Desalination and Water Treatment, Volume 299, Pages 179 - 189, July 2023

Valorization of face mask waste as an adsorbent for cationic dye adsorption

Abstract

The increasing environmental pollution caused by the disposal of untreated dye-containing effluent and face mask wastes in landfills has become a significant concern. To address this issue, this work focuses on the utilization of face mask wastes as alternative adsorbents for the adsorption of malachite green (MG) dye. These adsorbents offer advantages such as ease of operation, cost-effectiveness, high efficiency, and ready availability. In this study, the raw face mask wastes (RFM) undergo a thermal treatment process in a furnace at 800°C for 21 h before conducting the adsorption tests. The Fourier-transform infrared spectroscopy analysis revealed the presence of various functional groups, including alkane, alkene, alcohol, and carbonyl, in both the treated face mask adsorbent (TFMA) and RFM. The scanning electron microscopy with energy-dispersive X-ray spectroscopy analysis displayed the surface morphologies of RFM as a porous and homogeneous carbon sorbent structure, while TFMA exhibited a heterogeneous and flaky structure. Energy-dispersive X-ray spectroscopy analysis indicated that RFM primarily consisted of carbon elements, followed by oxygen and calcium elements, whereas TFMA predominantly comprised calcium and oxygen elements with a limited amount of carbon. The adsorption experiments, considering various parameters such as initial dye concentration (1,000–1,200 mg/L) and contact time (5–1,500 min), demonstrated that increasing the contact time and initial concentration led to an enhanced adsorption capacity. The maximum adsorption capacity of 2,127 mg/g confirmed the effectiveness of TFMA as an adsorbent for MG. Thermodynamic analysis revealed that the adsorption process was spontaneous and endothermic. The isotherm and kinetic studies showed a good fit between the adsorption data and the Brunauer–Emmett–Teller and pseudo-second-order models as evidenced by high R2 values and low error function values, suggesting a heterogenous adsorption of MG on TFMA.

Keywords

Dye adsorption; Face mask waste; Malachite green