DECREASING CONCENTRATION OF METHYLENE BLUE IN WATER BY USING ADSORBENT OF SULFONATED STYROFOAM WASTE WITH MAGNETITE MODIFICATION

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ABSTRACT

In order to decrease methylene blue (MB) dye concentration in the water and utilize styrofoam solid waste, in this present research a modification of the styrofoam waste to form an adsorbent that can remove MB and practically separated by magnetic field has been performed. This research consisted of sulfonation and magnetization of the styrofoam waste, characterization of the adsorbent, and adsorption study of the adsorbent for MB removal. The sulfonation and magnetization were performed by using sulfuric acid and Fe(II)/Fe(II) in base solution of the styrofoam waste to form magnetized styrofoam-sulfonate (styrofoam-SO_3/Fe_3O_4). In the preparation step, Fe_3O_4 fraction was varied. Characterization of the adsorbent prepared was conducted by FTIR, XRD, and SEM, instruments. In the adsorption process by batch technique, the influence of Fe_3O_4 fraction on the adsorption capacity and separable effectiveness was evaluated. Additionally, pH, time, and the MB initial concentration were optimized. In addition, kinetic and isotherm adsorption were also determined. The characterization results indicated that by sulfonation and magnetization toward styrofoam waste, it has been obtained an adsorbent that was able to adsorb MB effectively and to be separated practically by magnetic rod. The Fe_3O_4 fraction of 50.00% in the adsorbent gave compromisingly good adsorption capacity and separability. The optimum condition of the adsorption of MB 10 mg/L in 40 mL solution by *styrofoam*-SO_3/Fe_3O_4 50.00% was found as 15 mg of the adsorbent mass, 45 min of the contact time, pH solution of 7, with the effectiveness as ca. 93.11 %. The adsorption kinetic best fitted to pseudo-second order with adsorption rate constant as 0.065 g/mg.min, and it was well described by Langmuir isotherm model with adsorption capacity of 46.51 mg/g.

Keywords: adsorbent, Fe_3O_4, methylene blue, styrofoam, sulfonation.

BAB I
PENDAHULUAN

I.1 Latar Belakang dan Permasalahan

Biru metilena merupakan salah satu zat warna yang sering digunakan dalam industri tekstil maupun indikator mikrobiologi (Lyu dkk., 2017). Zat warna ini juga digunakan untuk kebutuhan farmasi, kosmetik, maupun pemrosesan pada industri makanan (Saini dkk., 2018). Dalam industri tekstil, sebanyak 13-15% zat warna menjadi limbah cair yang sering dibuang bebas ke lingkungan (Khoshsang dkk., 2018; Staron dkk., 2019).

Dampak negatif zat warna biru metilena bagi lingkungan di antaranya menghalangi masuknya sinar matahari ke perairan, mengganggu proses fotosintesis di dalam perairan, dan mengurangi level oksigen terlarut (Ferreira dkk., 2019). Beberapa penyakit yang dapat ditimbulkan dari paparan zat warna ini yaitu tekanan darah tinggi, rasa mual dan gangguan jaringan abdomen, sesak nafas, hingga gangguan mental (Lyu, 2017; Oz dkk., 2011). Mengingat dampak negatif yang ditimbulkan, maka penurunan konsentrasi zat warna biru metilena dalam air limbah sebelum dibuang ke lingkungan medesak untuk dilakukan.

Metode penurunan konsentrasi limbah cair zat warna biru metilena dapat dilakukan dengan berbagai cara seperti koagulasi-flokulasi (Anouzla dkk., 2009; Lou dkk., 2018), filtrasi membran (Kasperchik dkk., 2012), oksidasi kimia (Tűrgay dkk., 2011), elektrokimia (Kőrbahti., 2011), fotokosidasi (Sahunin dkk., 2006), ozonisasi (Zhang dkk., 2009), dan proses biologis (Oyelude dan Appiyah-Takyi., 2012), serta adsorpsi (Alizadeh dkk., 2017; Valdés dkk., 2009; Benhouria dkk., 2015; Salleh dkk., 2011; dan Gupta dkk., 2016). Di antara metode tersebut, adsorpsi dinilai lebih efektif, sederhana, dan ekonomis (Mtshatsheni dkk., 2019).

Adsorben yang telah digunakan untuk menghilangkan zat warna biru metilena antara lain zeolit (Valdés dkk., 2009), karbon aktif (Benhouria dkk., 2015), tanah lempung pertanian (Salleh dkk., 2011), dan biomassa (Gupta dkk., 2016). Selain dari bahan tersebut, pada dasarnya adsorben juga dapat dibuat dari suatu limbah, seperti limbah *styrofoam* atau gabus (Ogemdi, 2018). *Styrofoam*