Combustion of aerosols: droplet sizing study in microgravity

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Abstract

Spray and aerosol cloud combustion accounts for 25% of the world's energy use, and yet it remains poorly understood from both a fundamental and a practical perspective. Realistic sprays include a liquid breakup region, dispersed multiphase flow, turbulent mixing processes, and various levels of flame interactions through the spray. Idealization of spray configurations in a quiescent environment (the starting point for models) has been impossible in 1 g due to the settling of large droplets and buoyant pluming of post combustion gases. The objective of the present research is the experimental determination of the flame propagation velocity in aerosols. The first step of this work was to characterize experimentally the size of droplets composing the aerosol. This characterization was performed using a laser diffraction particle size analyzer "Sympatec-HELOS", using ethanol and isooctane as fuel. High pressure studies have been performed using of a high pressure combustion chamber (max pressure 12 MPa). This equipment was designed to be used aboard the Airbus A300-0g of the CNES. The interest of microgravity in this study is related to the possibility of creating aerosols without sedimentation effects. After ground tests, three parabolic flight campaigns were conducted. The results obtained allowed to determine the effects of initial temperature and pressure on the droplet diameter distribution of the aerosol. A systematic comparative analysis for identical initial conditions in normal and reduced gravity was performed, also between ethanol and isooctane droplets. During the experiments, the temporal evolution of the growth of droplet sizes was followed starting from the beginning of the condensation of expansion cooling. The durations of growth and evaporation were also measured.

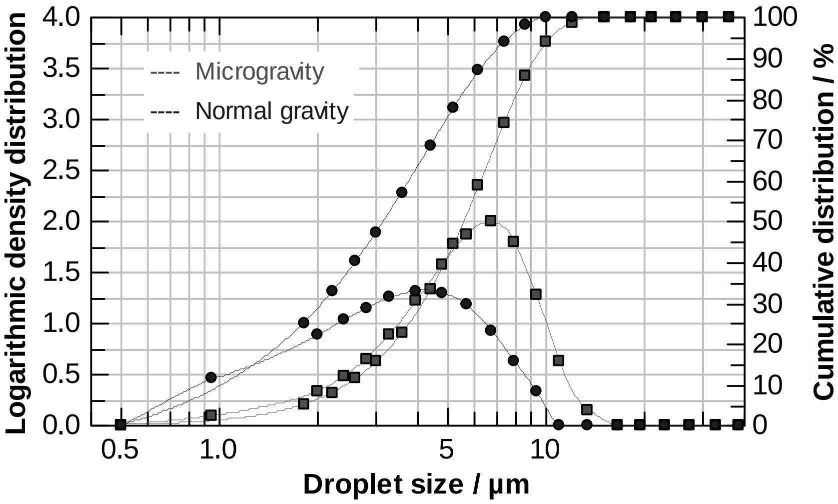

Figure: Ethanol droplets size distribution at 45 ° C, 8 bars and Ø=1 in microgravity --■-- and normal gravity --●--

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