

**THE EFFECT OF SURFACE MODIFICATION ON
ACTIVATED CARBON USING CITRIC ACID AND NITRIC
ACID FOR COPPER REMOVAL**

by

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TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	ii
TABLE OF CONTENTS	iii
LIST OF TABLES	vi
LIST OF FIGURES	viii
LIST OF SYMBOLS	ix
LIST OF ABBREVIATION	x
LIST OF APPENDICES	xi
ABSTRAK	xii
ABSTRACT	xiv
CHAPTER ONE : INTRODUCTION	
1.1 Research Background	1
1.2 Significant of Research	2
1.3 Research Objectives	4
1.4 Scope of The Research	5
CHAPTER TWO : THEORY AND LITERATURE REVIEW	
2.1 Impact of Heavy Metals	6
2.2 Copper	8
2.3 Activated Carbon Manufacturing	9
2.4 Activated Carbon Modification For Heavy Metal Removal	11
2.5 Adsorption Properties of Activated Carbon	15
2.6 Adsorption by Activated Carbon	16
(a) Characteristics of the AC	16
(b) Characteristics of the Adsorbate	18
(c) Characteristic of the Solution	18
(i) pH	18
(ii) Temperature	20
(iii) Competing Adsorbate Compound	20
2.7 Surface Chemistry and Its Effects On Adsorption	21
2.8 Adsorption Kinetics	23
2.9 Adsorption Principles	24
2.9.1 Adsorption Equilibrium and Isotherm	25

2.9.2	The Usefulness of Adsorption Isotherm	31
2.10	Surface Morphology of AC	32
2.11	Surface Functionalities of AC	34

CHAPTER THREE: MATERIALS AND METHODS

3.1	Materials	37
3.1.1	Activated Carbon	37
3.1.2	Chemicals and Equipment	39
	(A) Chemicals	39
	(B) Equipment	40
3.2	Sampling of Activated Carbon	41
3.3	Activated Carbon Preparation	42
3.3.1	Pre-Treatment of Activated Carbon (Unmodified AC)	43
3.3.2	Modification on Activated Carbon (Modified AC)	43
	(A) Citric Acid Modification	43
	(B) Nitric Acid Modification	44
3.4	Batch Adsorption Studies	46
3.4.1	Preparation of Metal Ion Solution	47
3.4.2	Batch Kinetic Studies	47
3.4.3	Batch Isotherm Studies	48
3.5	Characterization of Activated Carbon	49
3.5.1	Carbon pH	49
3.5.2	Scanning Electron Microscopy (SEM)	49
3.5.3	Fourier Transform Infrared Spectroscopy (FTIR)	50
3.5.4	Specific Surface Area (BET)	51

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1	Unmodified ACVA and ACVE	53
4.1.1	Effect of carbon dosages on copper adsorption	53
4.1.2	Kinetics Test	54
4.1.3	Batch Isotherm Studies	55
	(A) Langmuir Isotherm	55
	(B) Freundlich Isotherm	57
4.2	Citric Acid Modification	59
4.2.1	Kinetic Test	59
4.2.2	Batch Isotherm Studies	60

	(A) Langmuir Isotherm	60
	(B) Freudlich Isotherm	62
4.3	Nitric Acid Modification	63
4.3.1	Kinetic Tests	63
4.3.2	Batch Isotherm Studies	64
	(A) Langmuir Isotherm	64
	(B) Freudlich Isotherm	66
4.4	Characterization of Activated Carbon	69
4.4.1	Surface Area Analysis (BET)	69
4.4.2	Carbon pH	70
4.4.3	Scanning Electron Microscopy (SEM)	71
4.4.4	Fourier Transform Infrared Spectroscopy (FTIR)	73

CHAPTER FIVE : CONCLUSIONS AND RECCOMENDATIONS

5.1	Conclusions	80
5.2	Recommendations	82

REFERENCES	83
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APPENDICES

Appendix A	[Calculations]	86
Appendix B	[Raw Data]	88
Appendix C	[Publications]	96

