MEASUREMENTS IN A LIFTED-JET FLAME

APPLICATION NOTE STEREOPIV-003

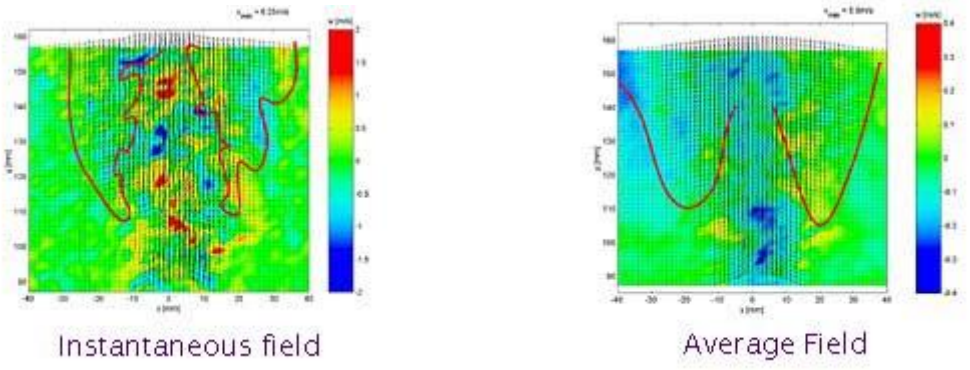
Courtesy of Stanford University

Stabilization and blowout mechanism of turbulent lifted jet diffusion flames have been of great interest to many. The flame base of a lifted flame has a highly complex three-dimensional structure owing to the interaction of the turbulent flow with heat release, density change, and possible buoyancy.

As a first step to understanding the complex three-dimensional structure of the lifted flame base, the stereoscopic particle image velocimetry (SPIV) technique is applied to measure the three components of the velocity field at different planes of the flame base of a lifted flame. In addition, the change of the refractive index, which occurs due to the heat release of a flame, impacts the implementation of the SPIV technique and has been investigated.

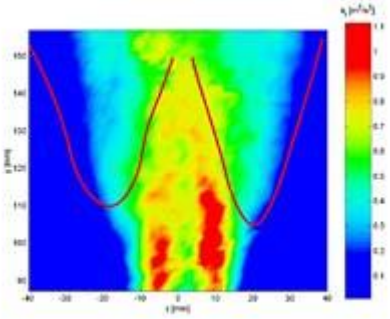
The fuel jet exit velocity and its corresponding Reynolds number are 25 m/s and 7000, respectively. The coflow speed is set to 0.5 m/s and the corresponding average liftoff height was 110mm (x/d = 24). Two progressive scan interline CCD cameras (PIVCAM 10-30, 1k×1k pixel resolution) are set up in the Scheimpflug configuration, which is known to be the optimal arrangement for SPIV measurements. A 120 mJ dual Nd:YAG laser system is used to illuminate the alumina (Al_2O_3) particles (nominal diameter 5 µm) in the flow. A master control unit (TSI Model 610034 Synchronizer system) provides the timing sequence for the laser, camera and interface for laser pulsing, image capture and data transfer. Image capture, data analysis and on-line display were carried out using INSIGHT™ software. Four processors are used in parallel by dividing an image into four different regions which accelerate data processing and display.

In this work, the instantaneous and the ensemble averaged three-component velocity and the turbulent quantities in various vertical planes at the flame base have been measured. Complex three-dimensional structures are observed at the flame base including the meandering in both in and out of plane directions.



Velocity fields at the base of the jet (z = 0)

In addition, the turbulent kinetic energy distribution in different vertical planes is obtained. The conditional velocity statistics at the instantaneous locations of the flame base are also reported.



Turbulent kinetic energy distribution (z = 0)

The flow properties in the diametrical vertical plane (z = 0) are shown here. Red lines in the image show the boundary of the broad thermal zone obtained by the particle seeding density change in the particle image.

Reference

Han, D., Su, L. K., Menon, R. K. and Mungal, M. G., “Study of a Lifted-Jet Flame using a Stereoscopic PIV System,” *10th International Symposium on Applications of Laser techniques to Fluid Mechanics*, Lisbon, Portugal, 2000.

