Desalination and Water Treatment
www.deswater.com

doi: 10.5004/dwt.2021.26906

216 (2021) 445–455
March

Synthesis and characterization of polyacrylonitrile based precursor beads for the removal of the dye malachite green from its aqueous solutions

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Received 11 July 2020; Accepted 7 December 2020

ABSTRACT

Polyacrylonitrile (PAN) precursor beads-shape with uniform particle size was prepared by phase inversion method and used for dye removal from aqueous solution. The morphology, diffraction patterns, pore size distribution, and chemical structure of the prepared PAN precursor beads were confirmed by scanning electron microscopy, X-ray diffraction analysis, physisorption analyzer, and Fourier-transform infrared spectroscopy, respectively. The structure of the prepared PAN precursor beads contains a porous structure with many large finger-like defects. The pores on the surface appear to be linked to those inside the bead. Malachite green (MG) dye was used as a model contaminant to investigate the prepared PAN precursor beads' adsorption capacity. The effect of different adsorption parameters, such as initial dye concentration, adsorbent dosage, pH of the solution, rotational speed, and temperature, were investigated. The effective pH was 7 and the process reached equilibrium in 5 h. Maximum dye elimination was 97% under optimal conditions: PAN dosage was 0.4 g, rotational speed was 200 rpm, initial concentration was 10 mg/L, and the temperature was 15°C. The adsorbent was regenerated and reused for MG dye adsorption showing a good removal up to 81% after the fifth run. The Langmuir and Freundlich adsorption models were used to characterize the equilibrium isotherms, and the former was ideally suited. Kinetic analysis showed that MG dye adsorption on PAN precursor bead followed a pseudo-second-order. The thermodynamic study has demonstrated that adsorption is a spontaneous and endothermic process.

Keywords: Adsorption; Malachite green; Polymer; Beads; Isotherm; Kinetic; Thermodynamic

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