AN AMERICAN NATIONAL STANDARD

Measurement of Gas Flow by Means of Critical Flow Venturi Nozzles

ASME/ANSI MFC-7M–1987

REAFFIRMED 2014

FOR CURRENT COMMITTEE PERSONNEL
PLEASE E-MAIL CS@asme.org

SPONSORED AND PUBLISHED BY

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

United Engineering Center 345 East 47th Street New York, N. Y. 10017

Date of Issuance: May 31, 1987

This Standard will be revised when the Society approves the issuance of a new edition. There will be no addenda or written interpretations of the requirements of this Standard issued to this edition.

FOREWORD

(This Foreword is not part of ASME/ANSI MFC-7M–1987.)

This Standard was prepared by Subcommittee 2, Working Group 5, of the American Society of Mechanical Engineers Committee on Measurement of Fluid Flow in Closed Conduits. The Committee is indebted to the many engineers who contributed to this work.

This Standard is intended to assist the public with the use of critical flow nozzles. Critical flow nozzles are especially suited to flow calibration work and precise flow control applications. They provide a stable flow of a compressible fluid through a closed conduit, the rate of which may be determined with a high degree of accuracy. The Committee has attempted to blend the best available technical information with common practice to develop this Standard. It is as complete a specification as the Committee determined appropriate. Some latitude and variation on the application of the Standard to critical flow venturi nozzles is allowed. However, neither these liberties nor this Standard is intended to replace proper judgment in the application of critical flow venturi nozzles.

This Standard was approved by the American National Standards Institute (ANSI) on February 27, 1987.

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Measurement of Fluid Flow in Closed Conduits

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R. G. Teyssandier, Daniel Industries, Inc., Houston, Texas

Subcommittee 2, Working Group 5 — Critical Flow Measurement

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D. Halmi, Primary Flow Signal Inc., Pawtucket, Rhode Island
R. M. Reimer, General Electric Co., Cincinnati, Ohio
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MEASUREMENT OF GAS FLOW BY MEANS OF CRITICAL FLOW VENTURI NOZZLES

1 SCOPE AND FIELD OF APPLICATION

This Standard applies only to the steady flow of single-phase gases and deals with devices for which direct calibration experiments have been made, sufficient in number and quantity to enable inherent systems of applications to be based on their results and coefficients to be given with certain predictable limits of uncertainty. The critical flow venturi nozzles dealt with can only be used within limits that are specified, for example nozzle throat to inlet diameter ratio and Reynolds number.

This Standard specifies the geometry and method of use (installation and operating conditions) of critical flow venturi nozzles inserted in a system to determine the mass flow rate of the gas flowing through the system. It also gives necessary information for calculating the flow rate and its associated uncertainty.

This Standard applies only to venturi nozzles in which the flow is critical. Critical flow exists when the mass flow rate through the venturi nozzle is the maximum possible for the existing upstream conditions. At critical flow or choked conditions, the average gas velocity at the nozzle throat closely approximates the local sonic velocity.

Information is given in this Standard for cases in which:

(*a*) the pipeline upstream of the venturi nozzle is of circular cross section; or

(*b*) it can be assumed that there is a large space upstream of the venturi nozzle.

The venturi nozzles specified in this Standard are called primary devices. Other instruments for the measurement are known as *secondary devices.* This Standard covers primary devices; secondary devices will be mentioned only occasionally.

2 SYMBOLS AND DEFINITIONS

2.1 Symbols

The symbols used in this Standard are listed in Table 1.

2.2 Definitions

2.2.1 Pressure Measurement

wall pressure tap — hole drilled in the wall of a conduit, the inside edge of which is flush with the inside surface of the conduit

static pressure of a gas — the actual pressure of the flowing gas, which can be measured by connecting a pressure gauge to a wall pressure tap. Only the value of the absolute static pressure is used in this Standard.

stagnation pressure of a gas — pressure that would exist in the gas if the flowing gas stream were brought to rest by an isentropic process. Only the value of the absolute stagnation pressure is used in this Standard.

2.2.2 Temperature Measurement

static temperature of a gas — actual temperature of the flowing gas. Only the value of the absolute static temperature is used in this Standard.

stagnation temperature of a gas — temperature that would exist in the gas if the flowing gas stream were brought to rest by an adiabatic process. Only the value of the absolute stagnation temperature is used in this Standard.

2.2.3 Critical Flow Nozzles

venturi nozzle — a convergent divergent restriction inserted in a system intended for the measurement of flow rate

throat — the minimum diameter section of the venturi nozzle

critical venturi nozzle — a venturi nozzle for which the nozzle geometrical configuration and conditions of use are such that the flow rate is critical

2.2.4 Flow

mass flow rate — the mass of gas per unit time passing through the venturi nozzle. In this Standard, flow rate is always the steady-state or equilibrium mass flow rate.

throat Reynolds number — In this Standard the nozzle throat Reynolds number is calculated from the gas velocity, density at the nozzle throat, and gas viscosity