20. *Measurement Technology for Benchmark Spray Combustion Data*

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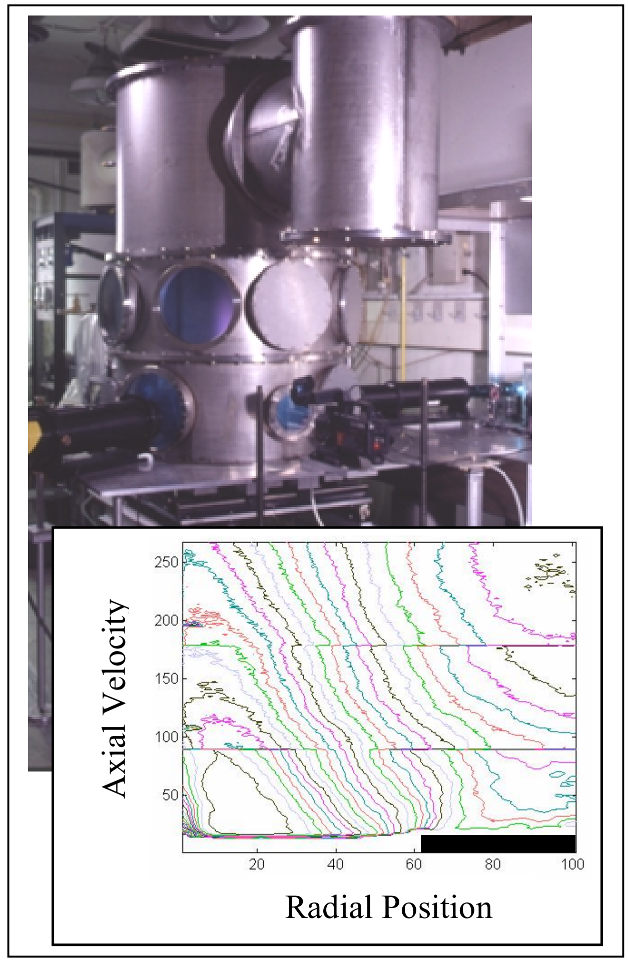
Objective: Develop measurement technology to provide benchmark experimental data for input/validation of multiphase combustion models, calibration of instruments/sensors, and development of advanced diagnostics.

Problem: Control of process efficiency and the formation of species byproducts from industrial combustion systems (*e.g.*, power generation and treatment of liquid chemical wastes), is relying increasingly on computational fluid dynamics (CFD) simulations to provide relevant process information in a cost-effective manner. However, there is a dearth of reliable data for specifying model initial/boundary conditions, and a need for experimental/numerical comparative analysis of conditions within the reactor. The need to provide benchmark data on the characteristics of the droplet field, flame structure, heat transfer, and particulate/gaseous byproducts, and its interrelationship with the system operating conditions (*e.g.*, desired stoichiometry) is crucial for the development and calibration of advanced computational models, diagnostics, and instrumentation.

Approach: The NIST reference spray combustion facility has evolved into a well-characterized and controlled test bed that can handle different 1) process liquid fuels and wastes, 2) atomizer designs, and 3) combustor configurations. The experimental apparatus consists of a swirl burner enclosed within a stainless steel chamber to allow for better-controlled operation of the system and reproducibility of the spray flame characteristics (see figure). A variety of diagnostics are employed or being developed to characterize the input fuel stream (fuel composition), spray flame (droplet size, velocity, and temperature), and flame emissions (particulates and chemical species). A coupled experimental/computational approach is used to involve modelers from our industrial partners directly in the program.

Results and Future Plans: Our efforts in FY00 focused on completing measurement of the burner



inlet conditions (see figure insert that indicates Planar Imaging Velocimetry measurement of the inlet air flow) and dissemination of the benchmark experimental database to our partners in industry and academia that expressed an interest in initiating the computation and validation process. A one-day workshop on metrology needs for multiphase combustion data was held with attendees representing industry (chemical, power, energy, and software developers), other government agencies, and academia. The workshop focused on familiarizing the participants with the NIST's Reference Spray Combustion Facility, evaluating the information provided currently in the database, and assessing the data needs for multiphase combustion modelers and level of interest in carrying out industry specific experiments for development of diagnostics and instrumentation.

Discussions focused on data needs for multiphase combustion models, and industrial metrology needs for development and calibration of instruments and diagnostics. A wide range of needs was discussed with some topics prioritized. There was significant interest in having NIST provide benchmark data on droplet atomization in the near-nozzle region and on low-level combustion byproducts (in particular, particulates). This information combined with other opportunities for collaboration within CSTL are the basis for re-orienting our efforts in this area toward that of developing particulate matter standards for industry.

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