

Flame front tracking and simultaneous flow field visualization in turbulent combustion

by

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ABSTRACT

Local extinction phenomena have a major influence on flame stability and a better understanding of the mechanisms leading to extinction is both of fundamental and practical importance. To study the importance of large scale structures for local flame extinction two-dimensional measurements of relevant quantities with high time resolution are desirable. Simultaneous measurements of both flow and flame quantities, allowing correlations between the two to be studied, are also useful in this respect. The present paper reports on a novel measurement technique which allows simultaneous time resolved measurements of the evolution of the OH radical distribution and the instantaneous velocity field in turbulent flames to be made. The combined measurement technique can be used to study the dynamics of turbulence/chemistry interactions in real time. High speed planar laser induced fluorescence (PLIF) of OH at repetition rates exceeding 13 kHz was used to track the response of the flame front to the turbulent flow field. From the OH PLIF sequences the position, in both space and time, where the local extinction of the flame front begins, could be identified. The temporal changes in local OH distribution during the extinction process could also be studied and the time scale of extinction events estimated. For the PLIF measurements a multiple Nd:YAG laser cluster and a high speed camera, consisting of several CCD units, were used. Instantaneous velocity field measurements were performed simultaneously using particle image velocimetry (PIV). In the velocity field the flow structures associated with the identified extinction events were visualized. The object of study was the TECFLAM turbulent non-premixed flame which serves as an international standard for model validation. Vortices impinging from the fuel side on the flame front was the dominating extinction mechanism found. Sequences recorded at various heights illustrating this mechanism are presented.

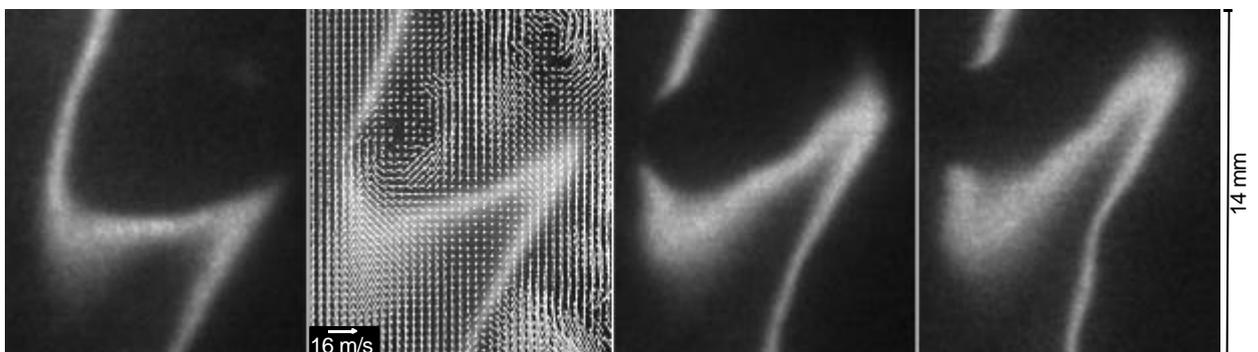


Figure 0: Sequence of OH distributions in the TECFLAM turbulent non-premixed flame, $Re \gg 20000$. The time separation between consecutive images is 125 μ s. The flow field was measured simultaneously with the second OH concentration image, and is plotted on top of this image. In the PIV image a mean vertical velocity of 9 m/s has been subtracted from the velocity vectors. A local extinction phenomenon is shown at a position 19 nozzle diameters above the burner; a vortex from the fuel side (to the right) impinges on the flame front and extinguishes the flame front.

