CHARACTERISATION OF ACTIVATED CARBON USED FOR GOLD ADSORPTION

By

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Declaration

I declare that this thesis is my own, unaided work, except where specific acknowledgement is made. It is being submitted for the Degree of Master of Engineering to the Faculty of Engineering, University of pretoria, Pretoria. It has not been submitted before for any degree or examination to any other university.

Makunga Daudet Seke

December 1999

To my fiancée Blandine Makwanza and
my brother Eric Makwala for their love and
encouragement.

Abstract

Characterisation of activated carbon used for gold adsorption

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The surface of activated carbon contains acidic and basic surface groups which influence the adsorption of gold di-cyanide from the aqueous solution. A surface charge density arises from ionisation of these surface groups in response to the solution pH and ionic strength. The surface of an activated carbon made from coconut shell was characterised by potentiometric titration. The point of zero charge, pH where the surface charge shifts from positive to negative, has been found to change with the time allowed between subsequent additions of the titrant and with the pre-treatment of the activated carbon. When submitted to slow titration, the activated carbon shows a neutral or acidic point of zero charge. However, slow titration leads to a point of zero charge that shifts towards more alkaline values. The surface potential calculated from the Gouy-Chapman relationship between the surface charge and the surface potential does not reflect a realistic picture of the potential distribution inside the carbon particle. The size of the micropore is to small to allow such a potential distribution from the pore walls. The Donnan potential has been introduced, because it takes into account the overlapping of the potential inside a highly porous adsorbent. However, more work has to be done on the way the Donnan potential should be evaluated for an activated carbon.

The gold adsorption activity of activated carbon was measured as a function of the chemical and physical properties of the carbon. Heat treatment of activated carbon in the presence of nitrogen gas produced surfaces that increased the adsorption of gold di-cyanide compared to the standard carbon. The immersion pH of the activated carbon showed an increase with heat treatment indicating a change in surface chemistry of the activated carbon. However, no drastic change in the pore volume

distribution was observed after heat treatment of the activated carbon. It was shown that micropore volume contributes to the adsorption of gold di-cyanide. The combined effect of textural properties and basicity of the activated carbon is relevant for the adsorption of gold di-cyanide.

Keywords- Gold di-cyanide, activated carbon, adsorption, potentiometric titration, surface chemistry, and gold adsorption activity.

Opsomming

Eienskappe van geaktiveerde koolstof vir die gebruik van goud adsorpsie

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Die oppervlak van geaktiveerde koolstof bevat suur- en basisoppervlakgroepe wat die adsorpsie van gouddisianied vanuit die waterige oplossing beïnvloed. 'n Oppervlakladingdigtheid vorm as gevolg van die ionisasie van hierdie oppervlakgroepe. Die pH van die oplossing en ioniese sterkte beïnvloed die ionisasie. Die oppervlak van geaktiveerde koolstof, verkry van 'n kokosneutdop, is gekarakteriseer deur potensiometriese titrasie. Daar is gevind dat die punt van nul-lading, die pH waar die lading op die oppervlak van positief na negatief verwissel, verskuif met die grootte van die tydsduur tussen opeenvolgende titraattoevoegings en vooraf-behandeling van die koolstof. Die geaktiveerde koolstof toon 'n neutrale of suur nul-ladingpunt tydens stadige titrasie. Stadige titrasie lei egter tot 'n nul-ladingpunt wat neig na alkaliese waardes. Die oppervlakpotensiaal, bereken uit die Gouy-Chapmanverwantskap tussen oppervlaklading en -potensiaal, gee nie 'n realistiese beeld van die potensiaal-verspreiding binne die koolstofpartikel nie. Die grootte van die mikropore is te klein om so 'n potensiaalverspreiding vanaf die poorwande toe te laat. Die Donnanpotensiaal is gebruik omdat dit die oorvleueling van potensiaal binne in 'n hoogs poreuse adsorbeerder inagneem. Meer werk moet

egter nog gedoen word op die wyse waarop die Donnanpotensiaal vir geaktiveerde koolstof geëvalueer kan word.

Die goudadsorbsie-aktiwiteit van geaktiveerde koolstof is gemeet as 'n funksie van die chemiese en fisiese eienskappe van die koolstof. Oppervlakke wat meer gouddisianied as die standaard koolstof adsorbeer is verkry deur die hittebehandeling van geaktiveerde koolstof in die teenwoordigheid van stikstofgas. Die onderdompelings-pH van die geaktiveerde koolstof neem toe met hittebehandeling, wat toon dat 'n verandering in oppervlakchemie van die geaktiveerde koolstof voorkom. Geen dramatiese verandering in poorvolume-verspreiding na hittebehandeling van die geaktiveerde koolstof is egter waargeneem nie. Dit is getoon dat die mikropoorvolume bydra tot die adsorbsie van gouddisianied. Die gekombineerde effek van tekstuureienskappe en basisiteit van die geaktiveerde koolstof is van belang vir die adorbsie van gouddisianied.

Sleutelwoorde-Gouddisianied, geaktiveerde koolstof, adsorpsie, potensiometriese titrasie, oppervlakchemie, goudadsorpie-aktiwiteit.

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