Modeling of photodegradation process to remove the higher concentration of environmental pollution

ABSTRACT

Environmental organic pollutants are mineralized to harmless final-products such H2O and CO2 by photocatalytic advanced oxidation processes (AOPs). In photocatalytic-AOPs, an appropriate concentration of p-Cresol was mixed with certain amount of ZnO in 500 mL deionized water according to an experimental-design. Then the mixture was irradiated by UV-A lamp at different pH for 6 h. At specific time intervals, the sampling was carried out to calculate the efficiency of the photodegradation. Therefore, the photodegradation as a system consists of four input variables such irradiation time, pH, amount of ZnO and p-Cresol's concentration while the only output was the efficiency. In this work, the system was modeled and optimized by semi-empirical response surface methodology. To obtain the empirical responses, the design was performed in laboratory. Then observed responses were fitted with several well-known models by regression process to suggest a provisional model. The suggested model which was validated by several statistical evidence, predicted the desirable condition with higher efficiency. The predicted condition consisted of irradiation time (280 min), pH (7.9), photocatalyst (1.5 g L−1), p-Cresol (95 mg L−1) and efficiency (95%) which confirmed by further experiments. The closed confirmation results has presented the removal (efficiency = 94.7%) of higher p-Cresol concentration (95 mg L−1) at shorter irradiation time in comparison with the normal photodegradation efficiency (97%) which included irradiation time (300 min), pH (7.5), photocatalyst amount (1.5 g L−1) and p-Cresol (75 mg L−1). As a conclusion, the modeling which is able to industrial scale up succeeded to remove higher concentration of environmental organic pollutants with ignorable reduction of efficiency.

Keyword: AOPs; Environment; Multivariate-modeling; Optimization; Organic-pollutant; Photocatalyst; Photodegradation; RSM; Water treatment; ZnO