LABORATORY WASTEWATER TREATMENT USING CLAY BIOCHAR COMPOSITES IN BIO-GEO FILTERS

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Thesis submitted in partial fulfillment of the requirements for the degree
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DECLARATION

"I declare that this is my own work, and that this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma at any other University or institute of higher learning, and that it does not contain any material previously published or written by another person to the best of my knowledge and belief, except where acknowledgement is made in the text." In addition, I grant the University of Moratuwa the non-exclusive right to reproduce and disseminate my thesis in whole or in part in print, electronic, or other media. I reserve the right to use this content in whole or in part in future works (for example, articles or books)."

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Name of the supervisor:

Name of the supervisors:	Prof. Bandunee Athapattu	Dr.M.M. Inoka D. Manthilake
Signature of the supervisor:		
Date :		

ABSTRACT

Laboratory waste is overlooked because of its low flow rate, despite the fact that it has a negative influence on the human and environmental systems. As a result, the focus of this research is on using clay biochar composites in horizontal flow bio geo filters to treat university laboratory wastewater in an environmentally acceptable manner.

The composite was made with a 1:5, 1:3, 1:1, 3:1, and 5:1 mass ratio of Cinnamon biochar and Neem biomass to clay from Giant tank, Murunkan, Mannar for laboratory research experiments, and then treated with slow pyrolysis at 400°C. To determine the hydraulic retention period, adsorption kinetic studies and isotherms were performed, followed by the m/v ratio and COD test. For both Neem and Cinnamon, the Clay: Biochar mass ratios, 1:1 ratio composite exhibits superior efficacy in COD elimination.

To ensure the presence of Montmonolite, clay samples were analyzed by Laser diffraction particle size analysis. As a result, clay samples taken from the Giant tank contain 3.42% and 4.99% nano clay, respectively. The existence of MMT in Murunkan clay is confirmed by FTIR readings of clay samples from Murunkan, which reveal a distinct and strong band at 998.03 cm^{-1} and 3620 cm^{-1}. XRF analysis was used to assess the chemical composition of biochar samples. The use of biochar with a greater K content supports heavy metal sorption and phosphors retention. H/C ratios of Cinnamon and Neem biochars were 0.06 and 0.02 respectively, according to CHN analyses. BET study revealed that the specific surface area (SSA) of gasified Cinnamon Biochar was $563m^2/g$. As a result, it has a higher adsorption affinity. Kinetic model parameters for COD adsorption onto Neem - BC and Cinnamon - BC composites were determined using the most commonly utilized adsorption kinetic mathematical models. The removal effectiveness of adsorbent constructed of Neem biochar composite is better than that of Cinnamon biochar composite.

The Bio Geo Filter was created using Subsurface Flow Constructed Wetlands design principles. For the treatment system, a composite sample of on-site stored wastewater was diluted to 1:100. The system is based on a mix of physical, chemical, and biological processes that occur naturally in wetlands and are linked to vegetation, sediments, and the microbial populations that live there. The removal effectiveness of the system for heavy metals (Cd, Cr, Hg, and Mn) was investigated, and all heavy metal concentrations in effluent were much lower than in influent. The effluent quality was assessed and compared to CEA criteria for inland surface discharge. When water travels through the systems and into the tanks, only phosphate levels increase. As a result, methods for using this by-product (Phosphate) as fertilizer must be developed. As a result, our newly designed cost-effective bio-geo filter treatment system is highly recommended for laboratory wastewater purification.

Keywords: *Laboratory wastewater, Murunkan Clay, Biochar, Constructed wetland, Bio-geo composite, Kinetic models & Isotherms*

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UGC	-	University Grant Commission
SLSI	-	Sri Lanka Standard Institute
NBRO	-	National Building Research Organization
NWS&DB	-	National Water Supply and Drainage Board
ITI	-	Industrial Technology Institute
CEA	-	Central Environmental Authority
SLLDC	-	Sri Lanka Land Development Corporation
CECB	-	Central Engineering Consultancy Bureau
NERD	-	National Engineering Research and Development
OUSL	-	Open University of Sri Lanka
COD	-	Chemical Oxygen Demand
BOD	-	Bio Chemical Oxygen Demand
TDS	-	Total Dissolved Solids
TSS	-	Total Suspended Solids
SSA	-	Specific Surface Area
BC	-	BioChar
WHO	-	World Health Organization
UV	-	Ultra Violet
HDPE	-	High Density Polyethylene
IBI	-	International Biochar Initiative
MMT	-	Montmorillonite
XRD	-	X-ray diffraction
DTA	-	Differential thermal analysis
TGA	-	Thermogravimetric Analysis
FTIR	-	Fourier transform infrared spectroscopy
BET	-	Brunauer-Emmett-Teller (BET)
XRF	-	X-Ray Florescence Analysis
SEM	-	Scanning Electron Microscopy
CEC	-	Cation Exchange Capacity
FWS CW	-	Free water surface constructed wetlands
FTWs	-	Floating Treatment Wetlands
HSF CW	-	Horizontal Subsurface Flow Constructed Wetland
VF CWs	-	Vertical Flow Constructed Wetlands
HFSS	-	Horizontal flow subsurface