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Measurement of liquid velocity in open channels — Design, selection and use of electromagnetic current meters

Mesurage de la vitesse des liquides dans les canaux découverts — Conception, choix et utilisation des débitmètres électromagnétiques

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. 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.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

— an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed every three years with a view to deciding whether it can be transformed into an International Standard.

Attention is drawn to the possibility that some of the elements of this Technical Specification ISO/TS 15768 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TS 15768 was prepared by Technical Committee ISO/TC 113, *Hydrometric determinations*, Subcommittee SC 1, *Velocity area methods*.

Introduction

The purpose of this Technical Specification is to highlight the particular characteristics of the typical electromagnetic current meter that distinguish it from the typical rotating element current meter, and to provide guidance to users of the electromagnetic device that will allow informed judgements to be made regarding its likely performance attributes and limitations in operational situations.

Measurement of liquid velocity in open channels — Design, selection and use of electromagnetic current meters

1 Scope

This Technical Specification gives guidelines for the design, selection and use of electromagnetic current meters used to determine point velocity for the purpose of measuring flow in an open channel using the velocity area method.

NOTE The electromagnetic current meter is acceptable as a device for making point determinations of velocity for the purposes of open channel flow determination by the velocity area method, using the multiple point velocity sampling technique described in ISO 748 (see reference [1] in the Bibliography).

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this Technical Specification. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this Technical Specification are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 772, *Hydrometric determinations — Vocabulary and symbols*.

3 Terms and definitions

For the purposes of this Technical Specification, the terms and definitions given in ISO 772 apply.

4 Units of measurement

The units of measurement used in this Technical Specification are SI units.

5 Physical characteristics of the electromagnetic current meter

5.1 General

5.1.1 An electromagnetic current meter will normally comprise the following components:

a) a sensing head (sometimes referred to as a "probe");

b) a means of suspension;

c) a control unit;

d) a signal cable (between the sensing head and the control unit);

e) a source of electrical energy.

5.1.2 The source of electrical energy will normally be a battery pack, contained within the control unit. The signal cable will generally contain separate conductors to convey the electrical signal output from the sensing head to the control unit and the subsequent electrical response from the control unit back to the sensing head.

5.1.3 The signal cable may or may not be detachable from the sensing head or from the control unit. This feature may vary between devices made by different manufacturers. Sensing heads may vary significantly in size and shape.

5.1.4 Most devices are capable of distinguishing and indicating flow polarity, i.e. whether the direction of flow is forward or backwards with respect to the reference axis of the sensing head itself. Some manufacturers offer variants that are able to determine and indicate flow direction with respect to absolute directional references in either or both of the horizontal or vertical planes.

5.2 Sensing head

5.2.1 The sensing head generally consists of a streamlined solid body, within which is located an electromagnetic coil (for generating a local electromagnetic field). It also contains one or more pairs of sensing electrodes capable of detecting the electrical potential generated by the movement of water (the electrical conductor) through the local electromagnetic field.

5.2.2 The sensing head may also contain one or more of the following:

a) signal conditioning and/or amplification electronics;

b) communications electronics.

5.2.3 The sensing head may be expected to be constructed in such a manner, and of such materials, as to prevent the ingress of moisture, under all conditions of use for which the device is intended, to any extent that would interfere with the device's reliable and accurate operation, and for the duration of the device's intended working lifetime.

5.2.4 Each pair of sensing electrodes present, generally appears at the surface of the head, at a given distance apart in function to the detailed design of the device. Movement of water (the conductor) through the electromagnetic field, generated by the device's internal coil, causes an electrical potential to be generated. This potential may be detected by the electrodes, and is proportional to

a) the strength of the field,

b) the size of the conductor, and

c) the speed of the conductor through the field.

5.2.5 The size of the conductor (the body of water whose mean speed is detected by the device) is a function of the shape and extent of the field generated by electrical stimulation of the coil and the orientation of that field with respect to the mean direction of flow. The maximum potential is normally generated when the straight line intercepting a pair of sensing electrodes is normal to the mean direction of flow. Different proprietary devices may create differently-sized electromagnetic fields and, hence, sample the speed of differently-sized bodies of water.

