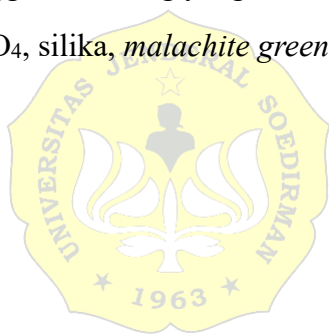


ABSTRAK

Malachite green (MG) merupakan zat warna yang banyak digunakan di industri tekstil dan berbahaya apabila masuk ke dalam perairan, sehingga perlu adanya teknik pemisahan untuk mengurangi dampak negatif yang ditimbulkan, salah satunya yaitu metode adsorpsi. Adsorpsi *malachite green* (MG) dilakukan menggunakan $\text{Fe}_3\text{O}_4@\text{SiO}_2$. Silika diekstrak dari limbah abu layang menggunakan metode sol-gel. Hasil sintesis $\text{Fe}_3\text{O}_4@\text{SiO}_2$ berupa padatan hitam dan dapat ditarik menggunakan magnet. Karakteristik dari $\text{Fe}_3\text{O}_4@\text{SiO}_2$ dianalisis menggunakan FTIR, SEM-EDX, XRD, TEM, BET, dan VSM. Berdasarkan karakterisasi, adsorben memiliki ukuran partikel rata-rata 170 nm, luas permukaan spesifik 35,7939 m^2/g , rentang ukuran pori 2–5 nm tergolong dalam mesopori dan sifat superparamagnetik. Adsorpsi MG pada $\text{Fe}_3\text{O}_4@\text{SiO}_2$ menunjukkan kinetika pseudo orde kedua dan energi aktivasi (E_a) adalah 37,30 kJ/mol. Studi termodinamika memberikan nilai positif pada entalpi (ΔH°) dan entropi (ΔS°), dan nilai negatif pada perubahan energi bebas (ΔG°), menunjukkan proses endotermis dan spontan. Persen adsorpsi mencapai 88% setelah 3 kali siklus menunjukkan bahwa adsorben memiliki kemampuan penggunaan ulang yang baik.

Kata Kunci: Adsorpsi, Fe_3O_4 , silika, *malachite green*, kinetika, termodinamika.



ABSTRACT

Malachite green (MG) is a dye that is widely used in the textile industry and is dangerous when entering the waters, so it is necessary to have a separation technique to reduce the negative impact caused, one of which is the adsorption method. The adsorption of malachite green (MG) was carried out using $\text{Fe}_3\text{O}_4@\text{SiO}_2$. Silica was extracted from fly ash waste using the sol-gel method. The synthesized $\text{Fe}_3\text{O}_4@\text{SiO}_2$ is a black solid and can be attracted using a magnet. The characteristics of $\text{Fe}_3\text{O}_4@\text{SiO}_2$ were analyzed using FTIR, SEM-EDX, XRD, TEM, BET, and VSM. Based on the characterization, the adsorbent was found to have an average particle size of about 170 nm, a specific surface area of 35,7939 m^2/g , a pore size range of 2–5 nm belonging to mesopores and superparamagnetic properties. The adsorption of MG on $\text{Fe}_3\text{O}_4@\text{SiO}_2$ showed second order pseudo kinetics and the activation energy (E_a) was 37,30 kJ/mol. Thermodynamic studies gave positive values in enthalpy (ΔH°) and entropy (ΔS°), and negative values in free energy change (ΔG°), indicating an endothermic and spontaneous process. Percent adsorption reached 88% after 3 cycles indicating that the adsorbent has good reusability.

Keywords: Adsorption, Fe_3O_4 , silica, malachite green, kinetics, thermodynamic.

