Desalination and Water Treatment
www.deswater.com

doi: 10.5004/dwt.2020.26204

201 (2020) 393–403
October

Kinetic and equilibrium studies on the batch removal of methylene blue from aqueous solution by using natural magnetic sand

Cigdem Ozer

Environmental Engineering Department, Engineering and Architecture Faculty, Bitlis Eren University, 13000, Bitlis, Turkey, Tel. +90 434 222 14 32; emails: cozer@beu.edu.tr/cigdemozer80@gmail.com

Received 12 February 2020; Accepted 4 June 2020

ABSTRACT

In this study, removal of methylene blue from aqueous solution using natural magnetic sand was investigated. The natural magnetic sand was characterized using an X-ray diffraction, Fourier transformation infrared spectrometer, electron scanning microscopy, energy dispersive spectroscopy, and nitrogen adsorption–desorption isotherms using Brunauer–Emmett–Teller isotherm models. The results revealed that natural magnetic sand composed mainly Fe and O atoms, which overlaps with Fe_2O_3 structure, having a low surface area. Batch adsorption experiments were conducted to investigate the effects of pH, initial methylene blue concentration, contact time, and natural magnetic sand dosage. Ninety-nine percent of the methylene blue was removed from aqueous solution (250 mL) containing 50 mg/L of methylene blue at original pH of 6.5 using 40 g natural magnetic sand and 240 min mixing time. Pseudo-second-order was found to be the best defining kinetic model for the methylene blue adsorption onto natural magnetic sand. Monolayer methylene blue adsorption capacity of natural magnetic sand was found to be 1.01 mg/g using Langmuir isotherm which is best fitted with the equilibrium data. Adsorbed methylene blue onto natural magnetic sand was quantitatively desorbed using ethanol and 0.1 M HNO_3 solution. This study showed that natural magnetic sand can be used as a natural, environmentally friendly, easy-to-access, and cheap adsorbent for methylene blue removal from aqueous solution.

Keywords: Natural magnetic sand; Methylene blue; Removal; Adsorption; Kinetic; Isotherm