REMOVAL OF PHENOLIC COMPOUNDS FROM AQUEOUS SOLUTION BY ADSORPTION ON MODIFIED MONTMORILLONITE

by

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Thesis submitted in fulfillment of the requirements for the degree of Master of Science

June 2005

PENYINGKIRAN SEBATIAN FENOL DARIPADA LARUTAN AKUAS DENGAN PENJERAPAN MENGGUNAKAN MONTMORILONIT TERUBAHSUAI

ABSTRAK

Kajian penjerapan fenol, 3-klorofenol dan o-kresol menggunakan montmorilonit terubahsuai telah dijalankan dengan menggunakan sistem kelompok dan hasil keputusan dibandingkan dengan komersil Karbon Teraktif Norit (NAC 120). Ujikaji penjerapan telah dijalankan pada beberapa keadaan kendalian yang berbeza iaitu kepekatan awal (25 - 200 mg/L), suhu (30, 38 dan 48°C) dan pH (2 - 12). Data eksperimen telah dianalisis menggunakan model Langmuir dan Freundlich. Data penjerapan garis sesuhu bagi sebatian fenol menggunakan montmorilonit terubahsuai dan NAC 1240 masing-masing padan dengan model Langmuir dan Freundlich. Montmorilonit terubahsuai menunjukkan sifat penjerap kos rendah yang efektif bagi penyingkiran sebatian fenol. Kajian tentang kinetik, termodinamik and sistem berterusan juga telah dijalankan ke atas penjerapan sebatian fenol menggunakan montmorilonit terubahsuai. Model pseudo tertib-pertama, pseudo tertib-kedua dan model resapan intrazarah telah digunakan untuk menerangkan data kinetik dan pemalar kadar ditentukan. Data dinamik padan dengan model kinetik tertib-kedua dan resapan intrazarah. Ini mencadangkan bahawa kelakuan penjerapan adalah kompleks dan boleh dijelaskan berdasarkan kedua-dua penjerapan kinetik kimia dan resapan intrazarah. Parameter termodinamik menunjukkan sifat eksotermik dalam penjerapan sebatian fenol menggunakan montmorilonit terubahsuai dengan nilai entalpi, ΔH°

antara -12.6 dan -21.2 kJ/mol. Nilai tenaga pengaktifan (E) adalah dalam julat -4.4 ke -30.5 kJ/mol dan menunjukkan proses tersebut adalah penjerapan fizikal. Beberapa siri eksperimen telah dijalankan untuk mengukur lengkung bulus bagi penjerapan sebatian fenol mengunakan montmorilonit terubahsuai di dalam turus penjerapan pada beberapa keadaan kendalian iaitu kepekatan awal (50, 100 and 200 mg/L), kadar aliran lapisan (40, 60 and 80 mL/min) dan tinggi lapisan (60, 80 and 100 mm). Didapati jumlah bahan terjerap, q_{eq} (mg/g) meningkat dengan peningkatan kepekatan awal dan kadar aliran dan menurun dengan peningkatan tinggi lapisan turus. Masa yang diperlukan bila kepekatan bahan terjerap adalah separuh daripada kepekatan awal ($t_{1/2}$) bagi penjerapan sebatian fenol menggunakan montmorilonit terubahsuai adalah antara 16 ke 24 minit. Tiga model dinamik iaitu model Thomas, Yoon & Nelson dan Clark telah digunakan untuk meramal ciri-ciri lengkung bulus. Data penjerapan sebatian fenol menggunakan montmorilonit terubahsuai padan dengan model Clark.

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ABSTRACT

The adsorption of phenol, 3-chlorophenol and o-cresol on modified montmorillonite was studied using batch system and the results were compared with commercial Norit Activated Carbon (NAC 1240). The adsorption tests were performed under different operating conditions including initial concentration (25 - 200 mg/L), temperature (30, 38 and 48°C) and pH (2 - 12). The experimental data were analyzed by Langmuir and Freundlich models. Adsorption isotherm data of phenolic compounds on modified montmorillonite and NAC 1240 fitted very well with Freundlich and Langmuir models, respectively. Modified montmorillonite demonstrated as an effective low-cost adsorbent for removal of phenolic compounds. Kinetic, thermodynamic and continuous system studies were also carried out for adsorption of phenolic compounds on modified montmorillonite. The pseudo first-order, pseudo second-order and intraparticle diffusion models were used to describe the kinetic mechanism and the rate constants were evaluated. The dynamic data fitted well the second-order kinetic and intraparticle diffusion models. This suggests that the adsorption behavior was a complex process and could be explained based on both chemical kinetic adsorption and intraparticle diffusion. Thermodynamic parameter depicts the exothermic nature of adsorption of phenolic compounds on modified montmorillonite with values of enthalpy, ΔH° between -12.6 and -21.2 kJ/mol. The values of activation energy (E) were in the range -4.4 to -30.5 kJ/mol and suggest that the process was a physical adsorption. A

series of experiments were conducted to measure the breakthrough curves for adsorption of phenolic compounds on modified montmorillonite in an adsorption column under different operating conditions including initial concentration (50, 100 and 200 mg/L), bed flowrate (40, 60 and 80 mL/min) and bed height (60, 80 and 100 mm). It was found that the amount of adsorbate adsorbed, q_{eq} (mg/g) increased with increasing initial concentration and flowrate and decreased with increasing height of column bed. The time required when the adsorbate concentration reached half of the initial concentration ($t_{1/2}$) for adsorption of phenolic compounds on modified montmorillonite was between 16 and 24 minutes. Three dynamic models namely, Thomas, Yoon & Nelson and Clark models were used to predict the breakthrough characteristics. The data of continuous adsorption of phenolic compounds on modified montmorillonite agreed well with Clark model.