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Comparative study between electrocoagulation used separately and coupled with adsorption for dairy wastewater treatment using response surface methodology design

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ABSTRACT

Dairy industrial wastewater is characterized by high chemical oxygen demand (COD) and other pollution loads. In this study, simulated dairy wastewater (SDW) was treated for turbidity and COD elimination via electrocoagulation (EC) with aluminum electrodes. COD concentration was not completely abated and exceeded allowable Algerian direct discharge limits. To enhance rate parameter pollution removal, electrocoagulation (EC) was combined with adsorption (AD) under the same operational electrocoagulation conditions. A full factorial design was employed to determine the optimum operating conditions for dairy wastewater treatment by electrocoagulation used separately or coupled with granular activated carbon (GAC). Current density, initial pH, and GAC mass were chosen as the controlling process parameters and examined at three levels. The results showed that EC reduced turbidity and COD from SDW to 98.75% and 78.09%, respectively, when pH = 4 and with current densities of 20.83–27.77 mA/cm^2. The EC/AD process enhanced turbidity reduction to 99.39% and COD removal to 87.12% when small masses of GAC (0.5 to 1.5 g) were used at the lowest applied current density level of 13.38 mA/cm^2. In comparison to classical electrocoagulation using aluminum electrodes in a batch system, coupling electrocoagulation to adsorption technique achieved faster removal of pollutants with lower operating costs. Operating costs of the EC/AD process for turbidity and COD removals were calculated as 0.360 €/m^3 and 0.746 €/m^3 vs. 0.494 €/m^3 and 0.692 €/m^3 for the EC process. Correlations with the experimental data for the EC process were R^2 = 95.78% for turbidity and R^2 = 96.22% for COD removal. For the coupled EC/AD they were R^2 = 96.61% for turbidity and R^2 = 95.48% for COD removal.

Keywords: Dairy wastewater; Chemical oxygen demand; Electrocoagulation; Adsorption; Operating cost; Full factorial design

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