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Modeling Investigation of Liquid Oxygen Flashing Spray with CFD

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Abstract

Injection of cryogenic propellants (e.g. liquid oxygen) into low-pressure environment (e.g. upper-stage rocket engine) may trigger flashing phenomenon, which severely affects the propellants' mixing and combustion. In order to unveil the characteristics of flashing sprays, numerical models of flashing sprays were developed and validated. First, a developed model based on Adachi-correlation was employed for the flashing spray simulation. The results show good agreements with the experiments, both for the flashing spray morphology and temperature distribution. In the near-injector region, the flashing evaporation dominates the spray vaporization with the evaporation mass flow rate of about 2 orders of magnitude higher than that by the other heat transfers, whereas downstream the injector, the external heat transfer (i.e. heat conduction and convection) does. Furthermore, a new flashing spray model based on the nucleate boiling theory was proposed, which shows an improved agreement of the droplet temperature between the simulation and test data.

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