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Optimization of process parameters during photocatalytic degradation of phenol in UV annular reactor

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ABSTRACT

In this work, photocatalytic oxidation of aqueous phenol solution was carried out in a novel UV-irradiated annular reactor in the presence of TiO_2 catalyst. The photocatalytic experiments were conducted by varying the flow rates (5, 7.5, and 10 LPH), substrate-to-catalyst ratios (0.083, 0.5415, and 1), and solution pH (3, 6, and 9). In each case, the demineralization of phenol in aqueous was investigated after an operating time of 3 h. The influence of each parameter on phenol degradation was thoroughly investigated and reported. The strategy consisted of several steps, such as selection of the variables and their experimental domain, use of a screening design to detect significant variables and interactions into the experimental region, study of the main effect of variables and interactions, and finally application of a Draper–Lin small composite design (orthogonal) to obtain the optimum values of the significant variables leading to high conversion of phenol. Efficiency of phenol degradation was found to decrease with increase in substrate to TiO_2 ratio. The flow rate and solution pH were found to affect the degradation appreciably. Kinetic study of the photocatalytic reaction revealed that phenol degradation could be well explained using Langmuir–Hinshelwood model. In dilute solution, the degradation was found to follow a pseudo-first-order model. The apparent rate constant was determined and reported.

Keywords: Photocatalytic oxidation; UV; Phenol conversion; TiO_2 dosage; Draper–Lin small composite designs; Langmuir–Hinshelwood model

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