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Improved electrocoagulation process using chitosan for efficient removal of cefazolin antibiotic from hospital wastewater through sweep flocculation and adsorption: kinetic and isotherm study

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ABSTRACT

Recently widespread usage of cephalosporin antibiotics in medical and veterinary fields has received growing attentions as severe contaminants of aquatic ecosystems. Since there is no report on the removal of cefazolin (CFZ) using electrocoagulation and adsorption (EC/AD) coupling treatment process, the present work deals with efficient removal of CFZ from hospital wastewater using EC/AD process. To achieve the optimal condition, response surface methodology (RSM) was applied successfully with the removal efficiency of 100% under optimal operating condition of 7.8 pH, 15.5 mA cm^{-2} current density, 60 mg L^{-1} initial CFZ concentration, 1.0 cm inter-electrode distance, 0.7 g L^{-1} chitosan dosage and electrolyte dose of 0.07 M NaCl within the equilibrium treatment time of 23 min which is in adequate agreement with the predicted model using analysis of variance. Kinetic and isotherm models were studied to figure out the exact mechanism of the CFZ removal. Kinetic studies revealed that the second-order model (R^2 = 0.9715) best fitted with the experimental results. Langmuir isotherm model (R^2 = 0.9851) predicted the maximum adsorption capacity of 1,250 mg g^{-1}. The obtained results suggested that charge neutralization of the negatively charged CFZ through binding with cationic hydrolysis products and sweep flocculation as the determinant mechanisms control the adsorption of CFZ molecules on aluminum hydroxide precipitates. Under the optimal condition, electrode consumption and electrical energy consumption were found to be 0.024 g during a single run and 1.251 kWh m^{-3}, respectively. The predicted treatment model for the synthetic wastewater is in satisfactory agreement with removal efficiency of the hospital wastewater.

Keywords: Cefazolin; Hospital wastewater; Electrocoagulation; Adsorption; Chitosan; Response surface methodology

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