November 1969

Brief 69-10712

NASA TECH BRIEF

Natural Gas Flow Through Critical Nozzles

The mass flow rates of methane and nineteen natural gas mixtures through critical flow nozzles have been calculated. The calculations assume the flow to be one-dimensional and isentropic. The pressure range investigated was 0 to 1000 pounds per square inch and the temperature range was from 450 to 700 degrees Rankine.

Critical flow factors that permit calculations of the isentropic mass flow rates of the gases through critical flow nozzles were determined for methane and two typical natural gas mixtures. From a study of 19 natural gases, an empirical method for calculating both the mass flow rate and upstream volume flow rate of natural gas through critical flow nozzles was determined. This method requires knowledge of the composition of the natural gas, and of the upstream pressure and temperature.

Without the use of the critical flow factors, when critical-flow nozzles are used for metering the mass flow rate of natural gas, the conventional isentropic flow relations do not apply. These equations only apply to a perfect gas, i.e., a gas having a compressibility factor of unity and a constant specific heat. Gases such as air and nitrogen closely approximate this ideal condition at room temperatures and pressures up to a few atmospheres. Natural gas, on the other hand, cannot be considered perfect even at pressures less than atmospheric because natural gas has an appreciable specific-heat variation with temperature. At higher pressures, the compressibility-factor variation also becomes important.

Critical flow nozzles are used to calibrate volumetric flowmeters for a wide range of applications in low pressure systems and as direct means of flow measurements in high pressure systems.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
Lewis Research Center
21000 Brookpark Road
Cleveland, Ohio 44135
Reference B69-10712

Patent status:

No patent action is contemplated by NASA.

Source: Robert C. Johnson
Lewis Research Center
(LEW-11031)

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