Intermittent multijet sprays for improving mixture preparation in HCCI engines

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In this work, the characteristics of droplets produced by a multijet impingement atomization process are measured with a Phase-Doppler Interferometer and statistically described using finite mixtures of weighted probability density functions (pdf).

\[ f_{\text{mix},K} = \sum_{i=1}^{K} w_i f(x|\beta_i) \]  

Through this statistical tool, drop size and axial velocity distributions are involved in the physical interpretation of the flow, instead of limiting it to first, and second order distribution moments. Each group of droplets with similar size characteristics has been modeled by lognormal distributions, and normal distributions relatively to drop axial velocity. The analysis based on finite mixtures identified three groups of droplets with similar size characteristics, although the group with smaller sizes is negligibly represented in the mixture. Also, the lognormal standard deviation in all groups is well correlated with the corresponding geometric mean diameter (Fig. 1).

![Fig. 1 Correlation between the characteristic mean diameter $\mu_{i,D}$ and the standard deviation $\sigma_{i,D}$.](image1)

In terms of axial velocity, mainly one distribution has been identified with a relatively constant standard deviation, and a characteristic velocity dependent on the duty cycle associated with the spray intermittent condition (Fig. 2).

The characteristics of droplets have been measured for the same operating conditions of previously reported heat transfer experiments, in order to evaluate their correlation, as well as the expected outcome of impact (Fig. 3). Results evidence the following:

- spray deposition is within the typical values observed for the usual sprays in PFI engines produced by pintle-type injectors. However, in the case of multijet impingement atomizers, a lower pumping pressure is required;
- multiple injection pulses with shorter time intervals between consecutive cycles, induce a greater importance to the relation between droplets’ axial velocity and liquid film thickness for heat transfer enhancement. Consequently, this improves evaporation and reduces fuel deposition.

Further research is required to assess multijet impingement sprays performance in a more real HCCI engine environment.

![Fig. 2 Variation of the second group of the axial velocity distribution ($\mu_{2,U}$) with the duty cycle (DC).](image2)

![Fig. 3 Comparison between Nu obtained experimentally and through an empirical correlation](image3)