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Modeling Target Disinfection By-Product Dynamics in Indoor Swimming Pools

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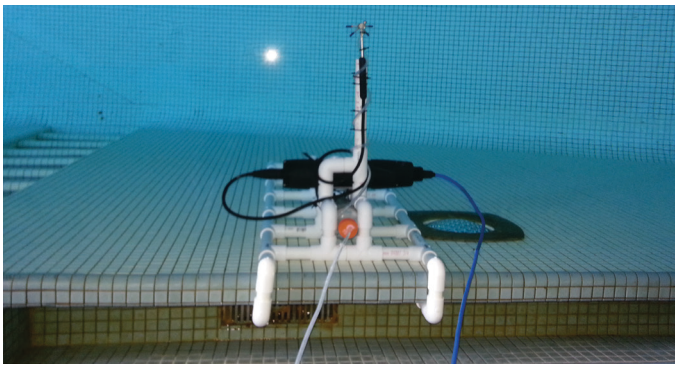
Chlorine is used to disinfect pool water, but can react with compounds in human sweat and urine to form disinfection by-products (DBPs). Certain DBPs in indoor swimming pools pose health risks. After forming within the water through a series of reactions, these DBPs may volatize and be transferred to the air, where they can then be ingested by swimmers and spectators. Children are most vulnerable to respiratory system damage from inhalation of DBPs. Research at Purdue University demonstrated that volatilization of DBPs is related to bather activity; high levels of activity in the pool, such as that during a swim meet, result in higher concentrations of gaseous DBPs within the facility. The goal of this project is to predict the transfer of DBPs in an indoor swimming pool with a model based on chemical and physical factors, including swimmer activity. We designed a preliminary experiment to quantify the relationship between bather activity and the liquid phase transport of DBPs over time. The effects of bather activity were quantified by measuring the turbulence (velocity fluctuations) below the water surface using an acoustic Doppler velocimeter (ADV), with the basic hypothesis that different bather activity levels produce different turbulence levels. Inert seeding material was introduced next to the ADV probe so that it could register water turbulence. Simultaneously, concentrations of target DBPs throughout the depth of the water were taken to determine DBP transfer within the pool over time. The preliminary findings show that DBP concentrations decrease near the water surface and turbulence decreases with depth. A model was created using MATLAB to output concentration values of a single DBP given water conditions and the number of swimmers. Revisions to the experimental setup to measure turbulence are needed before a complete DBP transport model for indoor pools can be created.

Research advisor Cary Troy writes, "Even though a swimming pool is a closed system with regular geometry, the modeling of DBP volatilization involves a complex system of coupled chemical reactions and the parameterization of what still remains the Achilles' heel of environmental transport modeling: turbulence. Barnard's work also highlighted the challenges in characterizing turbulence in pools, due to the extreme clarity of the water, which renders traditional acoustic and optical techniques, however advanced, impossible to use."



An acoustic Doppler velocimeter (ADV) was used to determine the turbulence in swimming pool water. This image was taken during a preliminary test run of the probe mounted against the side of an indoor swimming pool.

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