

**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*

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The dissertation  
*entitled*

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

*Submitted by*  
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has been accepted as a partial fulfilment of the requirements for the  
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## **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.

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**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<sub>3</sub> at 60° 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<sup>2</sup>/g from 45 m<sup>2</sup>/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<sup>-3</sup> g mg<sup>-1</sup> min<sup>-1</sup>. 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

|  |                                     |
|--|-------------------------------------|
| <b>1. INTRODUCTION.....</b>  | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| <b>1.1 GENERAL INTRODUCTION .....</b>  | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| <b>1.2 CHARCOAL AS AN ADSORBENT .....</b>  | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| <b>1.3 CHARACTERIZATION OF ACTIVATED CHARCOAL .....</b>                                      | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| <i>1.3.1 Proximate Analysis of the Adsorbent .....</i>                                       | <i>Error! Bookmark not defined.</i> |
| <i>1.3.2 Determination of Surface area.....</i>  | <i>Error! Bookmark not defined.</i> |
| <i>1.3.3 Functional group determination: Boehm Titration.....</i>                            | <i>Error! Bookmark not defined.</i> |
| <i>1.3.4 Scanning Electron Microscope (SEM).....</i>   | <i>Error! Bookmark not defined.</i> |
| <b>1.4 DETERMINATION OF CADMIUM (II) .....</b>   | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| <b>1.5 ADSORPTION OF METAL IONS .....</b>  | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| <b>1.6 ADSORPTION ISOTHERM.....</b>  | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| <b>1.7 ADSORPTION KINETICS .....</b>   | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| <b>1.8 LITERATURE SURVEY .....</b>   | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| <br>   |                                     |
| <b>2. OBJECTIVES OF THE PRESENT STUDY.....</b>   | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| <b>2.1 GENERAL OBJECTIVE .....</b>   | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| <b>2.2 THE SPECIFIC OBJECTIVES .....</b>   | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| <br>   |                                     |
| <b>3. EXPERIMENTAL .....</b>   | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| <b>3.1 PREPARATION OF REAGENTS .....</b>   | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| <i>3.1.3 Nitric Acid solution, 0.1 M.....</i>  | <i>Error! Bookmark not defined.</i> |
| <i>3.1.4 Sodium Hydroxide Solution, 1.0 M .....</i>  | <i>Error! Bookmark not defined.</i> |
| <i>3.1.5 Hydrochloric acid solution, 0.1 M .....</i>   | <i>Error! Bookmark not defined.</i> |
| <i>3.1.6 Buffer Solutions.....</i>   | <i>Error! Bookmark not defined.</i> |
| <i>3.1.7 Standard Solutions .....</i>  | <i>Error! Bookmark not defined.</i> |
| <b>3.2 PREPARATION OF ADSORBENTS .....</b>   | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| <i>3.2.1 Preparation of Charcoal from Lapsi (Choerospondias axillaris) seed (CASC) .....</i> | <i>Error! Bookmark not defined.</i> |
| <i>3.2.2 Activation of Charcoal.....</i>   | <i>Error! Bookmark not defined.</i> |
| <i>3.2.3 Commercial Activated Charcoal (CAC) .....</i>                                       | <i>Error! Bookmark not defined.</i> |
| <b>3.3 CHARACTERIZATION OF ACTIVATED CHARCOAL.....</b>                                       | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| <i>3.3.1 Proximate analysis of the Lapsi (Choerospondias axillaris) Seed Charcoal .....</i>  | <i>Error! Bookmark not defined.</i> |
| <i>3.3.2 Determination of Surface area of Charcoal.....</i>                                  | <i>Error! Bookmark not defined.</i> |

|             |   |                                     |
|-------------|---|-------------------------------------|
| 3.3.3       | <i>Determination of Surface functional groups.....</i>                      | <i>Error! Bookmark not defined.</i> |
| 3.3.4       | <i>SEM Image of the charcoal.....</i>                                       | <i>Error! Bookmark not defined.</i> |
| <b>3.4</b>  | <b>ADSORPTION STUDY .....</b>   | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| 3.4.1       | <i>Effect of pH .....</i>   | <i>Error! Bookmark not defined.</i> |
| 3.4.2       | <i>Effect of Adsorbent dose.....</i>  | <i>Error! Bookmark not defined.</i> |
| 3.4.3       | <i>Effect of Contact time.....</i>  | <i>Error! Bookmark not defined.</i> |
| 3.4.4       | <i>Adsorption Isotherm.....</i>   | <i>Error! Bookmark not defined.</i> |
| 3.4.5       | <i>Adsorption Kinetics.....</i>   | <i>Error! Bookmark not defined.</i> |
| <b>4.</b>   | <b>RESULTS AND DISCUSSIONS.....</b>   | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| <b>4.1</b>  | <b>CHARACTERIZATION OF THE CHARCOAL.....</b>                                | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| 4.1.1       | <i>Proximate analysis of Lapsi (Choerospondias axillaris) seed Charcoal</i> | <i>Error! Bookmark not defined.</i> |
| 4.1.2       | <i>Surface functional group determination (Boehm's Titration): .....</i>    | <i>Error! Bookmark not defined.</i> |
| <b>4.5</b>  | <b>EFFECT OF PH .....</b>   | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| <b>4.7</b>  | <b>EFFECT OF ADSORBENT DOSE: .....</b>                                      | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| <b>4.8</b>  | <b>EFFECT OF INITIAL METAL ION CONCENTRATION: .....</b>                     | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| <b>4.9</b>  | <b>ADSORPTION ISOTHERMS .....</b>   | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| <b>4.10</b> | <b>KINETIC STUDY:.....</b>  | <b>ERROR! BOOKMARK NOT DEFINED.</b> |
| <b>5.</b>   | <b>CONCLUSION.....</b>  | <b>ERROR! BOOKMARK NOT DEFINED.</b> |

## Appendix

### Graphs

### Figures

### References

## List of Abbreviations and Symbols

|                  |  |
|------------------|--|
| %                | Percentage   |
| mg/L             | Milligram Per Liter                                    |
| g/L              | Gram Per Liter   |
| $\mu\text{g/mL}$ | 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             | <i>Choerospondias axillaris</i> Seed Charcoal          |
| MCASC            | Modified <i>Choerospondias axillaris</i> 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                |