Desalination and Water Treatment
www.deswater.com

doi: 10.5004/dwt.2023.29338

286 (2023) 217–227
February

Modeling of pesticide adsorption on fixed-bed column using biomaterials: response surface methodology optimization

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Received 4 November 2022; Accepted 29 January 2023

ABSTRACT

Dynamic adsorption of bifenthrin pesticide onto treated gari tellinella shells (TGTS) was investigated using fixed-bed column technique. Response surface methodology based on Box–Behnken design has been used to study the influence operation parameters on the adsorption. Our main goal is to optimize the process at lower cost with maximum efficiency, identification of influential factors to the process, the evaluation of interactions between these factors and modeling mathematical result. The properties of TGTS biosorbent are determined by the application of X-ray diffraction, Fourier-transform infrared spectroscopy, scanning electron microscopy/energy-dispersive X-ray spectroscopy, thermogravimetric analysis/differential thermal analysis, pH_{pzc} and Brunauer–Emmett–Teller characterization techniques. TGTS is composed of a calcium carbonate ($CaCO_3$) phase and has a specific surface area equal to 151 $m^2 \cdot g^{-1}$. In the experiment field study, the amount of bifenthrin adsorbed by TGTS depending on flow rate (Q), bed height (L), particles size (Ps) and inlet concentration (C_0). The coefficients of flow rate, bed height and feed concentration are positive, thus these parameters positively affect the adsorption of bifenthrin onto TGTS biosorbent. Conversely, the particles size coefficient is negative, which means that its influence on the adsorption process is negative. Analysis of variance showed a high coefficient of determination (R^2 = 0.958) and satisfactory prediction of the regression model was derived. The largest amount adsorbed (20.73 $mg \cdot g^{-1}$), estimated by a multivariate experimental design, was found under the following optimal experimental conditions: flow rate of 5 mL/min, bed height of 4 cm, particles size of 50 μm, and initial bifenthrin concentration of 12.5 mg/L.

Keywords: Bifenthrin; Pesticides; Adsorption; Fixed-bed column; Modelling; Treated gari tellinella shells; Box–Behnken design

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