TECHNICAL REPORT

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Measurement of liquid flow in open channels — Electromagnetic current meters

Mesure de débit des liquides dans les canaux découverts — Moulinets électromagnétiques

Contents

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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.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

— type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;

— type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;

— type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/TR 11974, which is a Technical Report of type 2, was prepared by Technical Committee ISO/TC 113, *Hydrometric determinations,* Subcommittee SC 5, *Instruments, equipment and data management*.

This document is being issued in the Technical Report (type 2) series of publications (according to subclause G.3.2.2 of part 1 of the ISO/IEC Directives, 1995) as a "prospective standard for provisional application" in the field of hydrometric determinations because there is an urgent need for guidance on how standards in this field should be used to meet an identified need.

This document is not to be regarded as an "International Standard". It is proposed for provisional application so that information and experience of its use in practice may be gathered. Comments on the content of this document should be sent to the ISO Central Secretariat.

A review of this Technical Report (type 2) will be carried out not later than three years after its publication with the options of: extension for another three years; conversion into an International Standard; or withdrawal.

Annex A of this Technical Report is for information only.

Measurement of liquid flow in open channels — Electromagnetic current meters

1 Scope

This Technical Report specifies the operational requirements, construction, calibration and maintenance aspects of a solid-state electromagnetic current meter for the single-point measurement of velocity of electrically conducting liquids, including water.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this Technical Report. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this Technical Report 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 772:1996, *Hydrometric determinations — Vocabulary and symbols.*

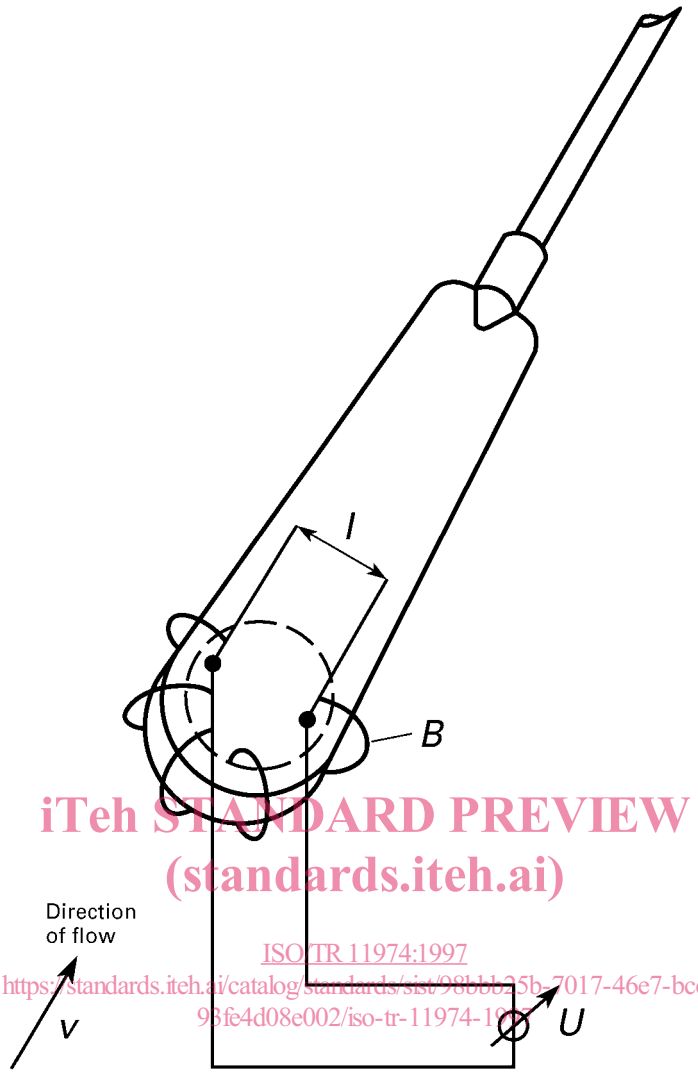
3 Definitions

For the purposes of this Technical Report, the definitions given in ISO 772 apply.

4 Principle of operation

The principle of operation of the electromagnetic current meter is illustrated in figure 1 and is based on the Faraday generator effect, which may generally be stated as follows:

> ".. when there is a perpendicular component of relative motion between an electrical conductor and a magnetic field, an electrical potential is induced in that conductor. The magnitude of the electrical potential is proportional to the velocity at which the conductor moves relative to the electromagnetic field."



Key:

B Lines of force of magnetic field

l Distance between electrodes

U Induced voltage

v Velocity of water

Figure 1 — Electromagnetic flow meter

The relationship can be expressed as:

$$E = f(vFB) \quad \ldots (1)$$

where

E is the electrical potential, in volts;

v is the velocity, in metres per second;

F is the shape factor of the electromagnetic field, in metres;

B is the magnetic field strength, in teslas.

Since F and B are fixed, and can therefore be taken as constants, v can be expressed in terms of E, so that:

$$v = KE \text{ (m / s)} \quad \ldots (2)$$

where K is a calibration factor.

