Engine Combustion Network

High-Speed Movies & Flow Visualization

Time records of the injection and combustion event were recorded using a high-speed CMOS camera. Four types of movies are available in the database: (1) high-temperature chemiluminescence, (2) natural soot luminosity, (3) shadowgraph and (4) liquid scatter from the spray. Movies are available for download in compressed (.mpeg) format. The scale of the image and time after start of injection are stamped on each frame of the movie.

Chemiluminescence imaging was performed with a visible f/1.2 lens and no filters, providing broadband collection along a line-of-sight. Chemiluminescence imaging was successful with exposure durations as short as 0.02 ms provided that the chemiluminescence source was from high-temperature combustion. Low-level cool-flame chemiluminescence was too weak for the non-intensified camera in such short exposure durations. Chemiluminescence imaging was applied to regions of the jet that were non-sooting, or during transients before the formation of soot, to prevent the strong soot incandescence emission from obscuring the much-weaker chemiluminescence. When soot formation does occur, the bright soot luminosity appears as saturated regions in the movies.

As soot luminosity is much stronger than chemiluminescence, the lens f/number and camera exposure duration were adjusted to prevent major saturation of the camera for soot luminosity imaging. These camera sensitivity settings varied significantly, depending upon the soot luminosity level.

Shadowgraph imaging was performed by collimating broadband emission from a xenon arc lamp, passing the light through a line-of-sight in the combustion vessel, and then using a concave mirror to direct the light directly onto the camera sensor. Shadowgraph imaging, like Schlieren imaging, is sensitive to gradients in refractive index, formed by either density or composition differences along the line-of-sight. This flow visualization technique is quite common. Applied to vaporizing diesel sprays, shadowgraph imaging identifies the vapor boundary of the penetrating jet (Naber, SAE 960034).

The liquid phase of the fuel spray was visualized using high-speed imaging during a single injection. A high-power continuous-wave laser was used to flood-illuminate the spray and elastic scattered light was collected at a right angle to the direction of the laser. A narrow bandpass filter at the laser wavelength (532 nm) was used to minimize collection of other emission sources, such as combustion luminosity.

For further information, contact Web Grand Pooh-Bar
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