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PELAPISAN SILIKA TERMODIFIKASI L-ARGININ PADA MAGNETIT SEBAGAI ADSORBEN Au(III)
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INTISARI

Amaria
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Pada penelitian ini telah dilakukan sintesis magnetit terlapis silika termodifikasi L-arginin, Fe_3O_4/SiO_2-GPTMS-Arg (MSGA) secara sol gel untuk adsorpsi Au(III) dalam larutan. Penelitian ini dibagi dalam 3 tahap pekerjaan. Pada tahap 1 dilakukan sintesis MSGA melalui dua perbedaan urutan pencampuran reagen (Rute 1 dan 2). Pada Rute 1, pencampuran dimulai dari magnetit (Fe_3O_4), larutan natrium silikat, glisidoksipropiltrimetoksisilan (GPTMS), L-arginin, dan diakhiri penambahan larutan HCl sampai pH 7. Pada Rute 2, pencampuran dimulai dari GPTMS dan L-arginin, kemudian larutan natrium silikat dan terakhir suspensi magnetit. Pada tahap 2 dilakukan sintesis MSGA dengan variasi jumlah mol L-arginin (0, 5, 10 dan 15 mmol) pada jumlah GPTMS tetap (5 mmol) (MSGA1:0, MSGA1:1, MSGA1:2, dan MSGA1:3) melalui Rute terpilih dari tahap 1. Hasil sintesis dikarakterisasi dengan spektrofotometer FTIR, Difraktometer sinar-X (XRD), *Energy Dispersive X-ray Spectrometer* (EDX), *Vibrating Sample Magnetometer* (VSM)), *Thermogravimeter Analysis* (TGA), *X-ray Photoelectron Spectrometer* (*XPS*), kestabilan terhadap asam, kadar gugus amino. Pada tahap 3 dipelajari sifat adsorpsi Au(III) dari keempat adsorben tersebut dalam variabel pH medium, konsentrasi awal Au(III), dan waktu adsorpsi. Di samping itu dipelajari mekanisme, selektivitas adsorpsi, efisiensi desorpsi, dan penggunaan ulang adsorben.

Hasil penelitian menunjukkan bahwa Rute 1 menghasilkan MSGA yang lebih stabil terhadap asam, tinggi kadar gugus amino dan kapasitas adsorpsi terhadap Au(III) dibandingkan MSGA hasil Rute 2. Sintesis MSGA1:0, MSGA1:1, MSGA1:2, dan MSGA1:3 melalui Rute 1 memperlihatkan bahwa jika jumlah mol L-arginin diperbesar kemampuan adsorpsi Au(III) juga meningkat. Adsorpsi Au(III) optimum terjadi pada pH 3 dan mengikuti kinetika model pseudo orde kedua dengan konstanta laju adsorpsi berturut-turut 0,38; 1,40; 2,04; dan 3,76 g $mmol^{-1}$ min^{-1} untuk adsorben MSGA1:0, MSGA1:1, MSGA1:2 dan MSGA1:3, serta mengikuti isoterm model Langmuir dengan kapasitas adsorpsi masing-masing $2{,}06 \times 10^{-4}$; $5{,}07 \times 10^{-4}$; $6{,}41 \times 10^{-4}$; dan $6{,}52 \times 10^{-4}$ mol g^{-1}. Hasil analisis spektra FTIR dan XPS serta analisis plot Schatchard mengindikasikan bahwa adsorpsi Au(III) pada MSGA1:2 terjadi melalui dua mekanisme, yaitu gaya tarik elektrostatik dan ikatan koordinasi dengan gugus amino terprotonasi ($–NH_3^+$) dan karboksilat ($–COO^-$). Adsorpsi disertai dengan reduksi Au(III) menjadi Au(I) dan Au(0). Desorpsi Au(III) dengan eluen tiourea 0,5 M dalam HCl 0,5 M menghasilkan 83,5%. Adsorpsi kompetitif terhadap Au(III) dan Cu(II) dalam larutan dwilogam Au(III)/Cu(II) menunjukkan bahwa MSGA1:2 memiliki koefisien selektivitas yang tinggi ($\alpha_{Au/Cu}$ = 663,7 pada perbandingan konsentrasi Au(III)/Cu 1:10). Pada pengulangan siklus adsorpsi-desorpsi Au(III) sebanyak 5 kali kemampuan adsorpsi MSGA1:2 menurun sebesar 6,5% dari 95,5% (siklus pertama) menjadi 89% (siklus kelima).

