NASA TECH BRIEF

Discharge Coefficients for Thick-Plate Orifices

Experimental discharge coefficients have been obtained for thick-plate orifices with approaching airflow perpendicular or inclined to the orifice axis. Other variables investigated were flow temperature and pressure; orifice pressure differential; approach Mach number; orifice diameter, thickness, and inlet edge radius; orifice surface finish; interference of multiple orifices; and approach passage geometry and length.

This investigation was undertaken to enable more accurate prediction of coolant flows within internally cooled turbine blades and vanes. The data should have broad applicability for predicting flows in designs where flow passages become comparatively complex.

The discharge coefficients (ratio of actual flow to ideal flow) were correlated with a velocity-head parameter which consisted of the ratio of the velocity head of the flow though the orifice to the velocity head of the flow approaching the orifice axis for various approach Mach numbers. The discharge coefficients were found to be dependent on the angle between the approaching flow and the axis of the orifice; on the ratio of the orifice thickness to orifice diameter; and on the inlet edge radius of the orifice. Also, the discharge coefficients were found to depend strongly on the approach Mach number and static pressure difference across the orifice. The effects of flow temperature and pressure levels, orifice surface finish, multiple orifice interference, and approach passage geometry and length on discharge coefficients were found to be negligible for the cases considered.

The geometry of the main flow duct in all cases but one was a 0.25 in.-diameter tube. (The exception was a rectangular cross-section main duct used to investigate the effect of curvature of the upstream face of the orifice.) The orifice thickness varied from 0.06 to 0.25 in. and the orifice diameters varied from 0.059 to 0.128 in. The inlet edge of the orifice was varied from a sharp corner to 0.030 in. radius. The main duct inlet airflow Mach number was varied from 0 to 0.65, static pressure was varied from 20.0 to 80.0 psia, and the temperature was varied from ambient to approximately 1000°F. Orifices with axes at 45° and 90° angles to the main duct flow were investigated.

Notes:

1. The following documentation may be obtained from:

   Clearinghouse for Federal Scientific and Technical Information
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.65)

   Reference:
   NASA-TN-D-5467 (N69-38012), Discharge Coefficients for Thick Plate Orifices with Approach Flow Perpendicular and Inclined to the Orifice Axis

2. Questions concerning this innovation may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B70-10062

Patent status:

No patent action is contemplated by NASA.

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