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

by

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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

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KESAN PENGUBAHSUAIAN PERMUKAAN KARBON TERAKTIF MENGGUNAKAN 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 terubahsuai 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-HNO3) 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 pengubahsuain. 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. Isoterma 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 ($0 < R_L < 1$).

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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, scaning 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 slowers 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