ACETONE PLIF MEASUREMENTS OF A LAMINAR JET

APPLICATION NOTE PLIF-002

Acetone PLIF Measurements of a Laminar Jet

Planar laser induced fluorescence was used to examine the concentration of Acetone within a laminar jet. Acetone was introduced into the airflow that produced a jet in order to act as a tracer for the jet location, concentration and diffusion.

Experimental Setup

A laminar jet of air mixed with acetone was produced by atomizing acetone using the TSI Model 9306 Atomizer and directing the output through a curved evaporation tube with inner diameter of 12.7 mm. The evaporated acetone exited the tube to the atmosphere forming a laminar jet. A wall was located 65 mm downstream of the tube exit, upon which the laminar jet impinged.

In order to examine the jet location, concentration and diffusion, a pulsed Nd:YAG laser with a frequency quadrupled harmonic generator was used to produce light of wavelength 266 nm at approximately 40 mJ/pulse. Light sheet optics capable of transmitting light in the UV range were mounted at the exit of the laser, creating a light sheet to illuminate the centerline of the jet downstream of the tube exit. The acetone is excited by the 266 nm light and fluoresces at approximately 440nm. A TSI 4MP camera was used to capture images that were timed with the laser pulses using a TSI Model 610036 synchronizer with a timing resolution of 1 ns. Images were captured at a rate of 15 Hz. A raw image of a single capture can be seen in fig. 1. The top of the field of view was at 8 mm downstream of the tube exit, and the field of view size was 35 mm square.

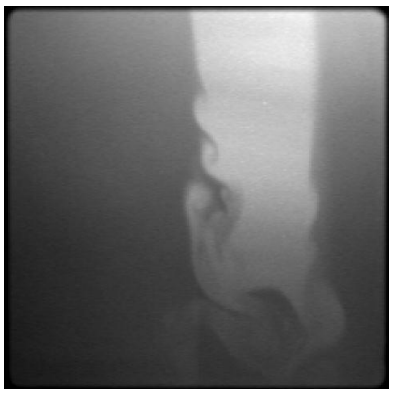

Fig. 1. Raw image of the laminar jet.

The spatial calibration was performed by placing a ruler in the plane of the light sheet and relating pixel distance to real-world distance. The concentration calibration was established by obtaining an image with the minimum intensity (no acetone present) and an image with the maximum intensity (highest concentration of acetone present across the entire image). The minimum intensity image was easily acquired by turning off the jet flow and acquiring a series of images with the laser operating and all of the cameras settings (such as focus and aperture) fixed; the series of images were then averaged using an image pre-processor within Insight 4G™ software. The maximum intensity image was created by panning the jet across the field of view over an extended period of time. An image pre-processor was used within Insight 4G software

that analyzed the series of images and determined the maximum intensity of each pixel across the entire image series. This was then set as the maximum intensity image for the calibration. The minimum and maximum images can be seen in Fig. 2. Note that variations in pixel sensitivity, as well as variations in light sheet intensity are taken into account in the calibration images – highlighting the obvious advantages of an in-situ calibration over a flat-field intensity calibration.

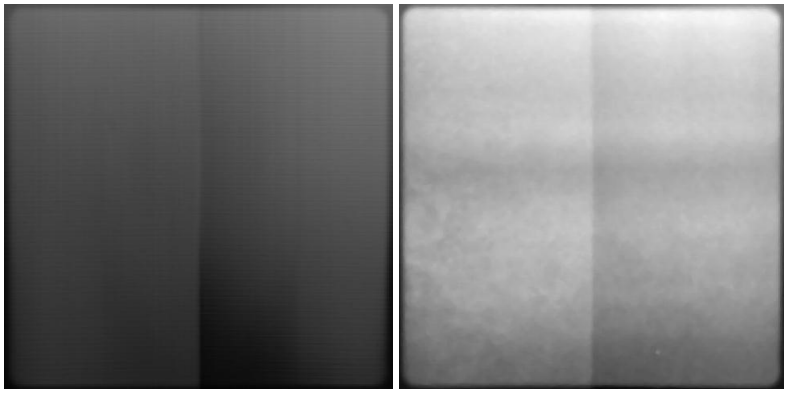

Fig. 2. Minimum (left) and maximum (right) calibration images. ***(Note: The intensity scale has been adjusted in order to accentuate differences in pixel sensitivity.)***

Results

The images were analyzed with the Insight 4G Laser Induced Fluorescence processing module. An example of a single, instantaneous capture can be seen in Fig. 3.

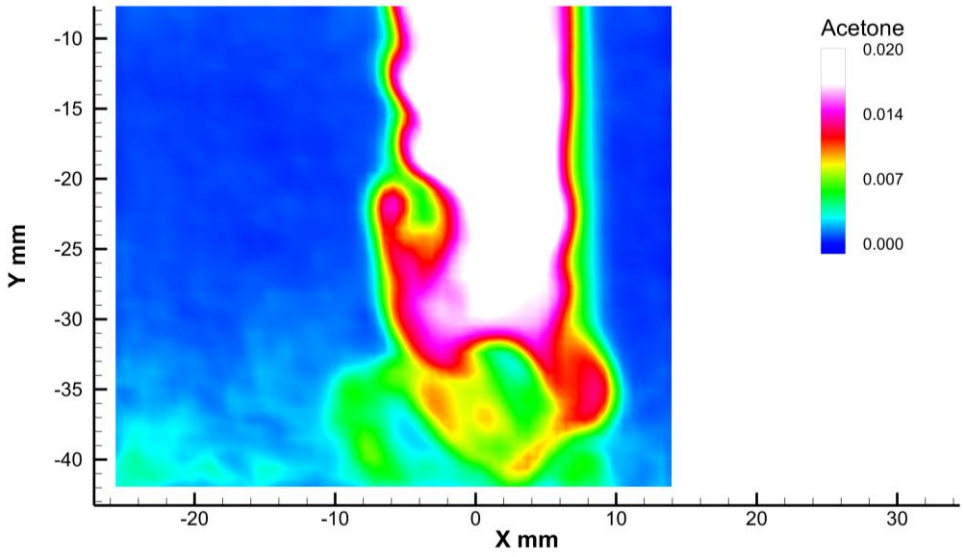

Fig. 3. Final Data result of the acetone concentration of the laminar jet.

The data clearly shows the location of the jet core, vortex roll-up region, as well as the region where diffusion begins to occur. The vortex roll-up region occurs primarily on the left side of the jet, due to the orientation of the curved evaporation tube. The left side of the image corresponds to the outside region of curvature, therefore, vortices roll-up more distinctly on that side. Near the bottom of the plot on the left side is seen regions of acetone concentration that are a result of the back-flow of the jet after impingement on the planar surface located at a y-position of -65mm.

The LIF system was well-suited for this sort of analysis.