Role of large-scale flow structure on ammonia spray diffusion ignition and its transition to extinction

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Abstract:

A well-stirred reactor (WSR) model-based dynamic large eddy simulation modeling framework is used to investigate the fundamental principles controlling ammonia spray structure and flame growth under advanced engine settings. In order to do this, a case study of ammonia is used to define the initial heat release, autoignition, and flame-developing patterns under ultra-lean circumstances in a well-controlled constant volume combustion under diffusion combustion mode. The combination of WSR and the turbulence modeling approach yields very accurate predictions for the igniting properties of ammonia spray. Spray development characteristics and the ignition process are extracted and examined using descriptive statistical analysis, resulting in the identification of two unique regimes. To better investigate the vortex-to-OH interactions of LES, global parameters including OH-based ignition delay time (OH-IDT) and lift-off length (LOL) are developed. The spatial organization of OH zones is described in terms of thickness, OH-vortex interaction length, and distribution in an ammonia diffusion spray at different axial positions. However, there hasn't been a thorough investigation of the probability density function that represents the thickness of OH zones before. For OH concentrations, probability density functions were also acquired. The spatially interactions between the OH and large eddies are well defined by these probability density functions.