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Measurement of Liquid Flow in Closed Conduits Using Doppler Ultrasonic Flowmeters

AN AMERICAN NATIONAL STANDARD



The American Society of Mechanical Engineers

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Two Park Avenue • New York, NY • 10016 USA

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FOREWORD

The need for a document describing measurement of liquid flows by means of ultrasonic flowmeters has been recognized for many years. The ASME Committee on Measurement of Fluid Flow in Closed Conduits (MFC) and its Subcommittee 5: Ultrasonic Flowmeters (SC 5) have agreed to publish three standards to assist the users in understanding the three technologies: transit time, cross-correlation, and scattering (Doppler).

Published in June 2011, ASME MFC-5.1, Measurement of Liquid Flow in Closed Conduits Using Transit-Time Ultrasonic Flowmeters, applies to ultrasonic flowmeters that base their operation on the measurement of transit time of acoustic signals. MFC-5.1 concerns the volume flow-rate measurement of a single-phase liquid with steady flow or flow varying only slowly with time in a completely filled closed conduit.

This Standard, Measurement of Liquid Flow in Closed Conduits Using Doppler Ultrasonic Flowmeters, applies to ultrasonic flowmeters that base their operation on the reflection of waves. It concerns the volume flow-rate measurement of a liquid dominant fluid with steady flow or flow varying only slowly with time in a completely filled closed conduit.

Suggestions for improvement of this Standard are welcome. They should be addressed to the Secretary, ASME MFC Standards Committee, Two Park Avenue, New York, NY 10016-5990.

This Standard was approved as an American National Standard on April 12, 2013.

ASME MFC COMMITTEE
Measurement of Fluid Flow in Closed Conduits

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Secretary, MFC Standards Committee
The American Society of Mechanical Engineers
Two Park Avenue
New York, NY 10016-5990
http://go.asme.org/Inquiry

Proposing Revisions. Revisions are made periodically to the Standard to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

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Interpretations. Upon request, the MFC Committee will render an interpretation of any requirement of the Standard. Interpretations can only be rendered in response to a written request sent to the Secretary of the MFC Standards Committee.

The request for interpretation should be clear and unambiguous. It is further recommended that the inquirer submit his/her request in the following format:

Subject:	Cite the applicable paragraph number(s) and the topic of the inquiry.
Edition:	Cite the applicable edition of the Standard for which the interpretation is being requested.
Question:	Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. The inquirer may also include any plans or drawings that are necessary to explain the question; however, they should not contain proprietary names or information.

Requests that are not in this format may be rewritten in the appropriate format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

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MEASUREMENT OF LIQUID FLOW IN CLOSED CONDUITS USING DOPPLER ULTRASONIC FLOWMETERS

1 GENERAL

1.1 Scope

This Standard applies only to ultrasonic flowmeters that base their operation on the reflection of acoustic waves, frequently referred to as a Doppler flowmeter. The flow measurement utilizes either frequency or time domain techniques. This Standard concerns the volume flow-rate measurement of a liquid dominant fluid with steady flow or flow varying only slowly with time in a completely filled closed conduit.

1.2 Purpose

This Standard provides a

(a) description of the operating principles employed by the ultrasonic flowmeters covered in this Standard

(b) guideline to expected performance characteristics of ultrasonic flowmeters covered in this Standard

(c) description of calibration and diagnostic procedures

(d) description of potential uncertainty sources and their reduction

(e) common set of terminology, symbols, definitions, and specifications

1.3 Terminology and Symbols

Paragraph 1.3.1 lists definitions from ASME MFC-1M used in this Standard. Paragraph 1.3.2 lists definitions specific to this Standard. Table 1.3-1 lists symbols used in this Standard. Table 1.3-2 lists subscripts used in this Standard.

1.3.1 Definitions From ASME MFC-1M

accuracy: the degree of freedom from error; the degree of conformity of the indicated value to the true value of the measured quantity.

NOTES:
(1) The concept measurement accuracy is not a quantity and is not given a numerical quantity value. A measurement is said to be more accurate when it provides a smaller measurement error.
(2) The term measurement accuracy is sometimes understood as closeness of agreement between measured quantity values that are being attributed to the measured. Measurement accuracy should not be mistaken for measurement precision.

axial flow velocity: the component of liquid flow velocity at a point in the measurement section that is parallel to the measurement section's axis and in the direction of the flow being measured.

calibration: the experimental determination of the relationship between the quantity being measured and the device that measures it, usually by comparison with a traceable reference standard. Also, the act of adjusting the output of a device to bring it to a desired value, within a specified tolerance, for a particular value of the input.

NOTE: This document is written with calibration defined as the determination of difference from a reference and the adjustment to align within a specified tolerance. This is common U.S. usage.

It is understood that in other parts of the world, some countries and groups define calibration as only the determination of difference from a reference. A second term used is calibration adjustment, which is to align within a specified tolerance.

cross-flow velocity: component of liquid flow velocity at a point in the measurement section that is perpendicular to the measurement section's axis.

nonrefractive system: an ultrasonic flowmeter in which the acoustic path crosses the solid/process liquid interfaces at a right angle.

refractive system: an ultrasonic flowmeter in which the acoustic path crosses the solid/process liquid interfaces at other than a right angle.

uncertainty: the range within which the true value of the measured quantity can be expected to lie with a specified probability and confidence level.

velocity profile correction factor, S: dimensionless factor based on measured knowledge of the velocity profile used to adjust the meter output.

1.3.2 Definitions Specific to This Standard

diagnostics: comparison of internal direct and derived measurement values to allow the user to ascertain the condition of the operation of the ultrasonic flowmeter.

measurement section: section of conduit in which the volumetric flow rate is sensed by the acoustic signals. The measurement section is bounded at both ends by planes perpendicular to the axis of the section and located at the extreme upstream and downstream transducer positions. The measurement section is usually circular in cross section; however, it may be square, rectangular, elliptical, or some other shape.