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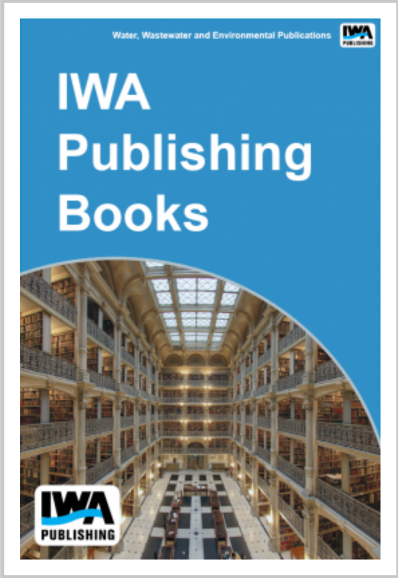
Numerical and Experimental Characterizations of Dose Distributions in UV Disinfection Systems



UV photoreactors, especially those used for disinfection, have emerged as important alternatives to conventional treatment operations. UV dose represents the master variable in governing the performance of these systems; however, the interpretation of the term dose in continuous-flow UV reactor systems has been unclear until fairly recently.

Although the existence of a dose distribution in continuous-flow UV systems is well-established, the methods used to quantify these distributions have not been formalized. Moreover, prior to this research, all methods for dose distribution estimation were based on numerical models. While these models have tremendous potential as tools for characterization of reactor behavior, the engineering and regulatory communities have expressed considerable skepticism as to the literal interpretation of predictions from such models. The development of methods for measurement of UV dose (distributions) has long existed as a top research priority within the community of engineers and scientists involved in this issue.

To address this need, two specific objectives of this research were identified:

- Development of numerical models for reactor analysis based on a particle-centered (Lagrangian) approach, and
- Development of an experiment-based method for measurement of dose distributions.

Numerical models of two reactor systems were developed based on a Lagrangian (particle-centered) frame of reference. These models were applied for prediction of reactor performance and compared with the results of microbial challenge experiments on each reactor. The models were shown to be capable of providing accurate representations of reactor performance when properly calibrated. However, problems with a particle-tracking algorithm within one of the CFD codes used in this research limited the accuracy of process predictions that were developed with that model.

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