It is conceivable that the calibration may be affected if the strength and shape of the generated field is interrupted or distorted in close proximity to the water/air or water/channel interface. Where this question arises, guidance should be sought from the manufacturer.

5 Electromagnetic current meters

5.1 General

An electromagnetic current meter has no moving parts and consists of a probe, with solid-state encapsulated circuitry and electromagnetic sensor, a control box, and a means of attaching the instrument to the suspension equipment.

5.2 Durability

The electromagnetic sensor of the current meter shall be constructed of noncorrodible/nondegradable material and shall be of sufficiently rugged construction to withstand conditions normally encountered in open channels and closed conduits, and to maintain calibration.

5.3 Interchangeability of parts

The electromagnetic probe shall be interchangeable so as to have uniform functional characteristics, cause minimum divergence from its rating, and facilitate easy replacement.

5.4 Resistance to flow

The current meter shall be so designed as to offer minimum interference to the flow.

5.5 Output response

Since the meter is sensitive to variations in the velocity of the fluid, some form of 'damping down' of the results, such as an average or a 'rolling mean' might be used.

The output shall be displayed in engineering units of velocity, averaged over a user-selectable period, or shown as a rolling-mean value over a user-selectable period. A negative sign should be used to indicate reverse flow. The manufacturer should show the algorithms used for the calculations of the displayed average or rolling-mean values.

The user shall be the final arbiter on the method used, but he/she shall be advised by the manufacturer of the options available to him/her.

The output shall show velocity and angular direction of flow with respect to a known datum.

5.6 Operating conditions

The manufacturer should specify the range of ambient and operating conditions (such as temperature and humidity) for the use of the probe and secondary instrumentation. The user should also satisfy himself that the equipment will work satisfactorily in the envisaged environmental conditions.

5.7 Power requirements

Where permanent or semipermanent installation is involved and no entry into the water by the technician is needed, mains sources may be used. Where portable meters are in use, a low voltage d.c. power source shall be used, in accordance with the relevant International Standards.

In some applications, it may be necessary for the equipment to be certified as suitable for use in potentially explosive atmospheres.

6 Operational aspects

6.1 Positioning of current meter

The deployment of the probe with two electrodes only should be such that the plane of the coil is essentially parallel to the direction of flow, within the manufacturer's specification. Deployment of probes with four electrodes, (the so-called vectorized electromagnetic sensor) can be random compared with the direction of flow. However, the manufacturer shall make it clear whether the readings provided by the meter represent the resultant of the velocity components and the direction, or some other variable.

The manufacturer should specify the minimum proximity and composition of any boundary which might affect the performance of the meter.

6.2 Electrical interference

The performance of the electromagnetic current meter should not be unduly influenced by electrical interferences such as power cables, radio transmitters or electrical motors.

6.3 Operating conditions

The current meter shall be capable of being used in silty or saline fluid as well as in fresh water. Measurement uncertainties may arise when applied to nonhomogeneous liquids.

7 Calibration

7.1 Ratings

The calibration of the current meter shall consist in establishing experimentally the relation between the velocity of the rating carriage and the velocity indicated by the meter. The design of the encapsulated circuitry and sensor should be such that the average of several ratings can be attributed to the same manufactured batch without rating other meters of that batch. To examine negative velocities during rating in a still-water towing tank, the sensor shall be mounted in the reverse position.

In the case of vectorized meters, the manufacturer shall establish experimentally the relationship between the readings and the direction of flow.

7.2 Velocity relationship

The meter should normally be used for that range of velocities for which it has been calibrated.

7.3 Measurement uncertainty

The manufacturer shall state the uncertainties at the 95 % confidence level at specified points within the stated operating range of the equipment, and the environmental conditions under which these apply. Uncertainties at the lower and upper ends of the rating, plus selected intermediate points, shall be provided by the manufacturer.

7.4 Type of suspension

The performance of a meter may be affected by its mode of suspension, and the sounding weight used. It is advisable that the calibration be carried out with the mode of suspension and the sounding weight intended to be used during the measurement.

It is possible to derive by experiment, coefficients which can be applied to gauging data to correct for the effects (if any) of different sounding weights and different modes, size and shape of suspension. Such coefficients are applicable only to the specific combination for which data have been experimentally obtained.

7.5 Recalibration

It should not be necessary to recalibrate an electromagnetic current meter unless its performance is suspect.

The manufacturer should provide a means of checking the calibration, but it is the responsibility of the user to determine when a meter needs recalibration.

8 Maintenance

The meter shall be examined before and after each discharge measurement for damage to the probe and assembly. The manufacturer shall supply with each instrument a handbook describing the operation of the meter, together with full details of maintenance and adjustments necessary to maintain the accuracy of the meter.

9 Transport and storage

A suitable instrument case shall be provided in which the current meter may be carried and stored, when not in use.

The manufacturer should specifiy the range of ambient conditions (such as temperature and humidity) for the storage of the probe and secondary instrumentation. The user should also satisfy himself that the equipment will withstand satisfactorily the envisaged storage conditions.

10 Log book

A log book showing the initial details of the meter and any change it has undergone since initial commissioning shall be maintained for each current meter.