SINTESIS SILIKA GEL DARI ABU DASAR BATUBARA-PASIR SILIKA SERTA APLIKASINYA SEBAGAI ADSORBEN METILEN BIRU

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INTISARI

Telah dilakukan penelitian mengenai sintesis silika gel dari abu dasar batubara-pasir silika serta aplikasinya sebagai adsorben metilen biru. Penelitian ini bertujuan untuk mengetahui kemampuan silika gel dari abu dasar batubara-pasir silika (SGAD) dalam mengadsorpsi metilen biru. Abu dasar batubara-pasir silika diaktivasi menggunakan HCl 6 M, kemudian dilebur menggunakan NaOH 3 M untuk menghasilkan natrium silikat. Larutan natrium silikat diasamkan dengan HCl 3 M sampai terbentuk silika gel. Karakterisasi adsorben dilakukan menggunakan XRF, FT-IR, dan XRD. Kajian parameter adsorpsi meliputi optimasi pH, waktu interaksi, massa adsorben, konsentrasi awal adsorbat. Konsentrasi zat warna dalam larutan dianalisis dengan metode spektrofotometer UV-Vis.

Hasil karakterisasi adsorben menunjukkan bahwa aktivasi abu dasar batubara-pasir silika dengan HCl telah berhasil menghilangkan pengotor pada permukaan tanpa merusak kekristalan struktur abu dasar. Sintesis silika gel dari abu dasar batubara-pasir silika sebagai adsorben telah berhasil dilakukan dengan kandungan Si sebesar 84,44%, amorf, serta situs aktif berupa gugus silanol dan siloksan. Kondisi optimum adsorpsi metilen biru diperoleh pada pH larutan 8, waktu interaksi 60 menit, massa adsorben 0,15 g, dan konsentrasi awal adsorbat 500 ppm. Adsorpsi metilen biru menggunakan adsorben SGAD mengikuti model kinetika orde kedua semu (Ho dan McKay) dengan nilai konstanta laju reaksi sebesar 0,0124 g mg^{-1} $menit^{-1}$ dan model isoterm Langmuir dengan kapasitas adsorpsi sebesar 64,94 mg g^{-1} serta energi adsorpsi sebesar 25,60 kJ mol^{-1}. Aplikasi adsorpsi metilen biru pada limbah buatan dengan konsentrasi awal 300 ppm oleh adsorben SGAD membutuhkan tiga kali tahapan adsorpsi untuk memenuhi baku mutu yaitu sebesar 4,17 ppm dengan persentase adsorpsi 98,68%.

Kata kunci: abu dasar batubara-pasir silika, adsorpsi, metilen biru, silika gel

SYNTHESIS OF SILICA GEL FROM COAL BOTTOM ASH-SILICA SAND AND ITS APPLICATION AS AN ADSORBENT FOR METHYLENE BLUE

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ABSTRACT

Silica gel was synthesized from coal bottom ash-silica sand and its application as an adsorbent for methylene blue been conducted. This research aimed to examine the ability of silica gel-based coal bottom ash-silica sand (SGAD) to adsorb methylene blue. Coal bottom ash-silica sand was activated using 6 M HCl solution and melted with 3 M NaOH to produce sodium silicate. The sodium silicate solution was acidified with 3 M HCl until silica gel was formed. The adsorbents were characterized by XRF, FT-IR, and XRD. The study of adsorption parameters included the optimization of pH, contact time, adsorbent mass, and initial concentration of adsorbate. The concentration of the dye in the solution was analyzed by the UV-Vis spectrophotometer method.

The characterization of materials showed that the activation of coal bottom ash-silica sand with HCl can remove impurities on the surface without destroying the crystal structure of bottom ash. Silica gel was successfully synthesized from coal bottom ash-silica sand as an adsorbent with a Si content of 84.44%. It is amorphous with active sites of silanol and siloxane functional groups. The optimum conditions for the adsorption of methylene blue with silica gel were obtained at a solution of pH 8, contact time of 60 min, adsorbent mass of 0.15 g, and an initial adsorbate concentration of 500 ppm. The adsorption of methylene blue using the SGAD adsorbent followed the pseudo-second order kinetics model (Ho and McKay) with a rate constant value of 0.0124 g mg^{-1} $menit^{-1}$ and the Langmuir isotherm model with an adsorption capacity of 64.94 mg g^{-1} and an adsorption energy of 25.60 kJ mol^{-1}. The adsorption of methylene blue by the SGAD adsorbent in artificial waste with an initial concentration of 300 ppm required three adsorption steps to meet the quality standard, namely 4.17 ppm, with an adsorption percentage of 98.68%.

Keywords: adsorption, coal bottom ash-silica sand, methylene blue, silica gel