A Practical Method for Designing a Virtual Sprinkler Spray

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Abstract

As the use of performance based design methodologies becomes more common within the fire protection engineering community, there is an increasing demand to better understand how sprinkler sprays can be incorporated into Computational Fluid Dynamics design tools. Currently, the methods which can be utilized to implement a sprinkler spray into a numerical simulation require a very complex understanding of the sprinkler spray characteristics – e.g. droplet size distribution, droplet velocity vector fields, spray geometry, etc. Collecting this information requires highly sophisticated equipment and specialized techniques, many of which are still in the early stages of development. As a result, the goal of the current project was to investigate if a more practical method could be developed for implementing a sprinkler spray into a numerical CFD model, utilizing direct measurements of the conditions within a compartment containing a fire and discharging sprinkler rather than of the sprinkler spray itself.

A statistical Design of Experiments (DOE) Response Surface Method (RSM) was utilized to design and calibrate a virtual sprinkler spray in FDS. The scenario of interest consisted of a 16 ft. wide by 32 ft. long by 8 ft. high UL1626 style residential test compartment containing a single open doorway. A steady state propane diffusion fire was located in the corner of the compartment opposite the doorway, and a single sprinkler was located 8 ft. from the walls adjacent to the fire. The method consisted of selecting a mean droplet diameter, spray velocity, and spray angles to reproduce the real world observations of average floor density, wall wetting height, and steady state sprinkler induced flow and temperature effects within the compartment doorway for a non-fire scenario. This calibrated sprinkler spray model was then validated against test data from various sprinklered fire scenarios with reasonable results.