

Methods for measurement of

Fluid flow in closed conduits, using tracers —

Part 2: Measurement of gas flow —

Section 2.1 General

[ISO title: Measurement of gas flow in conduits — Tracer
methods — Part I: General]

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Cooperating organizations

The Industrial-process Measurement and Control Standards Committee, under whose direction this British Standard was prepared, consists of representatives from the following Government department and scientific and industrial organizations:

- British Gas Corporation
- British Industrial Measuring and Control Apparatus Manufacturers' Association
- British Steel Corporation
- CBMPE (Council of British Manufacturers of Petroleum Equipment)
- Control and Automation Manufacturers Association (BEAMA)
- Department of Industry (Computers Systems and Electronics)
- Electrical, Electronic, Telecommunications and Plumbing Union
- Electricity Supply Industry in England and Wales*
- Electronic Engineering Association
- Engineering Equipment Users' Association*
- Institute of Measurement and Control
- Institution of Electrical Engineers
- Institution of Gas Engineers
- Oil Companies Materials Association
- Post Office Engineering Union
- Scientific Instrument Manufacturers' Association
- Sira Institute

The organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard:

- Department of Energy (Gas Standards)
- United Kingdom Atomic Energy Authority

This British Standard, having been prepared under the direction of the Industrial-process Measurement and Control Standards Committee, was published under the authority of the Executive Board and comes into effect on 31 March 1980

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National foreword

This British Standard has been prepared under the direction of the Industrial-process Measurement and Control Standards Committee, and is identical with ISO 4053-I:1977 “*Measurement of gas flow in conduits — Tracer methods — Part I: General*” published by the International Organization for Standardization (ISO).

Terminology and conventions. The text of the International Standard has been approved as suitable for publication, without deviation, as a British Standard. Some terminology and certain conventions are not identical with those used in British Standards; attention is especially drawn to the following.

The comma has been used throughout as a decimal marker. In British Standards it is current practice to use a full point on the baseline as the decimal marker. Wherever the words “International Standard” appear, referring to this standard, they should be read as “British Standard”.

Cross-reference

International Standard	Corresponding British Standard
ISO 4006:1977	BS 5875:1980 <i>Glossary of terms and symbols for measurement of fluid flow in closed conduits</i> (Identical)

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 12, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

0 Introduction

This International Standard is the first of a series of standards covering tracer methods of gas flow measurement in conduits.

The complete series of standards will be as follows:

- *Part I: General;*
- *Part II: Constant rate injection method using non-radioactive tracers;*
- *Part III: Constant rate injection method using radioactive tracers;*
- *Part IV: Transit time method using radioactive tracers.*

1 Scope and field of application

This International Standard deals with the measurement of gas flow in conduits by using tracer methods.

In a steady flow of compressible fluid, the only conservative parameter is the mass rate of flow q_m .

Therefore the whole of this International Standard will refer to mass rate of flow q_m .

However, for those fluids for which the composition (and therefore, the mass density) may not be known accurately, the volume rate of flow q_v could be measured, it being understood that this volume rate of flow is only valid for the conditions of temperature and pressure at which it has been measured.

This International Standard applies to flow measurement in conduits into which a tracer can be injected in such a way that effective mixing in single phase with the gas flowing in the pipe can be achieved.

The fluid in the conduit can be a mixture of several gases provided the thermodynamic state and conditions of flow of this mixture are well defined.

Two fundamental test procedures are used:

- The first, known as the constant rate injection method, is based on the dilution principle: a tracer solution is injected into the conduit and the dilution (ratio) of this tracer in the gas flowing in the conduit is determined, this dilution being proportional to the rate of flow.
- The second is a method of measurement of the transit time (formerly called Allen velocity method): the tracer is injected into the conduit and the time taken by the tracer to travel a specified length between two cross-sections in each of which it is detected, is measured.

The advantages and disadvantages of these two methods are considered in clause 4. The distance between injection and measuring sections shall be sufficient to achieve mixing of the tracer with the gas flowing in the conduit according to the methods; the adequate mixing distance is considered in clause 6.

A large number of different tracers may be used, such as radioactive or non-radioactive, mineral or organic materials. The choice of tracer depends on the circumstances of the measurement (see clause 5). The uncertainty of the measurements may be less than 1 % under good conditions (see clause 7).

2 Vocabulary and symbols

The vocabulary and symbols used in this International Standard are defined in ISO 4006, *Measurement of fluid flow-rate in closed conduits — Vocabulary and symbols*.

3 Units

The basic units in this International Standard are SI units.

4 Choice of method

4.1 Comparison between dilution method and method based on transit time measurement

4.1.1 Advantages of the dilution method

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

It is not necessary that the conditions of the gas flow rate (p , T) be constant along the measuring length.

4.1.2 Advantages of method based on transit time measurement

It is necessary only to determine the concentration-time distribution at two measuring cross-sections separated by a known volume of pipe.

It is not necessary to know volumes, masses or rates of flow of the injected tracer.

4.1.3 Special recommendation for the method based on transit time measurement

For this method, it is preferable to have a conduit length of constant cross-section between the two measuring points so that the flow parameters be approximately constant in the measuring length.

5 Choice of tracer

5.1 General

A large number of different tracers may be used, such as mineral or organic, radioactive or non-radioactive, but it is necessary for any tracer to comply with the following requirements:

- it should mix easily with the gas in the conduit;
- it should cause only negligible or known modifications of the rate of flow;
- it should be measurable with sufficient accuracy at a concentration lower than the highest permissible concentration while taking account of toxicity, corrosion, etc.;
- it should be chemically stable in the conditions of use;
- it should only be present in the gas originally flowing in the conduit at a negligible or constant concentration;
- it should be cheap.

In addition, for dilution method, it is important that the tracer:

- should not react with the gas flowing in the conduit or with any other substance with which it may come into contact (in particular, the conduit walls) in such a way as to affect the measurement.

Furthermore, for transit time methods, it is recommended that:

- the tracer concentration in the measuring cross-section can be determined, if necessary, at any moment;
- to obtain the greatest precision, the detector signal be proportional to the tracer concentration (of which it is not necessary to know the exact value) and that its response time be negligible.

The following substances are given as examples:

5.1.1 Non-radioactive tracers

- Helium He
- Sulphur hexafluoride SF₆
- Methane CH₄
- Nitrous oxide N₂O

5.1.2 Radioactive tracers

Tracer	Formula (if any)	Half-life
Argon 41		110 min
Arsenic 76	⁷⁶ AsH ₃	26,5 h
Bromine 82	C ₂ H ₅ ⁸² Br or CH ₃ ⁸² Br	36 h
Krypton 85		10,6 years
Sulphur 35	³⁵ SF ₆	87 days
Xenon 133		5,27 days

5.2 Comparison between the different tracers

5.2.1 Advantages of radioactive tracers

With tracers emitting γ radiation with sufficient energy, it is possible to carry out the measurement by means of probes located outside the conduit.

With short half-life tracers, the basic substance of which is chemically inoffensive, any radioactive contamination danger disappears quickly and there is no permanent pollution.

5.2.2 Advantages of non-radioactive tracers

It is not necessary for the operators to be specially trained and classified.