

INFLUENCE OF PEAT HUMIC ACID CONTENT ON HYBRID SILICA-CHITOSAN-HUMIC ACID ADSORBENT FOR THE ADSORPTION OF METHYLENE BLUE

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ABSTRACT

Research on the effects of peat humic acid content immobilized onto silica-chitosan to produce a hybrid adsorbent for the adsorption of methylene blue has been conducted. The research was aimed to synthesize a humic acid-based hybrid adsorbent and comprehend how humic acid content determines the characteristics and performance of the adsorbent in adsorbing methylene blue.

The synthesis encompassed humic acid extraction from peat soil, the preparation of silica-chitosan matrix using a sol-gel method followed by immobilization of humic acid of three different contents. The hybrid adsorbents tested for their total acidity, PZC, stability, optimum pH, adsorption isotherm and kinetics alongside the peat humic acid. They were also characterized using FTIR, SEM-EDX, and surface area analysis.

FTIR analysis, carbon element composition, and total acidity in the hybrid adsorbents, indicate that the synthesis was successful and that immobilization increased with humic acid content used. The hybrid adsorbents showed significantly increased stability withstanding solution of up to 8-10 higher in pH than humic acid. Gas sorption analysis presented that SiChiHA 0.2, 0.5, and 1.0 were mesoporous with surface areas of 12.71, 20.26, and 12.98 m²/g. The kinetics of methylene blue adsorption on HA and SiChiHA 0.2 were best described by pseudo-first order kinetics, whilst SiChiHA 0.5 and SiChiHA 1.0 were best described by Elovich and pseudo-second order kinetics. Moreover, the adsorption isotherms of HA, SiChiHA 0.2, and SiChiHA 1.0 were best described by the Langmuir isotherm model, whereas SiChiHA 0.5 was best described the Freundlich isotherm model. The adsorption capacities of HA, SiChiHA 0.2, SiChiHA 0.5, and SiChiHA 1.0 were 130.87, 156.96, 62.34, and 130.86 mg/g, respectively. No coherent and conclusive relation between the amount of humic acid immobilized on the adsorption ability of the hybrid adsorbents can be made as they showed variability and little trend in the characterizations.

Keywords: peat humic acid, immobilization, hybrid adsorbent

PENGARUH KADAR ASAM HUMAT GAMBUT TERHADAP ADSORPEN HIBRIDA SILIKA-KITOSAN-ASAM HUMAT UNTUK ADSORPSI METILEN BIRU

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INTISARI

Penelitian tentang pengaruh kandungan asam humat gambut yang diimobilisasi pada matriks silika-kitosan untuk menghasilkan adsorben hybrid terhadap metilen biru telah dilakukan. Penelitian ini bertujuan untuk mensintesis adsorben hibrida berbasis asam humat dan memahami bagaimana kandungan asam humat menentukan karakteristik dan kinerja adsorben dalam mengadsorpsi metilen biru.

Sintesis adsorben tersebut meliputi ekstraksi asam humat dari tanah gambut, preparasi matriks silika-kitosan menggunakan metode *sol-gel* diikuti dengan imobilisasi asam humat dari tiga kandungan yang berbeda. Adsorben hibrida diuji untuk keasaman total, PZC, stabilitas, pH optimum, isoterm adsorpsi dan kinetika bersama asam humat gambut. Sampel yang dihasilkan juga dikarakterisasi menggunakan FTIR, SEM-EDX, dan *surface area analysis*.

Analisis FTIR, komposisi unsur karbon, dan keasaman total pada adsorben hibrida, menunjukkan bahwa sintesis berhasil dan imobilisasi meningkat dengan kandungan asam humat yang digunakan. Adsorben hibrida menunjukkan peningkatan stabilitas yang signifikan terhadap pada larutan dengan pH 8-10 lebih tinggi dibandingkan dengan asam humat. *Gas sorption analysis* menunjukkan bahwa SiChiHA 0.2, 0.5, dan 1.0 bersifat mesopori dengan luas permukaan 12,71, 20,26, dan 12,98 m²/g. Kinetika adsorpsi metilen biru pada HA dan SiChiHA 0.2 paling baik dijelaskan oleh model kinetika Lagergren (*pseudo-first order*), sedangkan SiChiHA 0.5 dan SiChiHA 1.0 paling baik dijelaskan oleh model kinetika Elovich dan Ho (*pseudo-second order*). Selain itu, isoterm adsorpsi HA, SiChiHA 0.2, dan SiChiHA 1.0 paling baik dijelaskan oleh model isoterm Langmuir, sedangkan SiChiHA 0.5 paling baik dijelaskan model isoterm Freundlich. Kapasitas adsorpsi HA, SiChiHA 0.2, SiChiHA 0.5, dan SiChiHA 1.0 berturut-turut adalah 130,87, 156,96, 62,34, dan 130,86 mg/g. Tidak ada hubungan yang koheren dan konklusif antara jumlah asam humat yang diimobilisasi pada kemampuan adsorpsi dari adsorben hibrida yang dapat dibuat karena adsorben menunjukkan variabilitas dan tren yang kecil dalam berbagai karakterisasi.

Kata kunci: asam humat gambut, imobilisasi, adsorben hibrida