Experiments on turbulent ethanol spray flames in EEC conditions

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Abstract

An experimental study on the structure of ethanol turbulent spray flames in Excess Enthalpy Combustion (EEC) conditions and cold coflow was conducted Delft Spray in Hot Coflow burner. The setup consists in a spray issuing upwards in either a coflow of ambient air or hot-vitiated combustion products mixture. Different flame structures were observed depending on the coflow Reynolds number, injection pressure and coflow temperature and oxygen volume fraction. For the spray flame in cold air, a double flame structure that consists of two diverging flame fronts originating at the leading edge of the reaction zone and an increase of the lift-off height is observed with increasing injection pressure. In EEC conditions double flame structure is absent, flame exhibits low chemiluminescence and no lift-off height changes are attested with increasing injection pressure. Using Laser Doppler anemometry and Phase Doppler anemometry, we report space and time resolved measurements of the turbulent flow field and droplet spatial spectrum for a number of measurement locations in flames. Droplet radial distributions revealed important difference in the spray structure and the evidence of non-reacting droplet along the spray edges for both cases. The modeling of the flame structures observed represents a challenge for combustion scientists due to the richness of observed physics phenomena.

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