

Methods for measurement of

Fluid flow in closed conduits, using tracers —

Part 2: Measurement of gas flow —

Section 2.4 Transit time method using radioactive tracers

[ISO title: Measurement of gas flow in conduits — Tracer
methods — Part IV: Transit time method using radioactive
tracers]

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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
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- 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-IV:1978 “*Measurement of gas flow in conduits — Tracer methods — Part IV: Transit time method using radioactive tracers*” 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 4053-I:1977	BS 5857 <i>Methods for measurement of fluid flow in closed conduits, using tracers</i> Part 2 <i>Measurement of gas flow</i> Section 2.1:1980 <i>General</i> (Identical)

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 10, 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 fourth of a series of standards covering tracer methods of gas flow measurement in conduits.

The complete series of standards is 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 specifies the transit time method using radioactive tracers for the measurement of gas flow in conduits.

2 Reference

ISO 4053-I, *Measurement of gas flow in conduits — Tracer methods — Part I: General.*

3 Principle

Flow-rate measurement by the transit time method (formerly called the “Allen velocity method”) is based on measuring the transit time of “labelled” particles between two cross-sections of the conduit a known distance apart. Labelling of the fluid particles is achieved by injecting a tracer into the flow upstream of the two measurement cross-sections (i.e. detector positions) and the transit time is determined from the difference of the mean arrival times of the tracer at each of the detector positions.

Under certain conditions (see clause 4), the volume flow-rate q_v (see nomenclature in ISO 4053-I) in the measurement section is given by:

$$q_v = \frac{V}{\bar{t}}$$

where

V is the volume of the conduit between the detector positions;

$\bar{t}$ is the transit time of the labelled fluid particles.

In general, the theoretical condition for the validity of the formula is that the measuring section be “closed to diffusion” i.e. that the ratio of the local velocity to the longitudinal dispersion coefficient be equal at both ends of the measuring section.

In practice, this condition is fulfilled when the conduit has a constant cross-section.

The value of $\bar{t}$ is obtained by measuring the difference in abscissae of characteristic points (in theory, the centre of gravity, but in practice other characteristic points may be found, see 6.7) of recorded distributions, corresponding to concentration/time distributions or their integrals, obtained at each detector position. The signal from the detectors shall be proportional to the tracer concentration. The exact value of the proportionality constant and hence the concentration need not, however, be known.

The mass flow-rate is calculated by determining simultaneously the volume flow-rate and the gas density.

4 Required conditions

4.1 Tracer

The tracer shall meet the general requirements defined in clause 5 of ISO 4053-I. A list of tracers generally used, with their advantages and disadvantages, is also given in the same clause.

4.2 Mixing of tracer

The tracer shall be sufficiently mixed with the flow at the first detector position for the recorded concentration/time distributions at both detectors to be adequately representative of the mean flow (see 5.1). The selection of the positions for the injection and the detectors is controlled by the fluid velocity, tracer dispersion, and the conduit layout. The conditions for this selection are dealt with in clause 5. At low Reynolds number, $Re \leq 5\,000$, the mixing of tracer is not sufficient and no reliable measurement can be made.

4.3 Test procedure

The procedure for the preparation and the injection of the tracer gas (which in practice should be injected as rapidly as possible to minimize the longitudinal dispersion of the tracer) is covered in 6.3 and 6.4. The internal volume of the measuring section shall be determined with sufficient accuracy (see 5.7). Other requirements relating to the tests and the calculation of the transit time from the data are given in clause 6.

5 Choice of measuring length

In the transit time method, the measuring length consists of two parts:

- the length of conduit between the injection point and the position of the first detector;
- the length of conduit between detectors.