

PREPARASI SILIKA GEL DARI BAHAN ABU DASAR BATUBARA DAN APLIKASINYA UNTUK ADSORPSI ZAT WARNA KATIONIK KRISTAL VIOLET

Ayu Grahita
20/455460/PA/19675

INTISARI

Penelitian tentang preparasi silika gel dari bahan abu dasar batubara dan aplikasinya untuk adsorpsi zat warna kationik kristal violet telah dilakukan. Tujuan dari penelitian ini adalah untuk melakukan aktivasi abu dasar batubara dan sintesis silika gel berbahan abu dasar batubara yang teraktivasi HCl, menentukan kondisi optimum adsorpsi dengan mengkaji pengaruh pH, waktu kontak, massa adsorben, dan konsentrasi awal adsorbat, mempelajari model kinetika dan isoterm adsorpsi zat warna, serta melakukan uji aplikasi adsorpsi zat warna pada sampel air limbah buatan pada kondisi optimum adsorpsi.

Penelitian diawali dengan preparasi abu dasar batubara (AD) dan aktivasi dengan larutan asam kuat HCl melalui proses refluks sehingga didapatkan abu dasar batubara teraktivasi (AD-ACT). Adsorben AD-ACT kemudian diubah menjadi silika gel (AD-SG) melalui metode sol gel. Material AD, AD-ACT, dan AD-SG dikarakterisasi dengan instrumen XRF, FTIR, XRD, dan SEM. Adsorpsi zat warna kationik kristal violet dilakukan pada variasi pH larutan, waktu kontak, massa adsorben, dan konsentrasi awal larutan zat warna serta dilakukan kajian kinetika adsorpsi dan isoterm adsorpsi. Konsentrasi zat warna kristal violet sebelum dan sesudah dilakukan adsorpsi ditentukan dengan spektrofotometer UV-Vis pada panjang gelombang 590 nm.

Hasil karakterisasi XRF menunjukkan bahwa komponen mayor material AD, AD-ACT, dan AD-SG adalah unsur Si atau SiO_2 . Hasil karakterisasi FTIR membuktikan keberhasilan proses sintesis silika gel yang ditandai dengan munculnya gugus silanol (Si-OH) dan siloksan (Si-O-Si) yang merupakan gugus aktif adsorpsi. Berdasarkan hasil karakterisasi XRD, dapat diketahui bahwa material AD dan AD-ACT bersifat kristalin dengan kandungan utamanya adalah mineral kuarsa (SiO_2), sedangkan AD-SG bersifat amorf. Sementara itu, karakterisasi SEM menunjukkan bahwa terjadi perubahan bentuk dan ukuran pada AD-SG yang disebabkan oleh proses sol gel. Kondisi optimum adsorpsi zat warna kationik kristal violet menggunakan AD-ACT dan AD-SG berturut-turut pada pH larutan 6 dan 4, serta keduanya optimum pada waktu kontak 45 menit, massa adsorben 0,04 gram, dan konsentrasi awal adsorbat sebesar 125 ppm. Adsorpsi zat warna kationik kristal violet menggunakan AD-ACT dan AD-SG mengikuti model kinetika orde kedua semu dengan nilai konstanta laju adsorpsi sebesar 0,0314 dan 0,675 $\text{g mg}^{-1} \text{ menit}^{-1}$ serta model isoterm Langmuir dengan nilai kapasitas adsorpsi sebesar 34,97 dan 50,25 mg g^{-1} .

Kata kunci: abu dasar batubara, adsorpsi, kristal violet, silika gel.

PREPARATION OF SILICA GEL FROM COAL BOTTOM ASH AND ITS APPLICATION IN THE ADSORPTION OF CATIONIC CRYSTAL VIOLET DYE

Ayu Grahita
20/455460/PA/19675

ABSTRACT

Research on the preparation of silica gel from coal bottom ash and its application in the adsorption of cationic crystal violet dye has been carried out. This research aims to activate coal bottom ash and synthesize silica gel from HCl-activated coal bottom ash, determine the optimum adsorption conditions by studying the effect of pH, contact time, adsorbent mass, and initial concentration of adsorbate, study kinetics models and isotherms model, and to apply the adsorbent in the dye adsorption from artificial wastewater samples under optimum adsorption conditions.

This research was begun with the preparation of coal bottom ash (AD) and its activation using HCl through reflux process to obtain activated coal bottom ash (AD-ACT). AD-ACT was then converted into silica gel (AD-SG) via the sol-gel method. AD, AD-ACT, and AD-SG materials were characterized by XRF, FTIR, XRD, and SEM analytical methods. Adsorption of crystal violet cationic dye was studied at various pH, contact time, adsorbent mass, and initial concentration of the dye solution. Adsorption kinetics and adsorption isotherms were also studied. Concentration of the dye in the solution before and after adsorption was determined by UV-Vis spectrophotometry at wavelength of 590 nm.

The FTIR characterization showed that the major component of AD, AD-ACT, and AD-SG materials was Si or SiO₂. The FTIR characterization proved that the silica gel synthesis process was successful indicated by the presence of silanol (Si-OH) and siloxane (Si-O-Si) groups which are active groups of silica gel. Based on the result of XRD characterization, it can be seen that the AD and AD-ACT materials were crystalline with the main component being quartz mineral (SiO₂), while AD-SG was amorphous. Meanwhile, SEM characterization showed that changes in shape and size occurred in AD-SG due to the sol-gel process. The optimum conditions for the adsorption process of crystal violet dye using AD-ACT and AD-SG were obtained at a solution of pH 6 and 4 respectively, and both were optimum at a contact time of 45 minutes, adsorbent mass of 0.04 grams, and initial concentration of 125 ppm. The adsorption of cationic crystal violet dye by AD-ACT and AD-SG followed a pseudo second order kinetic model with an adsorption rate constant of 0.0314 and 0.675 g mg⁻¹ min⁻¹ and well described by a Langmuir isotherm model with an adsorption capacity of 34.97 and 50.25 mg g⁻¹.

Keywords: adsorption, coal bottom ash, crystal violet, silica gel.