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How chemical and physical mechanisms enable the influence of the operating conditions in a photocatalytic indoor air treatment device to be modeled

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Abstract

The photocatalytic degradation of toluene in indoor air conditions was performed in a closed-loop multi-pass photocatalytic reactor using the Box-Behnken experimental design methodology. The objective of this work was to rigorously determine a kinetic model in order to understand the behavior of the reactor in real indoor air conditions and to relate the kinetic parameters to physical and chemical mechanisms. Three main parameters were studied: initial toluene concentration, light irradiance and air stream velocity. The experimental results were used to calculate the single-pass removal efficiency for different operating conditions and to establish a relationship between the single-pass removal efficiency, light irradiance and air stream velocity. This relationship was integrated into an overall reaction rate law based on the Langmuir-Hinshelwood mechanism. The kinetic model obtained was then validated for various experimental conditions.

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