Spray flame in hot vitiated cross flow at high pressure

Chetankumar S. Vegad*, Kihun Moon*, Nicolas Noiray*

Atomization and combustion characteristics of jet A-1 spray in hot vitiated crossflow at elevated pressures are investigated. The test configuration comprises a lean CH_4-H_2 flame producing a turbulent vitiated crossflow that interacts with spray flame in the downstream regime (figure 1). This research work is relevant to the lean azimuthal flame (LEAF) configuration where a hot vitiated crossflow interacts with the spray flames distributed along the chamber circumference[1]. In the present study, an air blast atomizer (Delavan, SN30601-8) is used for the transverse injection of spray in the chamber of square cross-section. The hot crossflow of upstream lean flame products facilitates the moderate or intense low-oxygen dilution (MILD) combustion environment and enables low pollutant emissions[2]. The spray flame in crossflow is investigated for different operating pressures up to 5 bar. The upstream flame is operated at a constant equivalence ratio of 0.7, however it is varied for the downstream flame. The atomization characteristic of jet A-1 is controlled in terms of blast air-to-liquid mass flow ratio (ALR). The details of diffused interfaces at spray flame and hot crossflow interaction in the vicinity of jet A-1 injection are captured using the long-distance microscope and intensified camera in the laser-induced fluorescence (LIF) based approach. The interfacial study reveals the connection between initial spray formation and its penetration into crossflow. The spray flame topology and reaction zone are characterized by OH* chemiluminescence and OH-PLIF techniques. The spray-PLIF imaging data analysis confirms an efficient mixing and formation of distributed reaction zones due to deeper penetration of smaller droplets produced at high ALR.

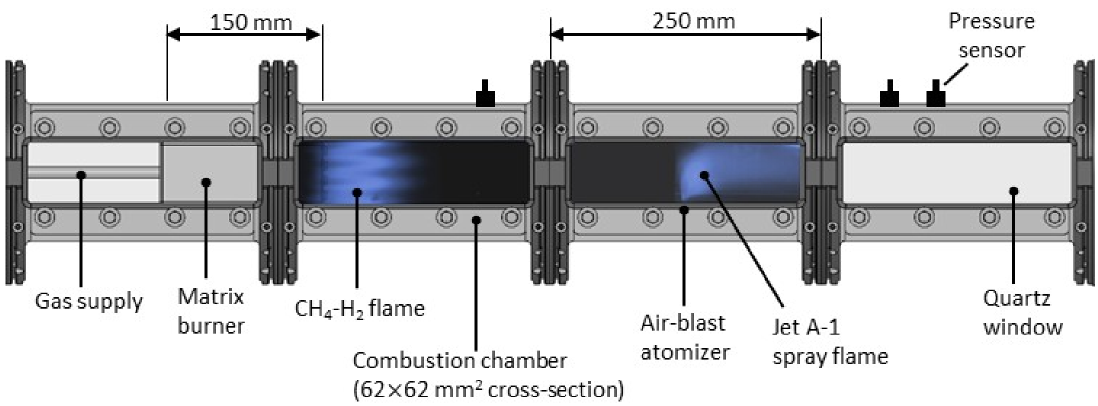

Figure 1: The test configuration demonstrating the lean CH_4-H_2 flame at upstream and spray flame in hot vitiated crossflow at the downstream regime.

*CAPS Laboratory, Department of Mechanical and Process Engineering, ETH Zürich, Zürich 8092, Switzerland
[1] Pandey et al.,*Proceedings of the Combustion Institute* **39**, 4791-4799 (2023)
[2] Miniero et al.,*Combustion and Flame* **256**, 112915 (2023)