Application of GO-Fe_3O_4 nanocomposite with ultrasonic in removal of Cefixime from aqueous solutions: Isotherm and kinetics study

Abstract

Background: Antibiotics, including cefixime (CEX), are drugs that are widely used in medicine and veterinary medicine and enter aquatic environments through various pathways such as agricultural runoff, direct discharge from municipal wastewater treatment plants, human excreta, direct disposal of medical, veterinary, industrial, etc.

Methods: The aim of this study was to investigate the applicability of GO-Fe_3O_4 nanocomposite with ultrasonic in the removal of CEX from aqueous solutions by the response surface methodology, which was conducted as an experimental-lab scale study, and the effect of important operational parameters such as solution pH, nanocomposite concentration, initial concentration of CEX and reaction time were investigated at three levels (+1, 0 and -1) with a constant intensity of ultrasound at 37 kHz. The structure of gravity and their morphology were investigated by FTIR, XRD, SEM, BET and VSM techniques. Isotherms (Langmuir and Freundlich) and adsorption kinetics at different concentrations were studied to evaluate the process. The optimization and analysis of the results were performed by design expert 10 and Statgraphics software and the residue of CEX was measured using a spectrophotometer at 288 nm.

Finding: The results showed that the quadratic model was suitable for the data (P-value <0.0001) and the proposed model (Quadratic) was approved with a high correlation coefficient (R^2 = 0.9824 and R^2_{Adj} = 0.9670). Under the optimal conditions for the process (pH = 3, nanocomposite of 1 g/L, initial concentration of CEX of 10 mg/L, and reaction time of 90 min), the observed removal efficiency was about 100%.

Conclusion: The proposed model presented by the software showed that the removal of CEX is affected by various parameters such as nanocomposite concentration, solution pH, reaction time and initial concentration of CEX. These factors are effective in increasing the process efficiency due to increasing the production of hydroxyl radicals, creating a suitable adsorbent surface and also the appropriate reaction time with the contaminant.According to the results, the GO-Fe_3O_4 with ultrasonic process was approved to be effective in the degradation of the antibiotic CEX, and the box-behnken design was found to be a suitable tool to optimize the process conditions in the removal of CEX.

Keywords: Cefixime, Graphene Oxide, Nanoparticles, Ultrasonic, Fe_3O_4, Box-Behnken