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Uncertainty quantification and sensitivity analysis of the efficiency of a biofilm reactor with a moving bed using a combination of Monte Carlo simulation and artificial neural network.

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In this study, the uncertainty and sensitivity analysis of the efficiency of a biofilm reactor with a moving bed were conducted using a combination of Monte Carlo simulation and artificial neural network. The qualitative prediction of the quality of petroleum source was estimated using artificial neural networks, and the removal efficiency of COD and TPH pollutants was predicted using a set of laboratory data.

This dataset included parameters such as TPH_{in}, COD_{in}, F/M, Filing Ratio, MLVSS/MLSS, DO, COD_{out}, and TPH_{out}, which are considered influential in the quality of petroleum sources. A 4-layer neural network with 7 neurons and an error rate of 4.06% was designed for COD removal efficiency prediction, and a 3-layer neural network with 8 neurons and an error rate of 3.95% was designed for TPH removal efficiency prediction. By incorporating the mathematical model as an activation function in the Monte Carlo method, the uncertainty and reliability of the estimated COD and TPH removal efficiencies were determined.In the Monte Carlo method, using the Latin Hypercubes algorithm, the removal efficiencies were obtained as intervals with a 95% confidence level, yielding satisfactory results. This is important as it reduces the risk of pollutant removal during managerial decision-making and covers sudden changes in the quality of petroleum sources that affect the removal efficiency. In previous random sampling methods, a random number was extracted from the probability distribution space of a data. However, this method divides the input's normal distribution into rows and columns, and then selects a random sample from among the created sections so that the realization of values with low probability is also practical. One of the advantages of using this method is obtaining confidence levels for risks with high effects but low probabilities [1].

Keywords: MBBR, Artificial Neural Network, Monte Carlo

References

[1] N. Gazzaz, M. Yusoff, A. Aris, H. Juahir, M. Ramli, *Marine Pollution Bulletin*, **2012**, 64(11), 2409-2420.