Stochastic model of the near-to-injector spray formation in Diesel-like conditions

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Abstract

The stochastic model of spray formation in the vicinity of the injector has been described and assessed by comparison with measurements in Diesel-like conditions. In this mesh-free model, the 3D configuration of continuous liquid core is simulated stochastically by ensemble of spatial trajectories of specifically introduced stochastic particles. Each trajectory of such particle corresponds to one realization of the liquid core geometry. The stochastic process is based on assumption that due to a high Weber number, the exiting continuous liquid jet is depleted in the framework of statistical universalities of a fragmentation under scaling symmetry. The parameters of such stochastic process are presumed from the physics of primary atomization. The spray formation model is consists in computation of spatial distribution of the probability of finding the non-fragmented liquid jet in the near-to-injector region. This model is combined with KIVA II computation of atomizing Diesel spray in two ways. First, simultaneously with the gas phase RANS computation, the ensemble of stochastic particles is tracking and the probability field of their positions is calculated, which is used for sampling of initial locations of primary blobs. Second, the velocity increment of the gas due to the liquid injection is computed from the mean volume fraction of the simulated liquid core. Another novelty in the model presented is that unsteadiness of the injection velocity is taken into account in breakup simulation. The critical Weber number, indicating when the atomization model is activated, is computed on the bases of the increment in time of the injection velocity, when the last one is decreasing, and thereby leads to supplementary breakup. We show that by such a numerical procedure, the measurements reported by Arcoumanis et al. (time-history of the mean axial centre-line velocity of droplet, and of the centre-line Sauter Mean Diameter), are fairly well predicted.

Key words: Diesel spray, primary atomization, spray model, stochastic modeling

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