Atomization Process of an Annular Liquid Sheet assisted by an Inner Gas Jet

N. Leboucher*, F. Roger, J. L. Carreau and A. Claverie
Laboratoire de Combustion et de Détonique, CNRS UPR 9028
University of Poitiers
ENSMA, 1 Avenue Clément Ader, BP 40109
86961 Chasseneuil Futuroscope, France

Abstract

In order to design new injectors in cryogenic propulsion, the atomization process of an annular liquid sheet assisted by a swirling inner gas jet with different ambient pressures is studied. The liquid used is water, the gas is air and three experimental techniques are performed. First, films at 12 500 and 14 000 frames per second show the behavior of the liquid sheet. Second, laser tomography is used to determine the break-up length. At last, axial and radial velocities as well as diameter are determined for droplets measuring from 5 to 230 μm by Phase Doppler interferometry (PDI). Basically, two break-up mechanisms are identified with high speed visualizations, namely bubble formation and "Christmas tree". The frequency of bubble formation and "Christmas tree" is related to gas and liquid velocities, gas and liquid densities and swirl intensity. In "Christmas tree mode", the tomography shows that the break-up length decreases with gas to liquid momentum flux ratio (J), swirl intensity, and without significant effect of ambient pressure. The droplets have high radial velocities and their mean axial velocities grow with J and decline with ambient pressure. Last, the gas swirl enlarges the previous radial profile, promotes a better primary atomization, and allows better homogenization of the droplet axial velocities. The Sauter Mean Diameter (SMD) of the liquid droplets increases slightly with radial and axial distances, showing that primary and secondary atomizations are very fast.

Key words: Atomization, visualization, PDA, annular sheet, swirl

* Corresponding author: nicolas.leboucher@lcd.ensma.fr