

INTISARI

Aspek Termodinamika dan Kinetika pada Adsorpsi Kimia Au(III) oleh Asam Humat dan Asam Humat Tereterifikasi

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Telah dilakukan penelitian tentang aspek termodinamika dan kinetika pada adsorpsi kimia Au(III) dengan asam humat (HA) dan asam humat tereterifikasi (HA_{Eter}). Parameter yang berpengaruh pada adsorpsi Au(III) oleh HA dan HA_{Eter} yang meliputi keasaman medium, temperatur, konsentrasi dan waktu adsorpsi serta keberadaan ion logam lain {Cu(II) dan Ni(II)} dan gugus fungsional HA yang berperan dalam adsorpsi dipelajari secara mendalam dan selanjutnya digunakan sebagai dasar penentuan parameter termodinamika (ΔG° , ΔH° dan ΔS°) dan kinetika (n , k dan E_a).

Penelitian ini dibagi menjadi dua bagian, yaitu (i) isolasi, pemurnian, sintesis dan karakterisasi adsorben HA dan HA_{Eter} serta (ii) adsorpsi Au(III) dengan HA dan HA_{Eter}. HA diisolasi dari tanah gambut yang diambil dari Rawa Pening, Jawa Tengah. Isolasi HA dari tanah gambut dilakukan dengan mengekstraksi HA dari tanah gambut menggunakan 0,1 M NaOH kemudian diendapkan dengan 0,1 M HCl dan dilakukan pencucian dengan 0,1 M HCl/0,3 M HF. Eterifikasi terhadap HA dengan mereaksikan HA dengan dimetilsulfat (DMS) dalam pelarut metanol untuk mendapatkan HA_{Eter} dan oksidasi terhadap HA untuk memperoleh HA_{Oks} dilakukan pula dengan cara mereaksikan HA dengan H₂O₂. Adsorpsi Au(III) dengan HA dan HA_{Eter} dipelajari dengan menggunakan larutan Au(III) dan larutan Au(III) yang mengandung juga Cu(II) dan Ni(II). Konsentrasi Au dalam larutan dinalisis menggunakan UV-Vis dan AAS. Padatan HA dan HA_{Eter} sebelum maupun sesudah adsorpsi dikarakterisasi dengan FTIR dan XRD.

Adsorpsi Au(III) oleh HA dan HA_{Eter} mencapai optimum pada pH 2, sedangkan pada HA_{Oks} optimum pada pH 3. Selanjutnya, adsorpsi Cu(II) dan Ni(II) pada HA dan HA_{Eter} optimum pada pH 5. Adsorpsi Au(III) oleh HA dan HA_{Eter} secara termodinamika cenderung mengikuti model isoterm Langmuir dengan kapasitas adsorpsi maksimum (q_{mak}) 41,08 – 70,40 mg/g. Proses adsorpsi berjalan lebih spontan jika temperatur ditingkatkan dan dari kisaran besarnya ΔH° (53,9 – 60,7 kJ mol⁻¹) disimpulkan bahwa adsorpsi Au(III) oleh HA dan HA_{Eter} merupakan proses adsorpsi fisika-kimia. Kinetika adsorpsi Au(III) oleh HA dan HA_{Eter} cenderung mengikuti model kinetika Ho. Konstanta laju adsorpsi (k) juga meningkat karena meningkatnya temperatur, sedangkan adanya Cu(II) dan Ni(II) dalam larutan menurunkan nilai k .

Kata kunci : asam humat, Au(III), adsorpsi kimia, termodinamik, kinetik.

ABSTRACT

Thermodynamic and Kinetic Aspects on the Chemical Adsorption of Au(III) on Humic Acids and Etherified Humic Acids

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Research on the thermodynamic and kinetic aspects of the chemical adsorption of Au(III) on humic acids (HA) and etherified humic acids (HA_{Eter}) has been conducted. Parameters affecting the adsorption of Au(III) on HA and HA_{Eter} which include medium acidity, temperature, concentration, and interaction time as well as effect of other metal ions {Cu(II) and Ni(II)} and functional groups of HA playing important role on the interaction were deeply studied, then they were used as basis for the determination of thermodynamic (ΔG° , ΔH° and ΔS°) and kinetic (n , k and E_a) parameters.

This research was divided into two parts, i.e (i) the isolation, purification, synthesis and characterization of HA and HA_{Eter} and (ii) the adsorption of Au(III) with HA and HA_{Eter}. The HA was isolated from peat soil collected from Rawa Pening, Central Java. Isolation of HA from peat soil was conducted by extraction the HA using 0.1 M NaOH, followed by precipitation with 0.1 M HCl, and purification of the precipitate with 0.1 M HCl/0.3 M HF. Etherification of HA was performed by reacting HA with dimethylsulfate (DMS) in methanol solvent to obtain HA_{Eter}. Oxidation of HA to obtain HAOks was also studied and it was performed by reacting HA with H₂O₂. The adsorption of Au(III) on HA and HA_{Eter} was studied by using the solution of Au(III) and the solution of Au(III) containing Cu(II) and Ni(II). The concentration of Au in the solution was determined by UV-Vis and SSA. The HA and HA_{Eter} solids before and after adsorption were characterized by FTIR and XRD.

Adsorption of Au(III) on both HA and HA_{Eter} was optimum at pH 2, whereas that on HAOks was optimum at pH 3. Furthermore, the adsorption of Cu(II) and Ni(II) on both HA and HA_{Eter} was optimum at pH 5. The adsorption of Au(III) on HA and HA_{Eter} thermodynamically has a tendency to follow Langmuir isotherm models with the maximum adsorption capacity (q_{mak}) from 41.08 to 70.40 mg/g. The adsorption proceeded more spontaneous as temperature increased and from the range of the magnitude of ΔH° values (53.9 to 60.7 kJ mol⁻¹), it was concluded that adsorption of Au(III) on HA and HA_{Eter} was a physico-chemical adsorption process. The adsorption kinetics of Au(III) on HA and HA_{Eter} has a tendency to follow Ho kinetics model. The adsorption rate constant (k) also increased as temperature increased and the presence of Cu(II) and Ni(II) in the solution decreased the value of k .

Keywords: humic acids, Au(III), chemical adsorption, thermodynamics, kinetics.