

ADSORPSI ZAT WARNA KATIONIK KRISTAL VIOLET DAN ANIONIK METIL ORANYE MENGGUNAKAN SILIKA GEL BERBAHAN DASAR ABU VULKANIK GUNUNG SEMERU

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INTISARI

Telah dilakukan sintesis silika gel berbahan dasar abu vulkanik Gunung Semeru sebagai adsorben untuk penghilangan zat warna kationik kristal violet (KV) dan anionik metil oranye (MO). Penelitian ini terdiri dari preparasi abu vulkanik (AV), aktivasi abu vulkanik dengan larutan asam kuat HCl (AV-ACT) melalui proses refluks, dan sintesis silika gel berbahan dasar abu vulkanik teraktivasi (AV-SG) dengan metode sol-gel. Ketiga material dikarakterisasi menggunakan instrumen XRF, FTIR, dan XRD dan selanjutnya dilakukan kajian adsorpsi zat warna KV dan MO menggunakan adsorben AV-ACT dan AV-SG. Parameter adsorpsi yang dikaji dalam penelitian ini adalah pengaruh pH larutan, massa adsorben, waktu interaksi, dan konsentrasi awal adsorbat.

Hasil karakterisasi menunjukkan bahwa AV-ACT memiliki kandungan utama Si dan Al, sedangkan kandungan utama dari AV-SG adalah Si. Data XRD dan FTIR menunjukkan bahwa AV-SG hasil penelitian berstruktur amorf dan memiliki situs aktif gugus siloksan dan silanol. Adsorpsi zat warna KV menggunakan adsorben AV-ACT dan AV-SG mencapai kondisi optimum pada pH 8, massa adsorben 0,045 g, waktu interaksi 15 menit, dan konsentrasi awal 100 ppm, sedangkan adsorpsi zat warna MO dengan adsorben AV-ACT mencapai kondisi optimum pada pH 5, massa adsorben 0,15 g, waktu interaksi 30 menit, dan konsentrasi awal 75 ppm. Adsorpsi zat warna MO menggunakan adsorben AV-SG mencapai kondisi optimum pada pH 4, massa adsorben 0,15 g, waktu interaksi 30 menit, dan konsentrasi awal 100 ppm. Adsorpsi zat warna KV dan MO mengikuti model kinetika orde kedua semu dan model isoterm Langmuir. Studi penghilangan zat warna dari sampel limbah buatan menunjukkan bahwa penghilangan zat warna KV dengan AV-SG membutuhkan tiga kali tahapan adsorpsi, sedangkan untuk zat warna MO memerlukan lima kali tahapan adsorpsi agar diperoleh konsentrasi zat warna yang memenuhi baku mutu (< 10 ppm).

Kata kunci: abu vulkanik, adsorpsi, kristal violet, metil oranye, silika gel.

ADSORPTION OF CATIONIC CRYSTAL VIOLET AND ANIONIC METHYL ORANGE DYES USING SILICA GEL PREPARED FROM MOUNT SEMERU VOLCANIC ASH

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ABSTRACT

Synthesis of silica gel prepared from Mount Semeru volcanic ash as an adsorbent for the removal of cationic crystal violet (KV) and anionic methyl orange (MO) dyes has been done. Volcanic ash (AV) was prepared and followed by the activation of volcanic ash with HCl solution (AV-ACT) through a reflux process. Synthesis of silica gel from activated volcanic ash (AV-SG) was carried out by sol-gel method. AV, AV-ACT, and AV-SG materials were then characterized by XRF, FTIR, and XRD. The adsorption study of KV and MO dyes were conducted using AV-ACT and AV-SG as adsorbents. The adsorption process was examined by various parameters such as the effect of solution pH, mass of adsorbent, interaction time, and initial concentration of the dye.

The characterization result showed that the main component of AV-ACT was Si and Al, while the main component of AV-SG was Si. The diffractogram of AV-SG showed that AV-SG had amorphous structures and FTIR spectra showed the active sites of siloxane and silanol groups. The optimum removal efficiency of KV dye using AV-ACT and AV-SG was obtained at pH 8; 0.045 g of adsorbent; 15 minutes of interaction time; 100 ppm of initial dye concentration, whereas the optimum adsorption of MO dye adsorption using AV-ACT was obtained at pH 5; 0.15 g of mass adsorbent; 30 minutes of interaction time; and 75 ppm of initial dye concentration. Adsorption of MO dye using AV-SG adsorbent was acquired at pH 4; 0.15 g of adsorbent; 30 minutes of interaction time; and 100 ppm of initial concentration. The adsorptions of KV and MO dyes were fit by pseudo-second order kinetics and followed the Langmuir isotherm model. The removal study of the dyes from artificial dye waste suggested that removal of KV dye using AV-SG as an adsorbent required three sequence adsorption steps, while MO dye entailed five sequence adsorption steps to obtain dye concentration, in accordance with quality standards (< 10 ppm).

Keywords: adsorption, crystal violet, methyl orange, silica gel, volcanic ash.