LIST OF TABLES

	Page	
2.1	Maximum contaminant level (MCL) of heavy metals in surface water and their toxicities.	7
2.2	Copper properties.	9
2.3	Adsorption capacity of <i>Citrus reticulata</i> for Ni ²⁺ different temperatures	20
2.4	Use of separation factor R_L in obtaining information about the nature of adsorption.	29
2.5	Surface area and pore volume of unmodified and modified F 400 AC.	32
3.1	Specification of activated carbon.	37
3.2	List of the chemical that has been used in this research.	39
3.3	Specification of Heidolph Orbital Shaker.	40
3.4	Brief description of the AC used in the kinetic and isotherm tests.	45
4.1	Langmuir equations for copper adsorption using unmodified AC.	56
4.2	Freudlich equations for copper adsorption.	58
4.3	Langmuir equations for copper adsorption onto citric acid modified AC.	61
4.4	Freudlich equations for copper adsorption onto citric acid modified AC.	62
4.5	Langmuir constants for copper adsorption using nitric acid modified AC.	65
4.6	Freudlich constants for copper adsorption using nitric acid modified AC.	66
4.7	Summary of adsorption capacities (mg/g) of unmodified modified AC for copper removal.	68
4.8	Properties of Unmodified and Modified AC.	70
4.9	Infrared spectral data showing the frequencies for the various functional groups in unmodified and modified AC with citric acid.	74
4.10	Infrared spectral data showing the frequencies for the various functional groups in unmodified and modified AC with nitric acid.	77

LIST OF FIGURES

	Page	
2.1	Comparison of the breakthrough curves of zinc, chromium and copper onto SDDC-carbon column, wastewater containing 27 mgL ⁻¹ Zn, 9.5 mgL ⁻¹ Cr(VI) and 37 mgL ⁻¹ Cu.	12
2.2	Langmuir isotherm for the sorption of Cu and Pb from electroplating wastewater using TARH.	13
2.3	Cr removal in term of time on CSC treated with different oxidizing agents.	14
2.4	Equilibrium adsorption of methane at 25 °C on silica gel, zeolite 5A, and activated carbon.	16
2.5	The effect of pH on the Cr removal efficiency using modified CSC.	19
2.6	Simplified schematic of some asidic functional groups on AC. These groups are bonded to aromatic rings.	22
2.7	Four major types of functional groups on oxidized AC surface.	22
2.8	Adsorption phenomenon on the boundry surface of an adsorbate.	24
2.9	Four types of single solute isotherms are most commonly used in solid-liquid system.	27
2.10	Scanning Electron Microscopy (SEM) of AC: (a) Unmodified AC, (b) Sodium Hydroxide Modified AC and (c) Nitric Acid Modified AC.	33
2.11	Fourier transform-infrared spectra of AC and nitric acid treated samples.	34
3.1	Schematic diagram of surface modification on activated carbon for copper removal.	36
3.2	ACVA granules 8x30 mesh (2.380-0.595 mm)	38
3.3	ACVE granules size of 20x50 mesh (0.841-0.287 mm)	38
3.4	Heidolph Orbital Shaker	40
3.5	Schematic diagram on activated carbon preparation	42
3.6	Schematic diagram showing batch adsorption tests examined at	46

	the unmodified and modified AC.	
3.7	Batch kinetic experiment was conducted using magnetic stirrer at a constant speed	48
3.8	The samples were placed on an orbital shaker during batch isotherm experiment	49
4.1	Copper removal of activated carbons with different dosages.	53
4.2	Effect of contact time on copper removal using unmodified AC in 0.5 mM Cu ²⁺ buffered solution at constant pH.	54
4.3	Langmuir plots for adsorption of copper onto ACVA and ACVE.	56
4.4	Freudlich plot for adsorption of copper onto ACVA and ACVE.	58
4.5	Effect of contact time on copper removal using citric acid modified AC in 0.5 mM Cu ²⁺ buffered solution at constant pH.	60
4.7	Freudlich plot for adsorption of copper using citric acid modified AC.	62
4.8	Effect of contact time on copper removal using nitric acid modified AC in 0.5 mM Cu ²⁺ buffered solution at constant pH.	64
4.9	Langmuir model plots for copper adsorption using nitric acid modified AC.	65
4.10	Freudlich model plots for copper isotherm adsorption using nitric acid modified AC.	66
4.11	Scanning electron micrographs of (a) ACVE, (b) ACVE-HNO ₃ (c) ACVE-CA and (d) ACVE-HNO ₃ -SH at a magnification of 100kx.	72
4.12	FTIR spectra for ACVA and ACVA-CA.	75
4.13	FTIR spectra for ACVE and ACVE-CA.	75
4.14	Representative FTIR spectra for ACVA and ACVA-HNO ₃ .	78
4.15	Representative FTIR spectra for ACVE and ACVE-HNO ₃ .	78
4.16	Oxidation of aromatic hydrocarbon (a) 9, 10-dihydrophenanthrene, (b) diphenylmethane and (c) benzene.	79

