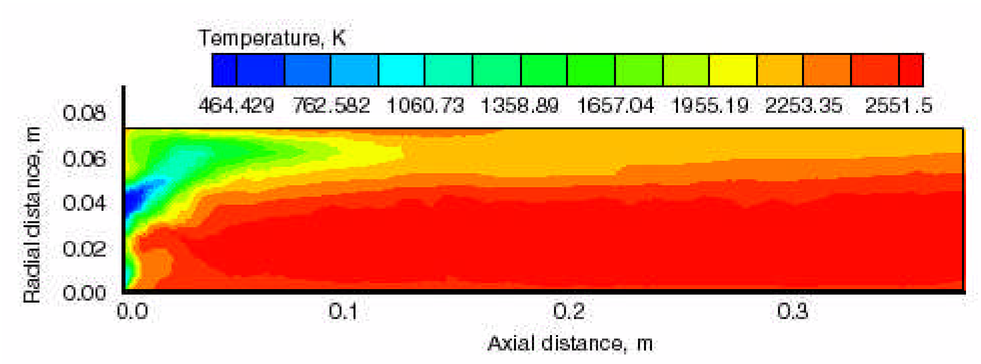
LSPRAY: Lagrangian Spray Solver for Applications With Parallel Computing and Unstructured Gas-Phase Flow Solvers



Temperature distribution in a confined, swirl-stabilized spray flame.

Sprays occur in a wide variety of industrial and power applications and in the processing of materials. A liquid spray is a phase flow with a gas as the continuous phase and a liquid as the dispersed phase (in the form of droplets or ligaments). Interactions between the two phases, which are coupled through exchanges of mass, momentum, and energy, can occur in different ways at different times and locations involving various thermal, mass, and fluid dynamic factors. An understanding of the flow, combustion, and thermal properties of a rapidly vaporizing spray requires careful modeling of the rate-controlling processes associated with the spray's turbulent transport, mixing, chemical kinetics, evaporation, and spreading rates, as well as other phenomena.

In an attempt to advance the state-of-the-art in multidimensional numerical methods, we at the NASA Lewis Research Center extended our previous work on sprays to unstructured grids and parallel computing (refs. 1 to 3). LSPRAY, which was developed by M.S. Raju of Nyma, Inc., is designed to be massively parallel and could easily be coupled with any existing gas-phase flow and/or Monte Carlo probability density function (PDF) solver. The LSPRAY solver accommodates the use of an unstructured mesh with mixed triangular, quadrilateral, and/or tetrahedral elements in the gas-phase solvers. It is used specifically for fuel sprays within gas turbine combustors, but it has many other uses. The spray model used in LSPRAY provided favorable results when applied to stratified-charge rotary combustion (Wankel) engines and several other confined and unconfined spray flames (refs. 2 to 3). The source code will be available with the National Combustion Code (NCC) as a complete package.

References

1. Raju M.S.; and Sirignano, W.A.: Multi-Component Spray Computations in a

Modified Centerbody Combustor. J. Propul. P. (AIAA Paper 88-0638), vol. 6, Mar.-Apr. 1990.

2. Raju, M.S.: Heat Transfer and Performance Characteristics of a Dual-Ignition Wankel Engine. J. Engines, 1992 SAE Transactions, Sec. 3, pp. 466-509.

3. Raju, M.S.: Application of Scalar Monte Carlo Probability Density Function Method for Turbulent Spray Flames. Numer. Heat Transfer, Part A, vol. 30, no. 8, 1996, pp. 753-777.

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