

**REMOVAL OF LEAD (II) BY NITRIC ACID-MODIFIED ACTIVATED  
CARBON**

**By**

**LOO LI YIN**

**Thesis Submitted to the School of Graduate Studies,  
Universiti Putra Malaysia, in Fulfilment of Requirement  
for the Degree of Master of Science**

**October 2006**

## **DEDICATION**

I would like to dedicate my work to both my beloved parents for their full support to carry out my Master Degree Study in Universiti Putra Malaysia.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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**Chairman: Associate Professor Abdul Halim Abdullah, PhD**

**Faculty: Science**

The effect of varying physical and chemical properties of activated carbons on the adsorption of  $Pb^{2+}$  was studied by modifying commercial activated carbon with  $HNO_3$ . The activated carbon was crushed and sieved into 200-300  $\mu m$  in size and modified with different concentration of nitric acid (3, 6 and 9 M) at different reflux time (6, 12 and 24 hours), and labelled as AXC. A portion of the AXC was subjected to calcination process and assigned as HT. Surface area and porosity of AXC and HT were characterized. The decreases in the surface area, micropore area and micropore volume of the AXC was due to the increasing of the surface oxygen group. The presence of carboxylic groups has been proven from the DTG curve and FTIR spectra. The adsorption experiments were performed to investigate the efficiency of  $Pb^{2+}$  removal at different initial concentrations (25, 50, 75 and 100 ppm) and different temperatures (303, 313, 323 and 333 K) by AXC and HT. The results showed that adsorption capacity of the AXC is higher than that of HT; the higher the concentration of nitric acid and the longer the refluxing time during the oxidation treatment the higher the percentage removal of the lead ion. The adsorption kinetics and adsorption equilibrium of  $Pb^{2+}$  obeyed the pseudo second-order and Langmuir

isotherm model respectively, which indicates that the adsorption of  $\text{Pb}^{2+}$  by AXC might be via chemisorption. The adsorption  $\text{Pb}^{2+}$  onto AXC was found to be thermodynamically, spontaneous and exothermic reaction. The adsorption of  $\text{Pb}^{2+}$  in multi component system was also investigated. In the single system, the adsorption affinity of AXC(9)24 to the  $\text{Pb}^{2+}$  is greater than  $\text{Cu}^{2+}$  and  $\text{Zn}^{2+}$ . The percentage removal of  $\text{Pb}^{2+}$  by AXC(9)24 decreased in the binary and ternary mixture system. The percentage removal of  $\text{Pb}^{2+}$  by  $\text{Cu}^{2+}$ -loaded and  $\text{Zn}^{2+}$ -loaded AXC(9)12 was lower than AXC(9)12. The competitive adsorption amongst  $\text{Pb}^{2+}$ ,  $\text{Cu}^{2+}$  and  $\text{Zn}^{2+}$  might be apparent for the multi component system.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia  
sebagai memenuhi keperluan untuk ijazah Master Sains

**PENYINGKIRAN PLUMBUM OLEH KARBON TERAKTIF YANG  
DIUBAHSUAI DENGAN ASID NITRIK**

Oleh

**LOO LI YIN**

**October 2006**

**Pengerusi: Profesor Madya Abdul Halim Abdullah, PhD**

**Fakulti: Sains**

Kesan perubahan ciri-ciri fizik dan kimia karbon teraktif terhadap penjerapan  $Pb^{2+}$  telah dikaji dengan mengubahsuai karbon teraktif komersil dengan asid nitrik. Karbon teraktif komersial telah dihancurkan, disaring kepada saiz 200-300  $\mu m$  dan diubahsuai dengan asid nitrik yang berbeza kepekatan (3.0, 6.0 dan 9.0 M) dan pada masa refluks yang berbeza (6, 12 dan 24 jam), dan dilabelkan sebagai AXC's. Sebahagian daripada AXC's telah dikalsin dan dilabel sebagai HT's. Luas permukaan dan keliangan AXC's dan HT's telah dicirikan. Penurunan luas permukaan, luas permukaan liang mikro dan isipadu liang mikro AXC's adalah diakibatkan oleh peningkatan kumpulan oksigen di permukaan. Kehadiran kumpulan karbosilik telah dibuktikan daripada lengkungan DTG dan spektrum inframerah. Eksperimen penjerapan telah dijalankan untuk mengkaji keberkesanan penyingkiran  $Pb^{2+}$  pada kepekatan awal yang berbeza (25, 50, 75 dan 100 ppm) dan juga pada suhu yang berbeza (330, 313, 323 dan 333K) oleh AXC's dan HT's. Keputusan telah menunjukkan bahawa kapasiti penjerapan daripada AXC's adalah lebih tinggi daripada HT's; semakin tinggi kepekatan asid nitrik maka semakin panjang tempoh masa refluks dalam proses pengoksidaan, maka semakin tinggi peratus penjerapan terhadap  $Pb^{2+}$ .

