ADSORPTION OF Cd (II) FROM AQUEOUS SOLUTION BY ACTIVATED CHARCOAL DERIVED FROM LAPSI SEEDS

A

Dissertation

Submitted as a Partial Fulfilment of Requirements for the Degree of

Master of Science in Chemistry

by

Nirmal Lamsal

Roll No (1374)

Central Department of Chemistry

Institute of Science and Technology

Tribhuvan University, Kirtipur

Kathmandu, Nepal

2009

Tribhuvan University
Institute of Science and Technology
Central Department of Chemistry
Kirtipur, Kathmandu
Nepal

The dissertation
entitled

Adsorption of Cd (II) from Aqueous Solution by Activated Charcoal Derived from Lapsi Seeds

Submitted by
Nirmal Lamsal
(Symbol No.1374)

has been accepted as a partial fulfilment of the requirements for the Master's Degree in Chemistry

---
Head
Central Department of Chemistry

External examiner

Supervisor
Dr. Raja Ram Pradhananga
Professor
Central Department of Chemistry

Foreword

The dissertation entitled "**ADSORPTION OF Cd (II) FROM AQUEOUS SOLUTION BY ACTIVATED CHARCOAL DERIVED FROM WASTE SEEDS**" submitted by Mr. Nirmal Lamsal for the MSc degree in Chemistry of Tribhuvan University was carried out under my supervision in the academic year 2006/2008. During the research period he had worked sincerely and satisfactorily to complete this dissertation.

Dr. Raja Ram Pradhananga
Professor
Central Department of Chemistry
Tribhuvan University
Kirtipur, Kathmandu
NEPAL

ACKNOWLEDGEMENT

During the course of research work and writing thesis, I came to know many people who have in one way or another contributed in its completion. First and foremost, I would like to thank my supervisor Prof. Dr. Raja Ram Pradhananga for his insight, guidance, support and absolutely everything that he did for me. The door of Raja Ram sir was always open to me whenever I had trouble during my practical work or had questions regarding research writing. He consistently encouraged me to make this paper to be my own work and steered me in right direction to present the practical work appropriately in written form.

I would like to extend my sincere gratitude to Prof. Dr. Tulsi Prasad Pathak, head of Central Department of Chemistry for providing necessary facilities to carry out this research.

I also appreciate Mrs. Armila Rajbhandari for the help that I received during the early stage of research work.

My thankfulness also goes to all of my thesis mates and laboratory colleagues for their kind help, cooperation and company. The one year research period became one of the wonderful times of my life due to their presence.

Finally, I am very much indebted to my entire family for their unconditional love, inspiration and support through out my study as well as research period.

NIRMAL LAMSAL

ABSTRACT

The potential and effectiveness of activated carbon derived from carbonization of Lapsi (*Choerospondias axillaris*) seed for adsorptive removal of cadmium (II) was examined by adsorption technique. The carbon obtained from Lapsi seed was chemically modified by treating with 1:1 HNO_3 at 60^o C. Boehm method was used to estimate the oxygen containing acidic functional groups. The acidic functional group, specific surface area and adsorptive capacity all greatly increased with chemical treatment with nitric acid. The specific surface area of the charcoal, after chemical treatment, increased to 600 m^2/g from 45 m^2/g. The ash, moisture and carbon contained in modified charcoal were found to be 3.5%, 0.2 % and 96.3 % respectively. The performance of the adsorbent was in par with commercial activated charcoal. Various parameters such as contact time, adsorbent dose, pH and metal ion concentrations on adsorption were studied, optimized and applied in the present study. The maximum adsorption capacity of charcoal to adsorb Cd(II) was found to be 12.53 mg/g at optimum pH of 6 and equilibrium was attained within 150 minutes. The adsorption of cadmium followed pseudo second order kinetic model and the rate constant of the process was found to be $1.73x10^{-3}$ g mg^{-1} min^{-1}. Results indicated that the Langmuir model gave a better fit to the experimental data in comparison with the Freundlich isotherm.

Keywords: heavy metals, Cadmium (II), activated carbons, *Choerospondias axillaris*, chemical activation, adsorption capacity, adsorption isotherm, adsorption kinetics

TABLE OF CONTENTS

List of Abbreviations and Symbols

%	Percentage
mg/L	Milligram Per Liter
g/L	Gram Per Liter
µg/mL	Microgram Per Milliliter
nm	Nanometer
ppm	Parts Per Million
mg/g	Milligram Per Gram
meq/gm	Milliequivalent per gram
mL	Millileter
Cd(II)	Divalent Cadmium
AC	Activated Charcoal
CAC	Commercially Activated Charcoal
CASC	*Choerospondias axillaris* Seed Charcoal
MCASC	Modified *Choerospondias axillaris* Seed Charcoal
C_o	Initial Concentration of Cd (II) in mg/L
C_t	Concentration of Cd (II) in mg/L at time‘t’
V	Volume of Cd (II) solutions in L
M	Weight of activated carbon in gram
R_{em}(%)	Percentage Removal
q_e	Amount of Cd(II) adsorbed per gram at equilibrium
C_e	Equilibrium concentration of Cd (II) in mg/L
q_m	Maximum adsorption Capacity in mg/g
b	Energy of adsorption
K	Adsorption capacity
n	Adsorption intensity
K_1	Pseudo first-order rate constant
K_2	Pseudo second-order rate constant
h	Initial adsorption rate

SEM	Scanning Electron Microscope
meq	Milliequivalent
R^2	Correlation Coefficient
L/g	Litre pergram