Libya

Ministry of Higher Education and Scientific Research

AL-Asmarya Islamic University

Faculty of Engineering

Innovative Recycling of Waste Face Masks for Methylene Blue Dye Removal from Aqueous Solutions

A graduation project is submitted to the Chemical Engineering Department in partial fulfillment of the requirements for the degree of *B.Sc.* in Chemical Engineering

BY

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April 2022

Abstract

In modern life, wearing face masks has been considered one of the important steps for reducing the transmission of the virus and the spread of COVID-19. Therefore, the irresponsible disposal of used masks in the environment has a significant impact on the pollution of the world's ecosystems. Therefore, this study provides a possibility for recycling waste face masks (WFMs) for separation applications. The inner layer (WFM_1) and outer layer (WFM_2) of waste face masks have been modified with polymer crosslinking chemistry of chitosan and malice anhydride (CTS-MA) in the form of flat-plate film. The role of WFM layers in the present work is that the layers provide high porous thin films. Therefore, bulk densities and porosities of the produced CTS-MA/WFM_1 and CTS-MA/WFM_2 were investigated. In addition, the surface properties of the produced films were evaluated by contact angle and pure water absorbency. Moreover, the thermal stability of the samples was also investigated and compared with the neat WFM layers. For practical applications, the produced CTS-MA/WFM_1 and CTS-MA/WFM_2 were employed as flat-plate modules of adsorbents for the removal of methylene blue dye (MBD) from water systems. The results indicated that the increase in contact time enhances the adsorption efficiency. The adsorption capacity was also increased with an increase in the operating temperature and initial pH of the initial solution. The results showed that the maximum 93.1% of MBD removal was achieved from an aqueous solution with an MBD initial concentration of 7.5 $mg \cdot L^{-1}$ and a pH value of 7.0 after 12 h. Furthermore, the effect of the initial concentration of MBD on the adsorption capacity was studied and the adsorption experimental data were fitted with the available adsorption isotherm

models in the literature, namely Langmuir, Freundlich, and Temkin equations. The experimental adsorption equilibria were adequately fitted with the Langmuir isotherm model and the adsorption process was well described by the pseudo-first-order kinetic model. The thermodynamic investigations showed that the MBD adsorption onto obtained flat-plate sorbents was a heterogeneous, spontaneous, and endothermic process.

KEYWORDS: Waste face masks; Chitosan; Flat-plate module sorbent; Wastewater treatment; Adsorption isotherm models; Adsorption kinetics and thermodynamics.