Desalination and Water Treatment
www.deswater.com
doi: 10.5004/dwt.2021.26925

220 (2021) 363–379
April

Mesoporous carbons as adsorbents to removal of methyl orange (anionic dye) and methylene blue (cationic dye) from aqueous solutions

Katarzyna Jedynak*, Marta Repelewicz, Krystyna Kurdziel, Dariusz Wideł

Institute of Chemistry, Jan Kochanowski University, Uniwersytecka 7, 25-406 Kielce, Poland, emails: kjedynak@ujk.edu.pl (K. Jedynak), martar@ujk.edu.pl (M. Repelewicz), krystyna.kurdziel@ujk.edu.pl (K. Kurdziel), dwidel@ujk.edu.pl (D. Wideł)

Received 7 October 2020; Accepted 11 December 2020

ABSTRACT

In this study, the removal of methyl orange (MO) and methylene blue (MB) from aqueous solutions using mesoporous carbon materials marked as ST-A and ST-A-CO_2 were investigated. The effects of different parameters that affect adsorption process such as contact time, pH, initial dye concentration, and temperature were studied. Removal of methyl orange from acidic solutions was more efficient than from basic solutions. In the case of methylene blue the reverse process was observed. To explain the kinetic model of adsorption, pseudo-first-order kinetic model, pseudo-second-order kinetic model, and the intraparticle diffusion model were used. The experimental data have been described by Langmuir, Langmuir–Freundlich, Freundlich, and Dubinin–Radushkevich adsorption isotherm models. The experimental data were fitted to the pseudo-second-kinetic model and Langmuir isotherm. Results of adsorption experiments showed that the studied carbons are characterized by high adsorption capacity in relation to the methyl orange and the methylene blue. The highest adsorption capacity was obtained for carbon ST-A-CO_2 (MO) (330 mg g^{-1} in temperature 315 K), lower successively for ST-A-CO_2 (MB) (222 mg g^{-1} in temperature 315 K), ST-A (MB) (187 mg g^{-1} in temperature 315 K), and ST-A (MO) (154 mg g^{-1} in temperature 315 K). Thermodynamic study showed that the adsorption was a spontaneous and endothermic processes ($\Delta G°$ ranges from –22.60 to –33.08 kJ mol^{-1} for all systems tested) and ($\Delta H°$ is 9.40, 8.12, 3.21, and 7.33 kJ mol^{-1} for ST-A (MO), ST-A-CO_2 (MO), ST-A (MB), and ST-A-CO_2 (MB), respectively).

Keywords: Adsorption; Methyl orange; Methylene blue; Mesoporous carbons; solution pH; Initial dyes concentration; Temperature; Isotherm; Kinetic; Thermodynamic

* Corresponding author.

1944-3994/1944-3986 © 2021 Desalination Publications. All rights reserved.