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NASA TECH BRIEF

Lewis Research Center

Computer Program for Natural Gas Flow Through Nozzles

A set of FORTRAN IV subroutines has been developed that calculates the isentropic mass flow rate of natural gas through nozzles and also thermodynamic functions such as compressibility factor, entropy, enthalpy and specific heat. The pressure range for these routines is 0.1 to 100 x 10^5 newtons per square meter, and the temperature range is from 200 to 400 Kelvin. Three sets of independent variables are permitted. In addition to the plenum pressure and plenum temperature, the other independent variable may be either the nozzle-exit pressure, the nozzle-exit Mach number, or the nozzle-exit temperature.

When nozzles are used for measuring the mass flow rate of natural gas, the conventional isentropic flow equations do not apply. These equations only apply to a perfect gas. A perfect gas is defined as one whose compressibility factor is invariant, with a value of 1, and whose specific heat is invariant. Natural gas cannot be considered perfect even at atmospheric pressure because of the specific-heat variation with temperature. At higher pressure, the compressibility factor variation also becomes important.

Since natural gas is being considered as a fuel for aircraft, as well as for other propulsion and power systems, an accurate method for making mass flow rate calculations is necessary for gas metering. The results indicate that the inaccuracy of these calculations is less than 1 percent over most of the permissible pressure and temperature range. The design of the routines is such that they may be easily modified for other gases.

Notes:

1. This program is written in FORTRAN IV for use on the IBM 7094 computer.
2. Inquiries concerning this program should be directed to:

   COSMIC
   112 Barrow Hall
   University of Georgia
   Athens, Georgia 30601
   Reference: LEW-11534

Patent status:

No patent action is contemplated by NASA.

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