitted by W.A.U. Witharana is a record of candidate's own work carried out by her under our supervision. The matter embodied in this thesis is original and has not been submitted for the award of any other degree.

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Decayed is this body, a frail nest of diseases. This foul mass breaks up. Indeed, the life ends in death.
Lord Buddha, B.C. 563. Dhamma Padaya, Jara vaggo, verse 148.

Dedication

To

All teachers

who have profoundly changed

the our lives

Acknowledgement

I owe my deepest gratitude to all the teachers who have guided me towards the success of my academic achievements.

Firstly, I am most grateful to Dr. Mahesh Jayaweera and Dr. J.M.A. Manatunge, who gave me the opportunity to pursue higher studies. This thesis would not have been a possibility unless my supervisors who have been very helpful in providing good guidance, advices and critical remarks during the period of Master's thesis. I would like to thank Prof. (Mrs). Ratnayake for her invaluable support and advises. It is my pleasure to thank external examination committee, Dr.(Mrs). Banduni Laiyanage, Prof. Suren Wijekoon and Dr. Udeni Nawagamuwa who has made available his support in numerous of ways.

I wish to extend my thanks to Sida, for granting financial support through ARRPET Phase II project. A major part of my work has been done in the Environmental Engineering Laboratory. I am indebted to the lab staff: Ms. Nilanthi Gunathilake, Mr. Justin Silva, Ms. Inoka Udayangani, Ms. Sulochana Boteju and Ms. Priyashani Cooray for their kind assistance. I would like to express my heartiest gratitude to Ms. Manjula Ranasinghe and Mr. Gayan Gunarathne for being available during hard times.

I would also like to express my sincere gratitude to Mr. C.H. Manoratne at Industrial Technology Institute, for assisting me in analyzing results.

I would like to show my deepest gratitude to my mother for her eternal love and to my brother and sister, who have been the strength in my life. Last but not least, I should thank to Nuwan, my beloved husband, for all the love and caring.

Abstract

There is an increasing demand for better water quality in order to safeguard public health, the social security and accomplish environmental integrity. It has been found over the past couple of years that health hazards associated with heavy metal have been on the rise, particularly the chronic health problems due to the ingestion or consumption of even low doses of heavy metal-rich waters. Accumulation of such metals is reported mainly due to non-treatment or poor treatment of industrial wastewaters. Lack of tertiary treatment may have attributed to this growing problem and hence the environmental pollution. Constructed wetlands have therefore received great attention in the recent past as a tertiary treatment method or a polishing technique due to low construction and operation costs, minimum maintenance and also as an environmental friendly system. However, finding a low-cost sorbent material which can be used as an alternative to activated carbon has been a problem for decades in wastewater treatment industry, especially in developing countries. Therefore, the present study focuses on the applicability of low-cost sorbent materials that can be used in constructed wetlands as a filter medium. The focus was on four sorbent materials: tile, brick, saw dust and rice husks, which were selected based on their local availability. Laboratory-scale experiments were performed to investigate their maximum adsorption capacity and removal efficiency with a synthetic Zinc solution. The Results revealed that tile material has the highest adsorption capacity (47.6 mg/g) and removal efficiency, (98%) while brick (37.0 mg/g, 86%), sawdust (20.4 mg/g, 80%) and rice husks (15.8 mg/g, 64%) have relatively low adsorption capacities and removal efficiencies, respectively. The percentage removal of Zinc by all the four sorbent materials increased with an increase of contact time. The kinetics of adsorption were relatively fast for all tested low-cost materials. The equilibrium data were correlated with both Langmuir and Freundlich isotherms. Adsorption isotherms are well described by Langmuir isotherms. The separation factor of equilibrium (R_L) indicates favourable isotherms ($0< R_L >1$) for all tested materials. Characterization of four sorbent materials was done by undertaking SEM, XRD and FTIR analyses. It can be concluded from the results that, the low-cost sorbent materials that were tested can be an attractive substitute for activated carbon in removing Zn from industrial wastewaters.

Keywords: adsorption isotherms, constructed wetlands, sorbent material, Zinc

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Abbreviations and Acronyms

AAS	Atomic Adsorption Spectrometer
BOD	Biological Oxygen Demand
BOI	Board of Investment of Sri Lanka
CAC	Commercially available Activated Carbon
CEA	Central Environmental Authority
CEC	Cation Exchange Capacity
CWs	Constructed Wetlands
FIAM	Free Ion Activity Model
FTIR	Fourier Transformation Infra-Red
FWS CWs	Free Water Surface Constructed Wetlands
FWS	Free Water Surface
HSSF	Horizontal Subsurface Flow
IAA	Indole Acetic Acid
IDB	Industrial Development Board
MoID	Ministry of Industrial Development
NEA	National Environment Act
N	Nitrogen
P	Phosphorus
SEM	Scanning Electron Microscope
SSHF CWs	Subsurface Horizontal Flow Constructed Wetlands
SSVF CWs	Sub-Surface Vertical Flow Constructed Wetlands
TOC	Total Organic Carbon
TON	Total Organic Nitrogen
TRP	Total Reactive Phosphorus
TSS	Total Suspended Solids
XRD	X-Ray Diffraction