Three-Dimensional Calculations of Supersonic Reacting Flows Using an LU Scheme

Sheng-Tao Yu, Y.-L. Peter Tsai, and Jian-Shun Shuen

Sverdrup Technology, Inc.,
NASA Lewis Research Center, Cleveland, Ohio

ABSTRACT

A new three-dimensional numerical program that incorporates comprehensive real gas property models has been developed to simulate supersonic reacting flows. The code employs an implicit, finite volume, Lower-Upper (LU), time-marching method to solve the complete Navier-Stokes and species equations in a fully-coupled and very efficient manner. A chemistry model with nine species and eighteen reaction steps is adopted in the program to represent the chemical reactions of H_2 and air. To demonstrate the capability of the program, flow fields of underexpanded hydrogen jets transversely injected into the supersonic airstream inside the combustors of scramjets are calculated. Results clearly depict the flow characteristics, including the shock structure, the separated flow regions around the injector, and the distribution of the combustion products.