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Modeling and optimization of the coagulation of highly concentrated coking wastewater by ferrous sulfate using a response surface methodology

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ABSTRACT

The coagulation process by ferrous sulfate was used to pretreat coking wastewater prior to a subsequent biological treatment. The central composite Box–Behnken experimental design and response surface method were applied to evaluate and optimize the interactive effects of three operating variables, namely the initial pH, dosage of ferrous sulfate, and interaction time, on the physical and chemical performances of coagulation. Four dependent parameters, namely COD removal, cyanide removal, sulfide removal, and total oil removal, were either directly measured or calculated as responses. According to analysis of variances results, the four models proposed in this work can be used to navigate the design space, with the high regression coefficient R^2 varying from 0.9158 to 0.9877. The initial pH, ferrous sulfate dosage, and interaction time had significant effects on the COD removal, cyanide removal, sulfide removal, and total oil removal due to their respective effects on chemical precipitation and coagulation removal. The synergies effect of chemical precipitation and coagulation during ferrous sulfate coagulation process controlled the treatment. A visual search of the overlaying critical response contours plot was carried out, and the results indicated the optimum conditions to an initial pH 11, ferrous sulfate dosage of 1.5 g/L, and reaction time of 120 min. The experimental date and models' predictions agreed well. COD removal, cyanide removal, sulfide removal, and total oil removal of 15.25, 93.82, 73.36, and 4.73%, respectively, were demonstrated. The results of a B/C analysis and cost evaluation show that $FeSO_4$ coagulation is an appropriate technology for coking wastewater pretreatment.

Keywords: Coking wastewater; Ferrous sulfate; Coagulation; Response surface methodology (RSM)

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