5.2.6 The strength and extent of the generated electromagnetic field may be of particular relevance when sensing heads are deployed in close proximity to the air/water interface or to the water/channel-bed interface. Device calibration may be affected if the electromagnetic field produced is interrupted by one or other (or both) of the mechanisms described. Where the question is relevant, guidance should be sought from the manufacturer or supplier of the device that is to be used.

5.2.7 In device variants equipped with two or more pairs of sensing electrodes, pairs are normally disposed in lines that are mutually perpendicular. Thus, in a two-pair device, the straight lines intercepting each separate pair of electrodes (or planes containing those straight lines) would themselves intersect at right angles. The two pairs would normally be deployed in the horizontal plane, and the device as a whole would thereby be rendered capable of determining and indicating true flow direction relative to an absolute directional datum also in the horizontal plane.

5.2.8 In a three-pair device, the third pair of electrodes are normally oriented at right angles to the plane of the other two pairs, and the overall device can determine and indicate the absolute direction with respect to the vertical as well as the horizontal.

5.2.9 In device designs that allow disconnection of the sensing head from the signal cable, the connector is normally fully water-resistant, capable of withstanding submergence to a depth indicated by the device manufacturer's product specification. However, it may be a prohibited to disconnect the head while the device is under power from its control unit. Furthermore, threaded connectors may be made of very fine thread pitch, requiring careful attention when disconnecting or re-connecting to avoid accidental damage to the thread (i.e. “stripping”) that might render the connector insecure or no longer water-resistant. It is also important to keep such connectors scrupulously clean.

5.2.10 For any electromagnetic current meter to perform satisfactorily, the water in which it is deployed needs to be adequately conductive. The minimum water conductivity at which a meter performs to its specification may vary between devices made by different manufacturers, or between different generic variants of the same manufacturer. Typical minimum values of water conductivity at which electromagnetic current meters may reasonably be expected to perform to specification, range between 30 µS and 100 µS, depending upon device manufacture and, also, upon water velocity. As a generalization, low velocity and low conductivity may not combine well to deliver adequate measurement performance in a specific meter.

5.2.11 Surface contamination of the sensing head may have an effect upon a device's calibration by altering the electrical conducting properties of its electrodes. Sensing heads should be handled as little as possible, and it is sound operational practice to wash them clean of silt or other waterborne contamination immediately after every use, and to clean them free of grease (with a soft cloth and a mild non-abrasive detergent) immediately before use. If an oil film is located on the water surface, a method should be provided for protecting the sensing head from being coated with oil during insertion into the water. For example, a plastic bag can be placed over the sensing head and then removed under water and under the oil film. It is recommended to follow the manufacturer's operating instructions or advice, when provided, on the subject of probe or head contamination.

5.2.12 The specific calibration of a device is also likely to be a function of the hydrodynamic characteristics of its sensing head, as determined by its specific shape, and by the state of surface roughness. Sensing heads are normally constructed from material that is appropriately resistant to damage by impact, abrasion or chemical attack. Nevertheless, care should be taken in the handling and deployment of the sensing head of an electromagnetic current meter to prevent accidental damage that alters its shape or smoothness of its surface finish to any significant degree. Where there is doubt as to the significance of an observable alteration of this nature, re-calibration or comparison of performance against a reference device may be appropriate.

5.3 Means of suspension

5.3.1 The sensing head of an electromagnetic current meter is normally constructed to make it deployable by easy attachment to gauging rods as a basic method of suspension. It may also be possible to suspend such a device by cable, and to attach a tail fin and a sinker weight to allow deployment in circumstances where rods are not appropriate.

5.3.2 Depending upon the specific design of a metering system, the length of the signal cable that connects the sensing head with the control unit may be limited. The calibration of a specific individual meter may be unique to the specific length and type of signal cable used in the course of calibration (see also 5.5.3).

5.3.3 Some meter designs (but not necessarily all), may allow meter deployment by means of a cableway system.