SINTESIS BIOCHAR OKARA TERAKTIVASI KOH SEBAGAI ADSORBEN SENYAWA MALATHION

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INTISARI

Sintesis biochar okara teraktivasi KOH sebagai adsorben senyawa malathion telah dilakukan. Penelitian ini bertujuan untuk membuat biochar okara teraktivasi KOH (BOK) sebagai adsorben senyawa malathion dan mengetahui kondisi optimal adsorpsinya. Pembuatan biochar diawali dengan pengeringan okara dengan oven dilanjutkan dengan pirolisis pada suhu 800 ºC hingga terbentuk serbuk biochar okara (BO). Aktivasi biochar dilakukan dengan mencampurkan BO dan KOH pelet lalu dipirolisis kembali. Aktivasi basa dilakukan karena dapat meningkatkan luas permukaan spesifik, memperbesar porositas, serta menambah gugus fungsional aktif. Karakterisasi BOK meliputi FTIR, XRD, SEM-EDX, dan SSA. Adsorben BOK digunakan mengadsorpsi senyawa malathion melalui penentuan kondisi optimal pH, massa adsorben, waktu kontak, konsentrasi awal adsorbat, dan temperatur. Analisis adsorpsi dilakukan menggunakan spektrofotometri UV-Vis. Kinetika adsorpsi diuji menggunakan model *pseudo first order* (PFO), *pseudo second order* (PSO), Elovich, dan difusi intrapartikel (IPD). Isoterm adsorpsi diuji dengan model Langmuir, Freundlich, Dubinin-Radushkevich, Temkin, dan Henry.

Adsorben BOK telah berhasil disintesis dan karakterisasi SSA mengkonfirmasi peningkatan luas permukaan setelah diaktivasi basa dari 0,200 m^2 g^{-1} menjadi 928,450 m^2 g^{-1}, diikuti dengan peningkatan volume pori dari 0,002 cc g^{-1} menjadi 0,519 cc g^{-1}. Analisis dengan SEM-EDX menunjukkan keberhasilan proses adsorpsi dengan meningkatnya % massa unsur S pada material yang telah digunakan untuk adsorpsi. Karakterisasi FTIR menunjukkan proses adsorpsi berlangsung melalui interaksi π-π, interaksi elektrostatik, dan *pore filling*. Pengkajian adsorpsi memberikan informasi bahwa proses adsorpsi malathion oleh BOK secara optimal terjadi pada kondisi pH larutan 8, massa BOK 15 mg, konsentrasi awal malathion 40 mg L^{-1}, waktu kontak selama 15 menit, dan pada temperatur 27 ºC . Kapasitas adsorpsi optimal malathion oleh BOK mencapai 23,06 mg g^{-1}. Studi isoterm sendiri menunjukkan adsorpsi malathion oleh BOK mengikuti model isoterm Dubinin-Radushkevich (D-R) yang menggambarkan interaksi secara kemisorpsi dengan nilai konstanta D-R 2,000 × 10^{-4} mol^2 kJ^{-2}. Model kinetika adsorpsi *pseudo second order* (PSO) menjadi model kinetika yang paling tepat untuk menjelaskan proses kinetika adsorpsi yang terjadi pada adsorpsi malathion oleh BOK dengan konstanta laju adsorpsi 4,470 × 10^{-2} g mg^{-1} $menit^{-1}$.

Kata kunci: adsorpsi, biochar, malathion, okara

SYNTHESIS OF KOH-ACTIVATED OKARA BIOCHAR AS AN ADSORBENT FOR MALATHION COMPOUNDS

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ABSTRACT

The synthesis of KOH-activated okara biochar as an adsorbent for malathion compounds has been conducted. This research aimed to produce KOH-activated okara biochar (BOK) as an adsorbent for malathion compounds and to determine its optimal adsorption conditions. The biochar production began with drying okara in an oven, followed by pyrolysis at 800 ºC to form okara biochar powder (BO). Biochar activation was carried out by mixing BO and KOH pellets and re-pyrolysis. Base activation was performed because it can increase the specific surface area, enhance porosity, and add active functional groups. Characterization of BOK included FTIR, XRD, SEM-EDX, and SSA. BOK adsorbent is used to adsorb malathion compounds by determining the optimal pH condition, adsorbent mass, contact time, initial adsorbate concentration, and temperature. Adsorption analysis was performed using UV-Vis spectrophotometry. Adsorption kinetics were tested using pseudo first order (PFO), pseudo second order (PSO), Elovich, and intraparticle diffusion (IPD) models. Adsorption isotherms were tested using Langmuir, Freundlich, Dubinin-Radushkevich, Temkin, and Henry models.

BOK adsorbent was successfully synthesized, and SSA characterization confirmed an increase in specific surface area after base activation from 0.200 m^2 g^{-1} to 928.450 m^2 g^{-1}, followed by an increase in pore volume from 0.002 cc g^{-1} to 0.519 cc g^{-1}. SEM-EDX analysis demonstrated the success of the adsorption process, indicated by an increase in the % mass of the S element in the material used for adsorption. FTIR characterization showed that the adsorption process occurred through π-π interactions, electrostatic interactions, and pore filling. Adsorption studies revealed that the optimal adsorption of malathion by BOK happened under the following conditions: solution pH 8, BOK mass 15 mg, initial malathion concentration 40 mg L^{-1}, contact time 15 minutes, and temperature 27 ºC. The optimal adsorption capacity of malathion by BOK reached 23.06 mg g^{-1}. The isotherm study showed that malathion adsorption by BOK followed the Dubinin-Radushkevich (D-R) isotherm model, which describes chemisorption interactions, with a D-R constant value of 2.000×10^{-4} mol^2 kJ^{-2}. The pseudo second order (PSO) adsorption kinetic model was the most suitable for explaining the adsorption kinetics of malathion by BOK, with an adsorption rate constant of 4.470×10^{-2} g mg^{-1} min^{-1}.

Keywords: adsorption, biochar, malathion, okara