STUDIES ON THE DEVELOPMENT OF NATURAL CATION EXCHANGER FOR HEAVY METALS REMOVAL

A Thesis Submitted to the Central Department of Chemistry

Institute of Science and Technology

Tribhuvan University, Nepal

For the Award of Doctor of Philosophy (Ph. D.) Degree in Chemistry

By

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This is to certify that **Mr. Puspa Lal Homagai** has completed this dissertation work entitled **Studies on the Development of Natural Cation Exchanger for Heavy Metals Removal** for the award of **Doctor of Philosophy (Ph. D.) Degree in Chemistry** under my supervision, to my knowledge this work has not been submitted for any other degree.

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Dedicated to my Parents

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ABSTRACT

Two types of novel bioadsorbents such as charred xanthated sugarcane bagasse (CXSB) and charred aminated sugarcane bagasse (CASB) are investigated. This research work elucidates the uptake performance of biosorbent for the sequestration of heavy metal ions such as Cd^{2+}, Pb^{2+}, Cu^{2+}, Ni^{2+} and Zn^{2+}, respectively. Xanthated and aminated biosorbent prepared from sugarcane bagasse under specific experimental conditions were characterized with FT-IR, TGA/DTA, SEM, Zeta potential and Elemental analysis.

Batch adsorption experiments were performed at eight different initial metal ion concentrations (25, 50,100, 200, 400, 600, 800, 1000 mg/L), at 293K temperature, while pH of the solutions was varied from 1 to 7. The results indicated that the uptake performance of CXSB and CASB biosorbent significantly changed with pH, concentration of metal ions and temperature. The selectivity order in the removal of heavy metals at pH around 4 follows the order Pb> Cu > Ni > Cd >Zn for CXSB whereas the order Pb> Cd > Zn > Ni >Cu for CASB. Moreover Irwing- Williams Series support the bindings' mechanism for Cu^{2+}, Cd^{2+},Pb^{2+}, $Zn^{2+}$and Ni^{2+} ions onto both the modified biopolymers.

Adsorption of heavy metal ions onto both CXSB and CASB biosobents followed pseudo-second order kinetics with faster adsorption within 15minutes to 40 minutes. All the obtained data well followed the Langmuir adsorption isotherm. The positive value of enthalpy change (ΔH) and negative of free energy change (ΔG) shows the adsorption process is endothermic and spontaneous. Moreover, the obtained positive entropy changes (ΔS) shows that an increase in randomness, is associated with the adsorption of metal ions onto the CXSB and CASB biosorbents.

As in the case of plastic materials like commercial synthetic cation exchanger, the CXSB and CASB based on sugarcane bagasse developed in our laboratory revealed to be an efficient cation exchanger for removing cadmium, lead, copper, nickel and zinc ions from the aqueous solution.

Keywords: Adsorption, xanthation, amination, heavy metals, sugarcane bassage.

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LIST OF ABBREVIATIONS

AAS	Atomic absorption spectrometry
C	Centigrade
CASB	Charred animated sugarcane bagasse
CSB	Charred sugarcane bagasse
cm	centimeter
CXSB	Charred Xanthated Sugarcane Bagasse
dm^3	Decimeter cube
DTA	Differential Gravimetric Analysis
FT-IR	Fourier Transform Infrared Spectroscopy
g	gram
K	Kelvin
L	Litre
m	meter
mg	milligram
µg	microgram
µm	micrometer
mL	milliliter
mm	millimeter
pH	power of hydrogen

rpm	rotation per minute
RSB	Raw sugarcane bagasse
SB	Sugarcane bassage
SEM	Scanning Electron Microscopy
TGA	Thermo Gravimetric Analysis