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Optimization strategy to improve the removal efficiency of commercial herbicides using a multivariable inverse artificial neural network adapted with particle swarm optimization

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ABSTRACT

The present work is focused on the implementation of a new optimization strategy using a multivariable inverse artificial neural network (ANNim) to increase the removal efficiency of commercial herbicides in a sonophotocatalysis process. This research contributes significantly for the removal of pollutants in aquatic ecosystems, reducing the chemical oxygen demand (COD). To carry out the strategy, it is necessary to develop an artificial neural network (ANN) model considering the multiple input variables of the process. The ANN model obtained satisfactory results, showing a coefficient of determination (R^2) of 0.9723 and a root mean square error equal to 0.0414. The training data was fitted with a Levenberg–Marquardt algorithm with a hyperbolic tangent sigmoid function in the hidden layer. Subsequently, an objective function is proposed using the coefficients generated by the ANN model to minimize the COD value. For the determination of optimal variables, this work adapted particle swarm optimization (PSO), obtaining the ANNim-PSO computational strategy. The hybridization of the ANNim model with the PSO algorithm was necessary to determine the optimal parameters in the shortest possible time, improving the rate of removal of the active ingredients of herbicides compared to other degradation methods. The results showed that by optimizing one variable at a time in a specific experimental test, it is possible to increase the removal efficiency of commercial herbicides from 84.1% to 100% due to the effect of the TiO_2 catalyst (250 mg/L) in 55 min. However, optimizing more than one variable at the same time, the elimination of commercial herbicides was achieved in less time, reaching 100% due to the combined effect of pH (5), TiO_2 (250 mg/L) and K_2SO_4 (3 mM) catalysts in 5 min. Finally, the optimal parameters imply a total removal of the active ingredients of commercial herbicides in a considerably short time due to the increase in the superficial concentrations, obtaining a better absorption of the energy produced by the effect of pH and the TiO_2, the deposition of K_2SO_4, and the effective combination of ultrasound with the photocatalysis process.

Keywords: Multivariable inverse artificial neural network; Sonophotocatalysis; Commercial herbicides; Chemical oxygen demand removal; Water treatment

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