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Measurement of the periodic flow of an enclosed lean premixed prevaporized stagnation flame

by

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ABSTRACT

Phase resolved velocity, pressure and OH-emission measurements and laser light sheet visualization have been applied in the analysis of an unsteady reacting flow. The measurements reported herein are for an enclosed, planar, lean premixed prevaporized kerosene flame, stabilized by means of a movable stagnation plate. The experimental setup displayed in figure 1 comprises a co-annular jet arrangement with a shielding air flow around a central fuel loaded jet, both impinging on the stagnation plate. The turbulent flames investigated show an abrupt change in their mode of oscillation depending on the position of the plate with respect to the outlet of the prevaporizing, premixing section. Two distinct modes can be identified. The lower branch mode exhibits combustion oscillations in the frequency range of 110-125 Hz with higher harmonics. In the higher frequency mode the oscillations show a single tone at a frequency of 175-195 Hz, depending on the flame position. The two branches are separated by a small zone with no oscillations. This zone is only a few millimeters thick in terms of the position of the stagnation plate, or in other words the position of the planar flame front.

The two modes appreciably differ in the phase relation between the pressure inside the combustor and the heat release measured by the spontaneous emission of OH-radicals. Phase averaged visualization of the flow shows large coherent structures in the shear layer of the co-annular flow in the lower frequency case. The periodic vortex shedding results in appreciable spatial and temporal fluctuations in the reacting flow field which generate large periodic fluctuations in the

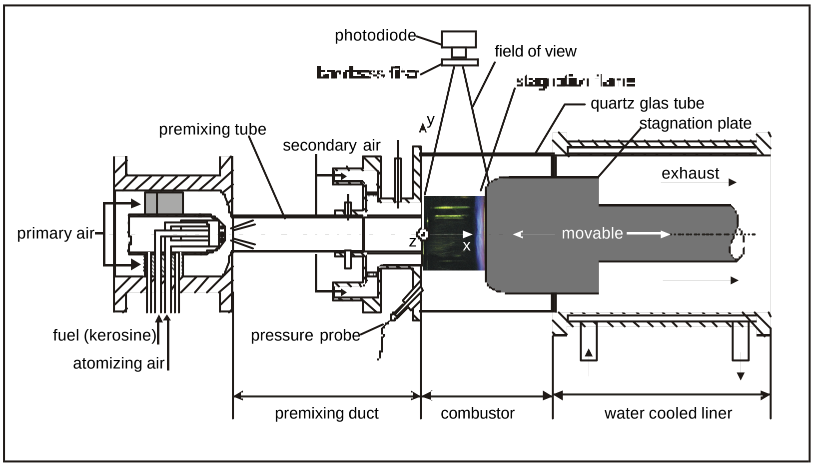

Fig. 1: Sketch of the experimental setup

heat release. For the higher frequency branch the visualization showed rather small spatial fluctuations. To further elucidate the difference between the two modes of oscillation phase resolved LDV measurements of the axial velocity in the turbulent flow have been conducted. The measurements show large non-linear fluctuations in the shielding air flow. These fluctuations induce velocity oscillations in the primary air with a phase lag of about 180°. Due to the phase lag between the flows excitation of the separating shear layer is evident, even though the time mean bulk velocities are equal. In the high frequency mode the oscillations in both flows are in-phase. As the two flows have the same bulk velocities at the inlet and to the combustor the effect on the shear layer is small. In this mode the combustion oscillations can rather be explained in terms of the sound particle velocity modulating the flow at the combustor inlet.