LIST OF SYMBOLS

Q_m	BET constant
C_0	initial concentration of metal ion (mg/l)
B	BET constant
c_s	saturation concentration of the solute in solution
Q_{\max}	maximum adsorption capacity (mg/g)
R_L	dimensionless constant separation factor
q	amount of Cu adsorbed at equilibrium (mg/g)
b	Langmuir constant related to the energy or net enthalphy
C	concentration of copper ions remaining after carbon adsorption, (mg/l)
C_e	concentration of adsorbate in solution at equilibrium (mg/l)
K_f	Freudlich adsorption constant
n	adsorption intensity
R^2	regression coefficient
V	volume of solution, (L)
X	amount of copper ions removed, (%)

LIST OF ABBREVIATION

AAS	Atomic Absorption Spectrometer
AC	Activated Carbon
ACVA	Activated Carbon (8x30) mesh
ACVE	Activated Carbon (20x50) mesh
BET	Bruneur, Emmet and Teller
Cd (II)	Cadmium (II)
COD	Chemical Oxygen Demand
CSC	Coconut Shell Charcoal
Cu	Copper
DI	Deionized
EPA	Environment Protection Agency
FTIR	Fourier Transform Infrared Spectroscopy
GAC	Granular Activated Carbon
KT	Karbon Teraktif
MCL	Maximum Contaminant Level
ppm	Parts Per Million
SDDS	Sodium Diethyl Dithiocarbamate
SEM	Scanning Electron Microscopy
TARH	Tartaric Acid Modified Rice Husk
TBA	Tetrabutyl Ammonium
TOC	Total Organic Compound
USS	United State Standards

LIST OF APPENDICES

	Page
1.1	Appendix A1 [Calculation of Copper Removal] 86
1.2	Appendix A2 [Calculation of Copper Adsorption] 87
1.3	Appendix B1 [Kinetic Data for Copper Removal] 88
1.4	Appendix B2 [Isotherm Data for Copper Adsorption] 92

LIST OF PUBLICATIONS AND SEMINARS

	Page
1.1	REMOVAL OF COPPER IN AQUEOUS SOLUTIONS BY GRANULAR ACTIVATED CARBON. 96
1.2	SURFACE MODIFICATION OF ACTIVATED CARBON FOR COPPER REMOVAL. 102

KESAN PENGUBAHSUAIAN PERMUKAAN KARBON TERAKTIF MENGUNAKAN ASID SITRIK DAN ASID NITRIK BAGI PENYINGKIRAN KUPRUM

ABSTRAK

Kajian ke atas kesan pengubahsuaian karbon teraktif (KT) menggunakan agen pengoksidaan untuk menyingkirkan kuprum (Cu) yang berkepekatan rendah telah dijalankan. Karbon teraktif tempatan yang telah dihasilkan berasaskan tempurung kelapa telah diperolehi dari Versatec Industries di Ipoh, Perak untuk digunakan dalam kajian ini. KT yang digunakan mempunyai saiz mesh iaitu 8x30 (ACVA) dan 20x50 (ACVE). Kedua-dua KT ini telah diubahsuaikan menggunakan asid sitrik berkepekatan 1 M dan asid nitrik pekat (69% HNO_3), diikuti dengan perawatan menggunakan natrium hidroksida (NaOH). Kajian kinetik dan isoterma secara kelompok telah dijalankan ke atas kedua-dua KT yang terubahsuaikan dan KT asal. Kesan ke atas pengubahsuaian permukaan KT ini juga dikaji dari analisis dan data yang diperolehi dari luas permukaan spesifik (BET), pH karbon, mikroskop pengimbas electron (SEM) dan spektroskopi infra-merah (FTIR). Pengubahsuaian menggunakan asid sitrik dan asid nitrik ini, telah meningkatkan kapasiti penjerapan KT. Pengubahsuaian menggunakan asid nitrik (ACVE- HNO_3) menunjukkan kapasiti penjerapan kuprum yang paling tinggi iaitu 8.31 mg/g pada masa keseimbangan 3 jam dengan penyingkiran kuprum sebanyak 90.45%. Bagi pengubahsuaian menggunakan asid sitrik ia telah meningkatkan kapasiti penjerapan kuprum sebanyak 38.9% dan 48.8% bagi masing-masing ACVA-CA dan ACVE-CA, tetapi kadar penjerapan adalah lebih perlahan memerlukan masa 10 jam untuk mencapai keseimbangan berbanding dengan masa 6 jam bagi KT tanpa pengubahsuaian. Ini adalah kerana asid organik seperti asid sitrik boleh terjerap oleh KT semasa pengubahsuaian. Disebabkan oleh saiz molekulnya yang besar, sebatian ini boleh menyebabkan liang dalam KT itu tersumbat (*pore blockage*). Maka, ini akan mengecilkan garis pusat dan melambatkan lagi penjerapan

