ASME MFC-13M–2006

Measurement of Fluid Flow in Closed Conduits: Tracer Methods

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AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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Three Park Avenue • New York, NY 10016

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

ASME issues written replies to inquiries concerning interpretations of technical aspects of this Standard. Interpretations are published on the ASME Web site under the Committee Pages at http://cstools.asme.org as they are issued.

The American Society of Mechanical Engineers
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FOREWORD

This Standard defines the use of tracer (dilution) methods in the measurement of single-phase fluid (gas or liquid) flows in closed conduits. This method of measurement is applicable only to single-phase homogeneous fluid mixtures.

This Standard was developed to fill the need for a generalized reference based on fundamental principles to measure fluid flow using tracer methods. ISO standards issued in 1977 addressed tracer methods for gas flows; these were withdrawn in 2001, leaving a void on this subject. An Internet search on this subject will find a large number of documents, standards, references, consultants, and manufacturers. Most of the papers, standards, and products are for very specific applications and provide detailed guidance only for those needs. This Standard defines the terms and principles needed for intelligent consideration of tracer methods for any application.

ASME MFC-13M–2006 was approved by the American National Standards Institute on September 29, 2006.

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Measurement of Fluid Flow in Closed Conduits

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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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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 will be rewritten in this format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

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MEASUREMENT OF FLUID FLOW IN CLOSED CONDUITS: TRACER METHODS

1 SCOPE AND FIELD OF APPLICATION

For steady-state flow of fluid in a closed conduit, the only conserved parameter is the mass rate of flow, q_m. If the mass density is known, the volume rate of flow, q_v, can be deduced.

The accuracy of flow rate measurement with the tracer methods is a function of how well the injected tracer material mixes with the flowing fluid. It is also a function of the accuracy and precision of the sensing devices, and the (tracer methods) techniques used.

The following two tracer methods are used:

(a) The dilution method is based on a constant rate of tracer injection, and the concentration of tracer found in the downstream conduit is a measure of the relative flow rates.

(b) The transit time method determines the flow rate by measuring the time it takes the tracer material to travel between two detector points or between the injection point and a detector point in the conduit.

The advantages and disadvantages of these two methods are reviewed in section 4.

A wide variety of tracer materials may be used — radioactive or nonradioactive, mineral or organic materials, etc. The choice of tracer depends on the purpose of the measurement and environmental concerns (section 5). The uncertainty of the measurements depends completely on the accuracy of the methods used (section 7). Some typical tracer fluids are listed in Nonmandatory Appendix A.

2 SYMBOLS

See Table 1.

3 UNITS

Calculations for mass and volumetric flow rates in this document are expressed in terms of ratios of lengths and in other nondimensional parameters, as shown in Table 1. Hence, no dimensional units are defined for those terms.

4 METHOD OF USE

4.1 Dilution

In the dilution method, a measured quantity of tracer fluid of known composition is injected into the flowing stream at the injection point. At the detection location, the mixture is analyzed for composition. A simple calculation provides the flow of the main stream. If the mass of the tracer stream is known, then the result is in mass units.

4.1.1 Advantages of the Dilution Method

(a) It is not necessary to know the geometrical characteristics of the conduit.

(b) It is not necessary that the flowing conditions of the fluid (p, T) be the same between the two measuring cross sections.

(c) It is not necessary to know the time of injection.

(d) It is inherently a mass flow measurement.

4.2 Transit Time Method

In the transit time method, a quantity of tracer fluid is injected into the flowing stream. Two detection points are commonly used, with both far enough downstream to allow adequate mixing and far enough apart to achieve adequate precision in the time measurement. The flow of the mixed fluids should be continuous from the time of injection until the mixed fluid is detected at the second detection point. The time for the detected change in fluid properties is compared at the two points to provide the average velocity of the fluid mixture. The shape of the detected rise time, the length of the pulse, and the rate of decay are all used to estimate the degree of mixing and possible error. The cross section of the flow conduit at the detection points is used with the flow time to determine the volumetric flow rate at the second detection point. The time required for tracer fluid injection is determined by the response time of the detector and the system geometry.

4.2.1 Advantages of the Transit Time Method

(a) It is necessary only to determine the modified fluid characteristic time distribution at two measuring cross sections separated by a known volume of pipe or conduit.

(b) It is not necessary to know the volume, mass, or flow rates of the injected tracer.

(c) Transit time is inherently a volumetric method.

(d) In some applications only one detection point is used, the injection point taking the place of the first detection point.