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NASA TECH BRIEF

Lewis Research Center

Design of Two-Dimensional Sharp-Edged-Throat Supersonic Nozzle with Boundary-Layer Correction

The problem:

Available computer programs that were written for the design of sharp-edged-throat supersonic nozzles did not account for effective nozzle geometry changes due to boundary-layer displacement thickness.

The solution:

A computer program has been developed for the design of sharp-edged-throat supersonic nozzles where losses are accounted for by correcting the ideal nozzle geometry for boundary-layer displacement thickness.

How it's done:

The ideal nozzle is designed by the method of characteristics. Boundary-layer parameters are calculated by Cohen and Reshotko's method for laminar flow and by Sasman and Cresci's method for turbulent flow.

The nozzle is designed to produce uniform parallel flow at the nozzle exit in the smallest possible distance. Boundary-layer parameters are calculated for the ideal nozzle, and the final nozzle geometry is obtained by adding the displacement thickness to the ideal nozzle coordinates. The boundary-layer parameters are also used to calculate the after-mixing conditions downstream of the nozzle, assuming the flow mixes to a uniform state.

The computer program input consists essentially of the nozzle-exit Mach number, specific-heat ratio, nozzle angle, throat half-height, nozzle subsonic section coordinates and corresponding pressure ratios, total temperature and pressure, gas constant, and initial momentum or displacement thickness. The program gas properties are set for air; for other gases, changes are required to the program. The computer program output consists of the corrected nozzle coordinates, the principal boundary-layer parameters, and the after-mixing conditions.

Notes:

1. This program is written in FORTRAN IV for use on the IBM-7094/7044 Direct Couple System.
2. Inquiries concerning this program should be directed to:

   COSMIC
   112 Barrow Hall
   University of Georgia
   Athens, Georgia 30601
   Reference: LEW-11636

Source: Louis J. Goldman and
Michael R. Vanco
Lewis Research Center
(LEW-11636)

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