Kata kunci: *L-arginin, silika, magnetit, adsorpsi, ion Au(III)*

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COATING OF L-ARGININE-MODIFIED SILICA ON MAGNETITE AS ADSOBENT OF Au(III)

ABSTRACT

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In this study, L-arginine-modified silica-coated magnetite, Fe_3O_4/SiO_2-GPTMS-Arg (MSGA) has been synthesized by sol-gel process for the adsorption of Au(III) in an aqueous medium. This research was divided into 3 stages. In stage 1 MSGA was synthesized via two different mixing routes (Route 1 and 2). In Route 1, mixing reagent sequence was started from magnetite (Fe_3O_4), sodium silicate solution, glycidoxypropyltrimethoxysilane (GPTMS) and L-arginine and the addition of HCl to reach pH 7. In Route 2, mixing was started from GPTMS and L-arginine, then a sodium silicate solution and magnetite suspension were added in the last. In stage 2, was synthesis of MSGA with Route 1 in a variation of L-arginine amount (0, 5, 10 and 15 mmol) at fixed GPTMS (5 mmol) through the selected Route of stage 1 to produce MSGA1:0, MSGA1:1, MSGA1:2, and MSGA1:3, respectively. The products were characterized with FTIR spectrophotometer, X-ray Diffractometer (XRD), Energy Dispersive X-ray Spectrometer (EDX), Vibrating Sample Magnetometer (VSM)), Thermogravimeter Analysis (TGA), X-ray Photoelectron Spectrometer (XPS), acidic stability test, the content of the amino group, and adsorption test of Au(III). Stage 3 was adsorption of Au(III) with variables of medium pH, an initial concentration of Au(III) and adsorption time for all the adsorbents resulted. Adsorption mechanism, desorption efficiency of Au(III), selectivity and reusability of adsorbent were also evaluated.

The results showed that MSGA obtained via Route 1 was more stable in acidic condition, higher amino group content and adsorption capacity of Au(III) than that of Route 2. The synthesis of MSGA1:0, MSGA1:1, MSGA1:2, and MSGA1:3 via Route 1 showed that the increase of mole number of L-arginine, the adsorption ability of Au (III) also increased. The adsorption of Au(III) on MSGA1:0, MSGA1:1, MSGA1:2, and MSGA1:3 was optimum at pH 3, followed kinetics model of a pseudo second-order with rate constants of 0.38; 1.40; 2.04; and 3.76 g $mmol^{-1}$ min^{-1}, respectively, and followed adsorption isotherm of Langmuir model with the capacity of 2.06×10^{-4}; 5.07×10^{-4}; 6.41×10^{-4}; and 6.52×10^{-4} mol g^{-1}, respectively. Analysis results of FTIR, XPS spectra, and Scatchard plot indicated that the interaction of MSGA1:2 with Au(III) occurred through two adsorption mechanisms, i.e protonated amino ($–NH_3^+$) and carboxylate ($–COO^–$) groups through electrostatic attraction and coordination bonds, respectively. Adsorption of Au(III) was accompanied by reduction of Au(III) to Au(I) and Au(0). Au(III) desorption by thiourea eluent 0.5 M in HCl 0.5 M reached 83.5%. Competitive adsorption of Au(III) and Cu(II) in the Au(III)/Cu(II) solution at pH 3, MSGA1:2 gave high selectivity coefficient ($\alpha_{Au/Cu}$= 663.7 in mole ratio Au(III)/Cu 1:10). At 5-cycle adsorption-desorption, adsorption ability of MSGA1:2 decreased 6.5% from 95.5% (the first cycle) to 89% (the fifth cycle).

***Keywords**: L-arginine, silica, magnetite, adsorption, Au(III) ion*