

SINTESIS MAGNETIT ASAM FULVAT ($\text{Fe}_3\text{O}_4\text{-AF}$) DAN APLIKASINYA UNTUK ADSORPSI-REDUKSI ION $[\text{AuCl}_4]^-$

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INTISARI

Sintesis magnetit asam fulvat ($\text{Fe}_3\text{O}_4\text{-AF}$) dan aplikasinya untuk studi adsorpsi-reduksi ion $[\text{AuCl}_4]^-$ telah dilakukan. Tujuan utama dari penelitian ini adalah untuk mengembangkan adsorben yang murah, ramah lingkungan dan efektif untuk *recovery* emas, yaitu $\text{Fe}_3\text{O}_4\text{-AF}$.

Penelitian diawali dengan ekstraksi asam fulvat (AF) dan dilanjutkan dengan sintesis $\text{Fe}_3\text{O}_4\text{-AF}$ secara kopresipitasi menggunakan agen pengendap NH_4OH pada campuran garam $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$, $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$ dan AF hasil ekstraksi. AF dan $\text{Fe}_3\text{O}_4\text{-AF}$ dikarakterisasi dengan spektroskopi FTIR, XRD, kemudian dilakukan penentuan pH *point of zero charge* (pH_{PZC}), kestabilan magnetit, keasaman total, kandungan $-\text{COOH}$, kandungan $-\text{OH}$ dan diaplikasikan untuk adsorpsi-reduksi ion $[\text{AuCl}_4]^-$. Pengaruh pH adsorpsi, kinetika adsorpsi dan isoterm adsorpsi juga telah dipelajari.

Pelapisan Fe_3O_4 oleh AF ditunjukkan dengan ikatan Fe-COOR pada FTIR. Karakterisasi dengan XRD menunjukkan Fe_3O_4 terlapis lebih terdispersi dan memiliki ukuran lebih kecil daripada Fe_3O_4 tanpa pelapisan, secara berurutan ukuran Fe_3O_4 dan $\text{Fe}_3\text{O}_4\text{-AF}$ adalah 16,67 dan 14,84 nm. Hasil penelitian menunjukkan bahwa $\text{Fe}_3\text{O}_4\text{-AF}$ memiliki nilai pH_{PZC} 6,37 dan stabil pada $\text{pH} > 3$. AF hasil ekstraksi memiliki keasaman total 866,61 cmol kg^{-1} , kandungan gugus $-\text{COOH}$ total 229,77 cmol kg^{-1} dan kandungan gugus $-\text{OH}$ total 636,84 cmol kg^{-1} . $\text{Fe}_3\text{O}_4\text{-AF}$ memiliki keasaman total 494,86 cmol kg^{-1} , kandungan gugus $-\text{COOH}$ total 67,80 cmol kg^{-1} dan kandungan gugus $-\text{OH}$ total 427,06 cmol kg^{-1} . Konstanta laju reaksi (k) dengan model kinetika Ho adalah 8006,53 $\text{g mol}^{-1} \text{menit}^{-1}$. Kapasitas adsorpsi (q_{max}) dengan model isoterm Langmuir adalah $1,24 \times 10^{-4} \text{mol g}^{-1}$. Logam Au hasil reduksi ditunjukkan dengan munculnya puncak 2 θ : 37,41; 43,66; 64,25 dan 76,67° pada difraktogram XRD. Foto mikroskop stereo menunjukkan gambar visual logam Au yang menempel pada permukaan adsorben.

Kata kunci: Asam fulvat, magnetit, $\text{Fe}_3\text{O}_4\text{-AF}$, adsorpsi, reduksi.

SYNTHESIS OF MAGNETITE FULVIC ACID ($\text{Fe}_3\text{O}_4\text{-FA}$) AND ITS APPLICATION FOR ADSORPTION-REDUCTION OF $[\text{AuCl}_4]^-$

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ABSTRACT

Synthesis of magnetite fulvic acid ($\text{Fe}_3\text{O}_4\text{-FA}$) and its application for adsorption-reduction of $[\text{AuCl}_4]^-$ had been conducted. The main goal of this research is to develop low-cost and environmentally friendly material i.e $\text{Fe}_3\text{O}_4\text{-FA}$, as adsorbent for gold recovery.

This research was initiated with extraction of fulvic acid and followed by synthesis of $\text{Fe}_3\text{O}_4\text{-FA}$ through coprecipitation method using NH_4OH as precipitating agent from a mixture of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$, $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$ and extracted FA. FA and $\text{Fe}_3\text{O}_4\text{-FA}$ were characterized by FTIR spectroscopy and XRD, followed by determination pH of point of zero charge (pH_{PZC}), magnetite stability, total acidity, $-\text{COOH}$ content and $-\text{OH}$ content. The effect of pH, adsorption kinetics and isotherm were also studied.

Characterization of FTIR indicated that the coating $\text{Fe}_3\text{O}_4\text{-FA}$ have been found by Fe-COOR chemical bond. The XRD measurement indicated that coated Fe_3O_4 successfully dispersed in smaller size instead of uncoated Fe_3O_4 , which Fe_3O_4 and $\text{Fe}_3\text{O}_4\text{-FA}$ size sequentially was 16.67 and 14.84 nm. Synthesized $\text{Fe}_3\text{O}_4\text{-FA}$ has pH_{PZC} 6.37 and stability at $\text{pH} > 3$. Extracted FA has total acidity $866.61 \text{ cmol kg}^{-1}$, $-\text{COOH}$ content $229.77 \text{ cmol kg}^{-1}$ and $-\text{OH}$ content $636.84 \text{ cmol kg}^{-1}$. $\text{Fe}_3\text{O}_4\text{-FA}$ has total acidity $494.86 \text{ cmol kg}^{-1}$, $-\text{COOH}$ content $67.80 \text{ cmol kg}^{-1}$ and $-\text{OH}$ content $427.06 \text{ cmol kg}^{-1}$. The adsorption rate constant (k) according to the Ho kinetic model was $8006.53 \text{ g mol}^{-1} \text{ min}^{-1}$. The adsorption capacity (q_{max}) according to Langmuir isotherm model was $1.24 \times 10^{-4} \text{ mol g}^{-1}$. The gold metal after reduction shown by the appearance of peaks at 2θ : 37.41° ; 43.66° ; 64.25° and 76.67° in the XRD diffractogram. Visual picture of stereo microscope shown that gold metal attached on the surface of adsorbent.

Keywords: Fulvic acid, magnetite, $\text{Fe}_3\text{O}_4\text{-FA}$, adsorption, reduction.