Kinetik penjerapan dan keseimbangan penjerapan daripada  $Pb^{2+}$  masing-masing memenuhi pseudo kadar-kedua dan model isoterma Langmuir, dimana menunjukkan penjerapan  $Pb^{2+}$  oleh AXC adalah jerapan kimia. Penjerapan oleh AXC adalah satu tindak balas yang secara termodinamik adalah spontan dan eksotermik. Penjerapan  $Pb^{2+}$  oleh AXC(9)24 dalam sistem yang mengandungi banyak komponen juga telah dikaji. Dalam sistem tunggal, tarikan penjerapan AXC(9)24 adalah lebih menonjol terhadap  $Pb^{2+}$  daripada  $Cu^{2+}$  dan  $Zn^{2+}$ . Peratus penjerapan  $Pb^{2+}$  oleh AXC(9)24 telah merosot dalam sistem dedua dan pertigaan. Peratus penjerapan  $Pb^{2+}$  oleh AXC(9)12 yang telah dimuatkan dengan ion  $Cu^{2+}$  dan  $Zn^{2+}$  adalah lebih rendah daripada AXC(9)12. Persaingan penjerapan mungkin telah berlaku di antara  $Pb^{2+}$ ,  $Cu^{2+}$  dan  $Zn^{2+}$  dalam sistem banyak komponen.

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I certify that an Examination Committee met on date of viva to conduct the final examination of Loo Li Yin on her master thesis entitled “removal of lead (II) by nitric acid-modified activated carbon” in accordance with Universiti Putra Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

Zulkarnain Zainal, **PhD**  
Professor  
Faculty of Science  
Universiti Putra Malaysia  
(Chairman)

Mohd Zobir Hussein, **PhD**  
Professor  
Faculty of Science  
Universiti Putra Malaysia  
(Member)

Mohd Zaizi Desa, **PhD**  
Associate Professor  
Faculty of Science  
Universiti Putra Malaysia  
(Member)

Ahmad Md Noor, **PhD**  
Associate Professor  
School of Chemical Sciences,  
Universiti Sains Malaysia  
(Independent Examiner)

---

(GULAM RUSUL RAHMAT ALI, Ph.D.)  
Professor/Deputy Dean  
School of Graduate Studies  
Universiti Putra Malaysia

Date:

This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisor Committee are as follows:

**Abdul Halim Abdullah, PhD**

Associate Professor  
Faculty of Science  
Universiti Putra Malaysia  
(Chairman)

**Md Jelas Haron, PhD**

Professor  
Faculty of Science  
Universiti Putra Malaysia  
(Member)

---

**AINI IDERIS, PhD**

Professor/ Dean  
School of Graduate Studies  
Universiti Putra Malaysia

Date: 16 JANUARY 2007

## **DECLARATION**

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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**LOO LI YIN**

Date: 16 NOVEMBER 2006

## TABLE OF CONTENTS

	<b>Page</b>
<b>DEDICATION</b>	<b>ii</b>
<b>ABSTRACT</b>	<b>iii</b>
<b>ABSTRAK</b>	<b>v</b>
<b>ACKNOWLEDGEMENTS</b>	<b>vii</b>
<b>APPROVAL</b>	<b>viii</b>
<b>DECLARATION</b>	<b>x</b>
<b>LIST OF TABLES</b>	<b>xiii</b>
<b>LIST OF FIGURES</b>	<b>xiv</b>
<b>LIST OF ABBREVIATION</b>	<b>xviii</b>
<b>CHAPTER</b>	
<b>I INTRODUCTION</b>	<b>1</b>
<b>II LITERATURE REVIEW</b>	<b>3</b>
Heavy Metals	3
Adsorption	5
Factors Influencing Adsorption at Liquid Phase	6
Adsorption Kinetics	7
Pseudo-First order	8
Pseudo-Second Order	8
Adsorption Isotherm	9
Brunauer-Emmet-Teller Isotherm	10
Langmuir Isotherm	11
Freundlich Isotherm	12
Effect of Temperature	13
Adsorbent	14
Activated carbon	15
Manufacturing Process	16
Adsorptive Properties of Activated carbon	18
Surface Functional Groups	20
Modification	21
Nitric Acid Oxidation	23
Application of the Modified Activated Carbon	24
Research Objectives	27
<b>III METHODOLOGY</b>	<b>28</b>
Modification of Activated Carbon	28
Nitric Acid Oxidation	28
Heat Treatment	30
Characterization of Activated Carbon	31
Surface Area and Porosity	31
Thermal Analysis	31
Infrared Analysis	32

	Moisture Content	32
	Ash Content	32
	Adsorption Studies	33
	Determination of pH Range for Adsorption	33
	Preparation for Calibration Curve	34
	Kinetic Studies	34
	Effect of Initial Concentration	34
	Isotherms Studies	35
	Temperature Studies	35
	Adsorption of Pb (II) in Multi Component System	35
<b>IV</b>	<b>RESULTS AND DISCUSSION</b>	<b>37</b>
	Characterization	37
	Moisture Content	37
	Ash Content	38
	Surface Area and Porosity	39
	Thermal Analysis	48
	Infrared Analysis	57
	Adsorption study	60
	Determination of pH Range for Adsorption of Lead Ion	60
	Kinetic Studies	63
	Effect of Initial Concentration	70
	Rate Constant	77
	Isotherms Studies	88
	Effect of Temperature	94
	Adsorption of Pb (II) in Multi Component System	96
<b>V</b>	<b>CONCLUSION</b>	<b>101</b>
	<b>REFERENCES</b>	<b>104</b>
	<b>APPENDICES</b>	<b>109</b>
	<b>BIODATA OF THE AUTHOR</b>	<b>131</b>