

ADSORPSI ION Cd²⁺ PADA ABU LAYANG BATUBARA TERMODIFIKASI SODIUM DODESIL SULFAT

Rindi Eliza Arta
19/439190/PA/19013

INTISARI

Abu layang batubara telah dimodifikasi menggunakan sodium dodesil sulfat (SDS) untuk meningkatkan kemampuan adsorpsinya terhadap ion Cd²⁺. Abu layang batubara diaktivasi dengan larutan HCl 6 M melalui metode refluks, kemudian dimodifikasi dengan SDS. Adsorben hasil aktivasi dan modifikasi dikarakterisasi menggunakan XRF, XRD, dan FTIR. Kajian adsorpsi dilakukan dengan variasi pH larutan, waktu kontak, dan konsentrasi awal ion Cd²⁺ pada adsorben FA-A dan FA-SDS. Konsentrasi ion Cd²⁺ setelah proses adsorpsi dianalisis dengan AAS. Data absorbansi selanjutnya dikaji dengan model kinetika orde pertama semu dan orde kedua semu serta model isoterm Langmuir dan Freundlich.

Hasil penelitian menunjukkan bahwa proses aktivasi dan modifikasi tidak mengubah fase kristal utama material berupa kuarsa dan mullit. Hasil FTIR menunjukkan munculnya pita serapan gugus sulfat pada 1226 cm⁻¹ serta pita vibrasi C-H pada 2924 cm⁻¹ dan 2854 cm⁻¹ pada FA-SDS yang mengindikasikan keberhasilan modifikasi adsorben. Kondisi optimum adsorpsi ion Cd²⁺ menggunakan FA-A diperoleh pada pH 7, waktu kontak 10 menit, dan konsentrasi awal 40 ppm dengan kapasitas adsorpsi sebesar 4,423 mg g⁻¹, sedangkan pada FA-SDS diperoleh pada pH 7, waktu kontak 60 menit, dan konsentrasi awal 100 ppm dengan kapasitas adsorpsi sebesar 7,061 mg g⁻¹. Adsorpsi ion Cd²⁺ pada FA-A dan FA-SDS mengikuti model kinetika orde kedua semu dengan laju adsorpsi awal (*h*) masing-masing sebesar 8,6730 dan 3,9761 mg g⁻¹ menit⁻¹. Adsorpsi pada FA-A mengikuti model isoterm Langmuir dengan *q_{max}* sebesar 4,0145 mg g⁻¹, sedangkan adsorpsi pada FA-SDS mengikuti model isoterm Freundlich dengan nilai *n* sebesar 2,9682.

Kata kunci: abu layang batubara, adsorpsi, kadmium, sodium dodesil sulfat

ADSORPTION OF Cd²⁺ IONS ONTO SODIUM DODECYL SULFATE-MODIFIED COAL FLY ASH

Rindi Eliza Arta
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ABSTRACT

Coal fly ash has been modified using sodium dodecyl sulfate (SDS) to enhance its adsorption capability toward Cd²⁺ ions. Coal fly ash was activated using 6 M HCl through a reflux method, followed by modification using SDS. The activated and modified adsorbents were characterized using XRF, XRD, and FTIR. Adsorption studies were carried out by varying the solution pH, contact time, and initial concentration of Cd²⁺ ions on FA-A and FA-SDS adsorbents. The concentration of Cd²⁺ ions after the adsorption process was analyzed using AAS. The absorbance data were subsequently evaluated using pseudo-first-order and pseudo-second-order kinetic models, as well as Langmuir and Freundlich isotherm models.

The results showed that the activation and modification processes did not alter the main crystalline phases of the material, namely quartz and mullite. FTIR analysis showed the appearance of sulfate absorption bands at 1226 cm⁻¹ and C–H vibration bands at 2924 cm⁻¹ and 2854 cm⁻¹ in FA-SDS, indicating the successful modification of the adsorbent. The optimum adsorption condition of Cd²⁺ ions using FA-A was obtained at pH 7, contact time of 10 minutes, and initial Cd²⁺ concentration of 40 ppm with an adsorption capacity of 4.423 mg g⁻¹, whereas the optimum condition for FA-SDS was obtained at pH 7, contact time of 60 minutes, and initial Cd²⁺ concentration of 100 ppm with an adsorption capacity of 7.061 mg g⁻¹. Adsorption of Cd²⁺ ions on FA-A and FA-SDS followed the pseudo-second-order kinetic model with initial adsorption rates (*h*) of 8.6730 and 3.9761 mg g⁻¹ min⁻¹, respectively. Adsorption on FA-A followed the Langmuir isotherm model with a *q_{max}* value of 4.0145 mg g⁻¹, while adsorption on FA-SDS followed the Freundlich isotherm model with an *n* value of 2.9682.

Keywords: adsorption, cadmium, coal fly ash, sodium dodecyl sulfate