Effects of superheat degree on flow field of multi-hole fuel sprays

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ABSTRACT

Superheated spray has the potential to improve the fuel atomization and evaporation processes which is quite attractive for engineering application. However, the mechanism of superheated spray is still not clear yet. In this study, n-hexane sprays from an eight-hole injector in both vertical and cross-sectional planes under various superheat degrees were investigated by using high-speed Particle Image Velocimetry (HS-PIV) technique within the lower density region. In cross-sectional direction, the spray pattern changes from the eight plumes to a “donut” shape, a “pancake” shape and then an “octopus arms” shape as the superheat degree increases. In vertical direction, a lost momentum of spray particles with increased fuel temperature under non-superheated conditions can be observed through the flow field, resulting in a shorter penetration. As the fuel spray enters into the superheated region, significant flash-boiling induced plume expansion with increased superheat degree is observed; the vertical velocity increases while the radial velocity decreases with increasing superheat degree, which results in spray plumes collapsing to the injector axis (gas-jet shape under fully superheated conditions) and dramatically penetration increment under highly superheated conditions. The self-preserving velocity behavior of the gas-jet shape plume is captured and analyzed for fully-superheated sprays (SD>48^{o}C). Obvious vortex at the spray plume outer boundary is observed. The vortex core of fuel sprays is identified. The vortex intensity and the vortex motion under various superheat degrees are also characterized, which are proved to be greatly dependent on the superheat degree. The results provide insight to the spray-collapsing processes under superheated conditions for multi-hole sprays. It’s regarded that superheat degree is the predominant factor influencing the flow field, thus the structure of the superheated spray.

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