kuprum. Pengubahsuaian menggunakan asid sitrik dan asid nitrik ini juga menghasilkan banyak kumpulan berfungsi seperti karbonil, karboksil dan kumpulan nitrat. Kandungan kumpulan berfungsi yang tinggi ini, meningkatkan penjerapan kuprum kerana afiniti diantara kuprum dan kumpulan berfungsi ini sangat tinggi. Rawatan seterusnya menggunakan NaOH didapati mengurangkan penjerapan Cu bagi kedua-dua KT yang telah terubahsuai dengan asid sitrik dan asid nitrik. Jika pengubahsuaian menggunakan asid menghasilkan kumpulan berfungsi yang besar untuk mengikat kuprum, rawatan tambahan dengan NaOH telah meneutralkan kumpulan berfungsi ini dan menyumbang kepada pengurangan penjerapan kuprum. Bagi kedua-dua KT tak terubahsuai dan KT terubahsuai, partikel saiz yang lebih kecil iaitu 20x50 mesh menunjukkan penjerapan yang lebih baik dan kadar penjerapan yang lebih cepat berbanding dengan partikel saiz yang lebih besar iaitu 8x30 mesh. Pengubahsuaian permukaan juga mengurangkan luas permukaan kesan daripada liang tersumbat oleh kumpulan-kumpulan berfungsi yang teroksida dan hakisan terhadap KT oleh asid-asid ini. Isotherma Langmuir didapati sesuai dengan data yang diperolehi yang menunjukkan bahawa penjerapan ion kuprum terjadi di atas permukaan yang homogen dengan satu lapisan penjerapan tanpa wujud interaksi di antara ion-ion yang telah terjerap. Permukaan KT ini bolehlah dianggap sebagai terdiri daripada cantuman liang-liang penjerapan kecil yang homogen antara satu sama lain. Dalam sistem akues kedua-dua KT tak terubahsuai dan KT terubahsuai dalam kajian menunjukkan keadaan yang cenderung kepada penjerapan Cu daripada nilai-nilai faktor pemisah R_L yang telah diperolehi ($0 < R_L < 1$).

THE EFFECT OF SURFACE MODIFICATION ON ACTIVATED CARBON USING CITRIC ACID AND NITRIC ACID FOR COPPER REMOVAL

ABSTRACT

Studies on the effects of surface modification on activated carbon (AC) was carried out by oxidizing agents for removal of copper (Cu) in low concentration. A locally produced coconut shell-based activated carbon (AC) was obtained from Versatec Industries in Ipoh, Perak was used in this study. The AC used were of 8x30 mesh (ACVA) and 20x50 mesh (ACVE) sizes. Both AC were modified with 1 M citric acid (CA) and concentrated nitric acid (69% HNO_3) followed by further treatment with sodium hydroxide (NaOH). These modified and unmodified AC were used in a series of kinetic and isotherm batch studies. The effects of surface modification on the AC using citric acid and nitric acid were studied from the analysis results and data obtained from the specific surface area (BET), carbon pH, scanning electron microscopy (SEM) and Fourier transform infrared (FTIR) spectroscopy. Both citric and nitric acid modifications significantly have improved the adsorption capacities of the AC. Nitric acid modification on ACVE- HNO_3 stands out for having the highest Cu adsorption capacity of 8.31 mg/g at equilibrium time of 3 hours with about 90.45% of Cu removed. For the citric acid modification it has improved the Cu adsorption capacity as much as 38.9% and 48.8% for ACVA-CA and ACVE-CA respectively, but the adsorption rate is much slower at 10 hours equilibrium time compared to the unmodified AC, which is only 6 hours. This is because organic acids such as citric acid can be adsorbed by the AC during the surface modification. Due to its bigger molecular size, these compound may caused pore blockage in the AC. Hence, it reduces the diameter of the pores and slower the uptake of Cu. Acids modifications also generate a large number of functional groups such as carbonyl, carboxyl and nitrate groups. Higher content of these functional groups can significantly improve the Cu adsorption as the affinity between Cu and the groups are very high. Further