NASA TECH BRIEF

Langley Research Center

Program to Determine Radiating, Nonadiabatic, Inviscid Flow Over a Blunt Body by the Method of Integral Relations

The problem:

To perform the many calculations necessary for solving the radiating nonadiabatic flow of air in chemical equilibrium. The results would describe a blunt-body flow field in the subsonic region.

The solution:

A computer program was developed in support of the study of the radiating, nonadiabatic, inviscid flow properties (pressure, temperature, density, velocity, and enthalpy) around a blunt body in equilibrium air by use of a modified method of integral relations.

How it's done:

The program calculates the radiating nonadiabatic flow of air in chemical equilibrium. Results obtained agree with results from inverse and time-dependent techniques. The agreement indicates that this method of solution provides an accurate description of the blunt-body flow field in the subsonic region.

The equations which govern inviscid, radiating, nonadiabatic steady flow of equilibrium air over a blunt body travelling at hypersonic speeds are a system of nonlinear partial differential equations derived from the laws of conservation of mass, momentum, and energy. The modified method of integral relations is used to transform the governing equations into a set of ordinary differential equations that are numerically integrated to yield the details of the thermodynamic and flow properties within the shock layer. Provisions have been made in the governing equations for coupled radiating flow-field analysis.

The governing differential equations are solved by a fourth-order Runge-Kutta integration technique to give shock-layer thickness, shock angle, and the fluxes of mass, momentum, and energy at the body surface.

The documentation contains a description of the computer program along with the methods used in the digital approximations, flow charts, instructions for the user, and a test case with input and output listings.

Notes:

1. This program is written in FORTRAN IV to be utilized by the CDC-6600 computer.
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