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Measurement of liquid flow in open channels — Tracer dilution methods for the measurement of steady flow —

Part 2: Radioactive tracers

*Mesure de débit des liquides dans les canaux découverts — Méthodes
de dilution en régime permanent utilisant des traceurs —*

Partie 2: Traceurs radioactifs



Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 9555-2 was prepared by Technical Committee ISO/TC 113, *Measurement of liquid flow in open channels*, Subcommittee SC 4, *Dilution methods*.

ISO 9555 consists of the following parts, under the general title *Measurement of liquid flow in open channels — Tracer dilution methods for the measurement of steady flow*:

- Part 1: General
- Part 2: Radioactive tracers
- Part 3: Chemical tracers
- Part 4: Fluorescent tracers

Annex A of this part of ISO 9555 is for information only.

Introduction

The former standard series ISO 555 was subdivided into parts on the basis of the method of field measurement, i.e. constant-rate injection method and integration (sudden injection) method. Since the choice of the type of tracer to be used in a field measurement will often depend on the expertise and the laboratory facilities available, this new series of standards ISO 9555 is divided into parts based on the type of tracer used. This revision has enabled the unnecessary repetition of text of the various parts to be avoided and will, it is hoped, prove to be a more convenient form of presentation for the user.

ISO 9555 deals with the measurement of steady flow in open channels by dilution methods using tracers. The methods described may also be applied to the measurement of slowly varying flow, but they may only be used when flow conditions ensure adequate mixing of the injected solution throughout the flow.

For the measurement of very large flows, tracer methods can be onerous in terms of tracer costs and measurement times. However, the use of tracers often reduces danger to personnel during flood periods.

ISO 9555-1 presents the general principles of the methods of constant-rate injection and integration (sudden injection). ISO 9555-2, ISO 9555-3 and ISO 9555-4 deal with the specific aspects of the use of radioactive, chemical and fluorescent tracers, respectively, as well as specific analytical procedures.

This approach has been adopted for the following reasons:

- to facilitate subsequent updating, additions or revisions which concern only ISO 9555-2, ISO 9555-3 and ISO 9555-4;
- to provide a more practical document for the user, who is often obliged to choose the tracer best suited to the available analytical equipment.

In this part of ISO 9555, the following two types of tracers are used:

- a) Gamma-radiation emitters, which can be measured in the field;
- b) Beta-particle emitters, which can usually be measured in the laboratory.

Radioactive tracers have the following advantages.

- a) The measurement of their concentration is independent of dissolved substances and particles suspended in water. They are therefore particularly useful for the measurement of polluted water discharge.
- b) The concentration of gamma emitters can be determined without taking samples, by means of detectors immersed *in situ*, which allows continuous recording.

- c) Owing to their use in small volumes, radioactive tracers offer the possibility of carrying out the measurement of very large flows (several thousand cubic metres per second) as long as there is no loss of tracer.
- d) When tracer adsorption errors are likely to occur, such errors can be minimized by using a carrier for the tracer.

The disadvantages of using radioactive tracers result from the fact that

- a) it may be necessary to obtain (depending on the country) for each measurement an administrative permit issued on the basis of an appropriate technical report,
- b) the tracers may, for safety reasons have to be used by specially skilled personnel and, in view of the legislation relating to the use of radionuclides, have to be used by officially licenced personnel,
- c) in view of the short half-life of certain tracers, there may be some problems of supply, and
- d) the transport and injection of the product require certain special safety precautions to be taken and containers for transporting the tracers may be heavy.

Radioactive tracers should be used in conformity with the legislation in force at the time of measurement.

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Measurement of liquid flow in open channels — Tracer dilution methods for the measurement of steady flow —

Part 2:

Radioactive tracers

1 Scope

This part of ISO 9555 deals with the techniques and problems which are particular to the use of radioactive tracers for the measurement of open-channel flow using dilution methods.

This method of flow measurement is particularly suited for

- a) gauging of flows which are highly polluted or which carry a heavy sediment load, provided that there is no appreciable deposition,
- b) gaugings where a record of flow is required, and
- c) gauging of very large flows (several thousand cubic metres per second).

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this part of ISO 9555. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this part of ISO 9555 are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 9555-1:—¹⁾, *Measurement of liquid flow in open channels — Tracer dilution methods for the measurement of steady flow — Part 1: General*.

1) To be published.

3 Definitions

For the purposes of this part of ISO 9555, the following definitions apply.

3.1 radioactive tracer: An emitter of gamma rays or beta particles.

3.2 radiation detector: That part of the detection apparatus, sensitive to gamma radiation, that permits the measurement of activity or count rate. The detector comprises a solid scintillation detector which uses the excitation of atoms or molecules by gamma radiation, and a photomultiplier tube and preamplifier.

3.3 lead castle: Lead shield designed to attenuate radiation from a radioactive source during transport, and to protect analytical instruments from background radiation.

3.4 carrier: Non-radioactive chemical substance, soluble in water, of the same composition as the radioactive substance used as the tracer. It is added to the radioactive solution when the concentration of the radioactive isotope of the element is so small that there is a danger of loss by adsorption on the walls of the receptacle or on sediment.

3.5 half-life $T_{1/2}$: Period of time over which the activity of a radionuclide declines by half:

$$T_{1/2} = 0,693/\lambda$$

It is expressed in minutes, hours or years.

3.6 radioactive decay: The radioactive count rate at a time t , given by the expression