

Article

Removal of Chromium (VI) from Water Using Orange peel as the Biosorbent: Experimental, Modeling, and Kinetic Studies on Adsorption Isotherms and Chemical Structure

Amel Khalfaoui ¹ , Abderrezzaq Benalia ^{1,2} , Zineb Selama ¹, Amira Hammoud ¹, Kerroum Derbal ³, Antonio Panico ⁴  and Antonio Pizzi ^{5,*} 

- ¹ Laboratoire de l'Ingénierie des Procédés de l'Environnement, Faculty Process Engineering, University of Constantine 3, Ali Mendjeli Nouvelle Ville, Constantine 25000, Algeria; khalfaoui_amel@yahoo.fr (A.K.); benalia.abderrezzak@gmail.com (A.B.); zineb-selama@gmail.com (Z.S.); hammoud.amira@gmail.com (A.H.)
 - ² Department of Physics and Chemistry, Higher Normal School of Constantine, Ali Mendjeli Nouvelle Ville, Constantine 25000, Algeria
 - ³ Laboratory of Process Engineering for Sustainable Development and Health Products (GPDDPS), Department of Process Engineering, National Polytechnic School of Constantine, Constantine 25000, Algeria; derbal_kerroum@yahoo.fr
 - ⁴ Department of Engineering, University of Campania L. Vanvitelli, 81031 Aversa, Italy; antonio.panico@unicampania.it
 - ⁵ Laboratoire d'Etude et Recherche sur le Matériau Bois (LERMAB), Ecole Nationale Supérieure des Technologies et Industries du Bois (ENSTIB), University of Lorraine, 27 Rue Philippe Seguin, 55000 Epinal, France
- * Correspondence: antonio.pizzi@univ-lorraine.fr

Abstract: The present work aims to assess the effectiveness and efficiency of orange peels as a low-cost biosorbent for removing Cr(VI) from an aqueous solution by the biosorbent process. The orange peels as adsorbent was characterized using different methods, such as FTIR, pH_{pzc} , equilibrium pH, TGA, XRD, SEM, and (BET). The tests were conducted in the batch mode, and the effects of different parameters, such as the pH, dosage of the bioadsorbent, influent Cr(VI), and time, on the biosorption of Cr(VI) were investigated. The adsorption kinetics proved that a contact time of 90 min resulted in the highest (approximately 97.8%) Cr(VI) removal, with an adsorption capacity of 4.96 mg/g. Moreover, the increase in the biosorbent dosage (from 1 to 10 g/L) resulted in the enhancement in the Cr(VI) removal effectiveness. Moreover, the pH of the solution also affected significantly the effectiveness of the removal. The tests were conducted under acidic pH solution conditions, and the prediction of the pH value at a zero charge (pH_{pzc}) was confirmed experimentally. Furthermore, the results from the batch-mode assays were successfully tested by an experimental design (full factorial design). The biosorption of Cr(VI) on orange peels occurred mostly according to the pseudo-second-order kinetic model and the uptake of Cr(VI) was satisfactorily described by the Langmuir model.

Keywords: biosorption; chromium; water treatment; batch mode; kinetic; orange peels



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1. Introduction

Chromium (Cr) is one of the most widely used chemicals in the industry thanks to its valuable effects in processing skin for tannery [1], textiles [2], wood and manufacturing dye [3] as well as in paint and paper [4] and in oil refining [5]. Cr(III) and Cr(VI) are two stable oxidation states of Cr that persist in the environment [6]. Cr (III) is essential for human nutrition, especially in glucose metabolism, while Cr(VI) is toxic for humans, animals, and bacteria. Cr(VI) compounds are known to be carcinogenic [7,8]. According to the World Health Organization (WHO) guidelines, the concentration thresholds of Cr(VI)

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