1. Role of Flow Visualization in the Development of UNICORN

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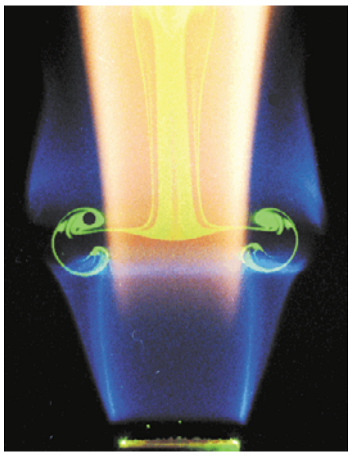


Figure 1 (a)

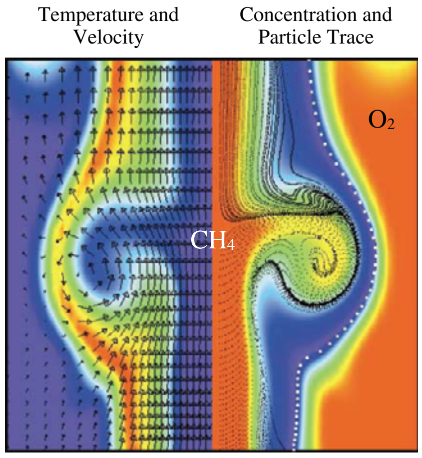
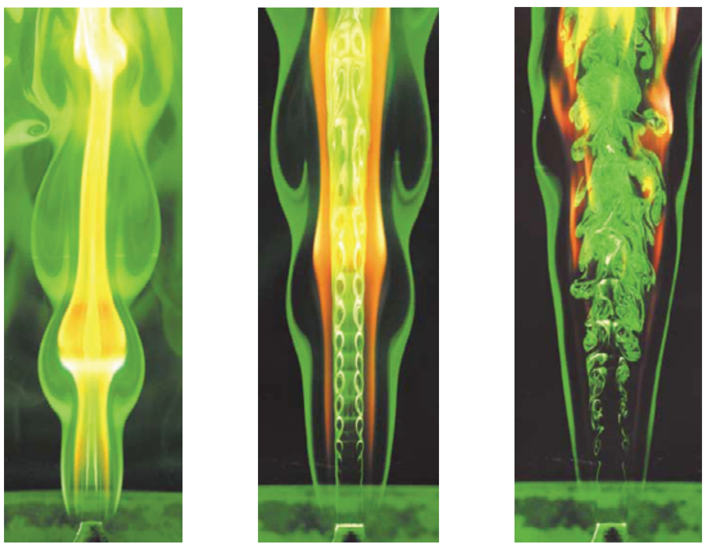


Figure 1 (b)

Interaction of a vortex and a flame surface is studied experimentally and numerically. A vortex is created within a laminar jet diffusion flame by driving the fuel jet at 30 Hz using a loud speaker. Phase-locked Reactive-Mie-Scattering visualization at 10 ms after the firing of the vortex is shown in Fig. (a). The vortex structures have a dark green-yellow appearance, while the flame image is indicated by yellow and blue. Visualization of the computed vortex-flame interaction is shown in Fig. (b), with an iso-temperature plot on the left side and the iso-concentration plots of fuel and oxygen separated by the peak-temperature surface (white dots) on the right. The instantaneous particle field is superimposed on the right-hand side of the image, and the velocity field is superimposed on the left-hand side.



Laminar Transitional Near Turbulent

Figure 2

Detailed information on the mixing and transport processes that occur within and around jet flames is obtained for the development of gas-turbine-combustion models such as UNICORN. The three methane flames shown here have an annulus-air velocity of 0.15 m/s. The fuel-jet velocity is varied to obtain cold-flow exit plane Reynolds Numbers of 408, 1867, and 5834 for the laminar, transitional, and near-turbulent flames, respectively. The flow structures are visualized using the Reactive-Mie-Scattering technique in which the light sheet is formed with a Nd:YAG laser. The green scattered light from TiO_2 particles is captured with a 10-ns laser pulse, and the yellow flame is captured with a 2-ms shutter opening.