

Limbah agrikultural pabrik gula berupa ampas tebu dimanfaatkan menjadi adsorben hydrochar dengan perlakuan *hydrothermal carbonization* (HTC). Adsorben hydrochar digunakan untuk mengadsorpsi limbah zat pewarna *methylene blue*. Beberapa tahapan pembuatan adsorben terdiri dari *grinding*, *screening*, proses HTC, aktivasi KOH dan dilanjutkan dengan studi adsorpsi. Preparasi diawali dengan menghaluskan limbah ampas tebu kering dengan grinder lalu mengayak (*screening*) ampas tebu hingga diperoleh ukuran -32 +48 mesh. Proses HTC dilakukan pada suhu 270°C, tekanan 10 Bar selama 30 menit. Hydrochar kemudian di aktivasi menggunakan KOH 0,5 N dan 1 N kemudian kinerja hydrochar dibandingkan dengan hydrochar tanpa aktivasi KOH. Hasilnya menunjukkan bahwa hydrochar dengan aktivasi KOH mampu meningkatkan persentase removal ~11%. Akan tetapi, variasi konsentrasi KOH kurang menunjukkan hasil yang signifikan. Hasil uji FTIR menunjukkan bahwa peningkatan suhu HTC menyebabkan beberapa gugus fungsi menurun intensitasnya dan beberapa ada yang menghilang dan sebagian terlarut dalam fase liquid. Gugus fungsi yang mendominasi hydrochar adalah O-H, C=O, -O- dan senyawa aromatis. Studi adsorpsi terdiri dari kinetika, isotherm, dan termodinamika dilakukan selama 120 menit. Studi isotherm dilakukan pada *initial concentration* 20, 30, 40, 50 dan 60 mg/L dan persen *removal* yang dihasilkan sebesar 99,40; 97,9; 93,73; 88,45; 84,03%. *Fitting* model isotherm menunjukkan bahwa adsorpsi cenderung mengikuti kedua model baik Langmuir dan Freundlich dikarenakan nilai $R^2 > 0,9$. Sedangkan studi kinetika, menunjukkan adsorpsi mengikuti *pseudo second order* dengan nilai konstanta kecepatan adsorpsi (k_2) berkisar 0,3423 – 2,2693 gram/(mg.menit). Hasil mekanisme adsorpsi menunjukkan bahwa adsorpsi termasuk adsorpsi kimia karena nilai k_2 lebih kecil dibandingkan k_{diff} . Studi termodinamika dilakukan pada konsentrasi adsorbat (MB) sebesar 50 mg/L dengan variasi suhu adsorpsi 303, 313 dan 323 K. Hasilnya menunjukkan bahwa adsorpsi MB menggunakan hydrochar ampas tebu tergolong dalam proses endotermis yang artinya proses adsorpsi lebih disarankan pada suhu yang lebih tinggi dari suhu ruang. Kapasitas adsorpsi yang dihasilkan secara berturut-turut adalah 4,3919; 4,7113; 4,8632 mg/g. Nilai ΔG° yang dihasilkan masing-masing sebesar 0,7325; -1,7254; -4,1834 kJ/mol. Sedangkan nilai ΔH° dan ΔS° masing-masing sebesar 75,2084 kJ/mol dan 0,2458 kJ/mol.

Kata kunci : Ampas tebu, Hydrochar, Adsorption, *Methylene blue*, *hydrothermal carbonization*

ABSTRACT

Agricultural industry waste from sugar factory in the form of bagasse is utilized as hydrochar adsorbent by hydrothermal carbonization (HTC) treatment. Hydrochar adsorbent is used to adsorb methylene blue. Several stages to synthesize the adsorbent including grinding, screening, HTC treatment, KOH activation, and adsorption studies. The preparation begins with grinding the dry bagasse, then screening the bagasse to obtain the size of -32 +48 mesh. The HTC process was carried out at a temperature of 270 °C, initial pressure of 10 Bar for 30 minutes. The obtained hydrochar was then activated using 0,5 N and 1 N KOH. The performance of hydrochar was compared between hydrochar with KOH activation and without activation. The result showed that hydrochar with KOH activation increasing the removal percentage by ~11%. However, the variations in KOH concentration did not show the significant results. The FTIR results showed that the increasing in HTC temperature causes some functional groups to decrease during heating and the others were partially dissolved into the liquid phase. Dominants functional groups of hydrochar are O-H, C=O, -O- and aromatic compounds. The adsorption study consisted of kinetic, isotherm, and thermodynamic was carried out for 120 minutes. The isotherm studies were carried out at initial concentrations of 20, 30, 40, 50 and 60 mg/L and the percentages of removal were 99,40; 97,89; 93,73; 88,45; 84,03%. The result showed that the adsorption follows both Langmuir and Freundlich models because the R^2 value is $>0,9$. Meanwhile, the kinetic study showed that the adsorption followed *pseudo second order* model with the adsorption rate constant (k_2) ranging from 0,3423-2,2693 gram/(mg.minutes). The thermodynamic studies were carried out with adsorbate concentration (MB) of 50 mg/L with various adsorption temperatures of 303, 313 and 323 K. The result showed that the adsorption of MB using sugarcane bagasse hydrochar was classified as an endothermic process, which means that the adsorption process is favourable in higher temperature than in room temperature. The adsorption capacities were 4,3919; 4,7113; 4,8632 mg/g. The ΔG° values were 0,7325; -1,7254; -4,1834 kJ/mol respectively. Meanwhile, the values of ΔH° and ΔS° are 75,2084 kJ/mol and 0,2458 kJ/mol, respectively.

Keyword(s) : Sugarcane Bagasse, Hydrochar, Adsorption, *Methylene blue*, *hydrothermal carbonization*