Sintesis dan Studi Adsorpsi Komposit Alginat/Polivinil Alkohol/Silika Sebagai Adsorben Zat Warna *Crystal Violet*

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INTISARI

Penelitian ini bertujuan mensintesis dan mengkarakterisasi komposit Alginat/PVA/Silika (APS) sebagai adsorben untuk penghilangan zat warna *crystal violet* (CV). Sintesis dilakukan melalui metode penautan silang ganda menggunakan $CaCl_2$ dan H_3BO_3. Komposit yang dihasilkan kemudian dikarakterisasi menggunakan FTIR untuk mengidentifikasi gugus fungsi, SEM-EDX untuk mengamati morfologi dan distribusi unsur, serta spektrofotometri UV-Vis untuk analisis adsorpsi. Kajian adsorpsi dilakukan dengan memvariasikan pH larutan, massa adsorben, waktu kontak, dan konsentrasi CV guna menentukan kondisi optimum.

Hasil penelitian menunjukkan terbentuknya jaringan komposit dengan interaksi antar komponen dan morfologi berpori yang stabil. Kapasitas adsorpsi maksimum diperoleh sebesar 143,75 mg g^{-1} pada konsentrasi CV 250 mg L^{-1}, menggunakan 40 mg komposit APS pada pH 6 selama 120 menit. Proses adsorpsi mengikuti model orde dua semu (R^2 = 0,97) dan isoterm Langmuir (R^2 = 0,97), sedangkan uji desorpsi terbaik dicapai dengan KCl 0,1 M sebesar 70%. Temuan ini memperlihatkan potensi komposit APS untuk diaplikasikan sebagai adsorben ramah lingkungan dalam pengolahan limbah cair industri berwarna dan pengendalian polusi air.

Kata kunci: Alginat/polivinil alkohol/silika; komposit hidrogel; *crystal violet*; adsorpsi; kinetika dan isoterm; desorpsi

Synthesis and Adsorption Study of Alginate/Polyvinyl Alcohol/Silica Composite as an Adsorbent for Crystal Violet

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ABSTRACT

This study aimed to synthesize and characterize an Alginate/PVA/Silica (APS) composite as an adsorbent for the removal of crystal violet (CV) dye. The composite was synthesized through a dual crosslinking method using $CaCl_2$ and H_3BO_3. The obtained material was characterized by FTIR to identify functional groups, SEM-EDX to observe morphology and elemental distribution, and UV-Vis spectroscopy to analyze adsorption performance. Adsorption studies were conducted by varying solution pH, adsorbent dosage, contact time, and CV concentration to determine the optimum conditions.

The results confirmed the formation of a porous and stable composite network with strong interactions among the components. The maximum adsorption capacity was 143.75 mg g^{-1} at 250 mg L^{-1} CV, using 40 mg of APS composite at pH 6 for 120 minutes. Adsorption followed the pseudo-second-order kinetic model (R^2 = 0.9476) and fitted the Langmuir isotherm (R^2 = 0.9963), while desorption experiments showed the highest efficiency (70%) with 0.1 M KCl. These findings highlight the potential of APS composite as an eco-friendly adsorbent for treating dye-contaminated industrial wastewater and for broader applications in water pollution control.

Keywords: Alginate/polyvinyl alcohol/silica; hydrogel composite; crystal violet; adsorption; kinetics and isotherm; desorption