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Measurement of fluid flow in closed conduits — Guidance to the selection, installation and use of Coriolis meters (mass flow, density and volume flow measurements)

AMENDMENT 1: Guidelines for gas measurement

Mesure de débit des fluides dans les conduites fermées — Lignes directrices pour la sélection, l'installation et l'utilisation des mesureurs à effet Coriolis (mesurages de débit-masse, masse volumique et débit-volume)

AMENDEMENT 1: Lignes directrices pour le mesurage des gaz

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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 2.

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.

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

Amendment 1 to ISO 10790:1999 was prepared by Technical Committee ISO/TC 30, *Measurement of fluid flow in closed conduits*, Subcommittee SC 5, *Velocity and mass methods*.

This Amendment contains additional considerations and guidelines for the use of Coriolis meters in gas flow measurements.

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Measurement of fluid flow in closed conduits — Guidance to the selection, installation and use of Coriolis meters (mass flow, density and volume flow measurements)

AMENDMENT 1: Guidelines for gas measurement

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Page 1, Scope

Replace Clause 1 with the following:

1 Scope

This International Standard gives guidelines for the selection, installation, calibration, performance and operation of Coriolis meters for the determination of mass flow, density, volume flow and other related parameters of fluids, synonymous for liquids and gases as a first approach. For gases, it gives the determination of gas mass flow and standard volume flow (using predetermined standard density). It also gives appropriate considerations regarding the fluids to be measured.

The primary purpose of Coriolis meters is to measure mass flow. However, some of these meters offer additional possibilities for determining the density and temperature of fluids. From the measurement of these three parameters, volume flow and other related parameters can be determined.

Measurements of gas flow, in principle, are possible using any Coriolis meter if special considerations are made. Specific considerations for gas flow measurements are given in Annex E.

The content of this International Standard is primarily applicable to the metering of liquids and where possible to gas measurements.

Page 3, Clause 2

Replace entries 2.12 and 2.13 with the following:

2.12
flashing
⟨liquids⟩ phenomenon which occurs when the line pressure drops to, or below, the vapour pressure of the liquid

NOTE 1 This is often due to pressure drops caused by an increase in liquid velocity.

NOTE 2 Flashing is not applicable to gases.

2.13
cavitation
⟨liquids⟩ phenomenon related to and following flashing if the pressure recovers causing the vapour bubbles to collapse (implode)

NOTE Cavitation is not applicable to gases.

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Page 3, Clause 2

Add the following new entries 2.14 to 2.17:

2.14
relative humidity
actual amount of water vapour contained in a gas as a percentage of the maximum water vapour content if the gas was fully saturated at metering conditions

2.15
choked flow
maximum flowrate for a particular geometry which can exist for the given upstream conditions

NOTE 1 When choked flow occurs, the velocity at a cross-section is equal to the local value of the speed of sound (acoustic velocity), the velocity at which small pressure disturbances propagate.

NOTE 2 Choked flow can occur either at the inlet or the outlet of a Coriolis meter.

2.16
shock wave
discontinuity in supersonic flow across which there is a sudden rise in pressure and temperature

2.17
critical nozzle
Venturi nozzle for which the nozzle geometrical configuration and conditions of use are such that the flowrate is critical

NOTE See also ISO 9300.

After page 28, after Annex D

Add new Annex E as follows:

Annex E
(normative)

Guidelines for gas measurement

E.1 General

This annex gives guidelines that are specifically applicable to gas measurements using Coriolis meters.

E.2 Coriolis meter selection criteria

E.2.1 General

The Coriolis meter should be selected to measure mass flow within the required range and accuracy. However, since noise is created by high flow velocities usually present in gas applications, achievable mass flow rates are normally lower than for liquid applications.

Consideration should be given to the points given in E.2.2 to E.2.6 when selecting a Coriolis meter.

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E.2.2 Accuracy

The expression of accuracy varies depending on the parameter to which it applies. For specific recommendations on mass flow, see 5.2.

Manufacturers' accuracy statements should be given for specified reference conditions. If the conditions of use are significantly different from those of the original calibration, the meter's performance can be affected.

E.2.3 Physical installation

E.2.3.1 General

The manufacturer should describe the preferred installation arrangement and state any restrictions of use. See Annex C.

The installation arrangement should be designed to provide a maximum operating lifetime. If required, strainers, filters, separators or other protective devices should be placed upstream of the meter for the removal of solids or condensate that could cause damage or provoke errors in measurement.

E.2.3.2 Orientation

Coating, trapped condensate or settlement of solids can affect the meter's performance. The orientation of the sensor will depend on the intended application of the meter and the geometry of the oscillating tube(s). The orientation of the Coriolis meter should be recommended by the manufacturer to minimize these effects.

E.2.3.3 Valves

Valves upstream and downstream of a Coriolis meter, installed for the purpose of isolation and zero adjustment, can be of any type, but should provide tight shutoff. Control valves in series with a Coriolis meter should be installed downstream in order to maintain the highest possible pressure.

Due to the high velocities encountered in gas flow, acoustic noise may be generated by valves. This may interfere with the meter performance. Care should be taken in selecting the type of valve and its location.

E.2.3.4 Cleaning

In certain applications (for instance asphalt deposits from gas), the Coriolis meter may require *in-situ* cleaning which can be accomplished by:

a) mechanical means (using a pig or ultrasonically);

b) hydrodynamic means:

— sterilization (steaming-in-place, SIP);

— chemical or biological (cleaning-in-place, CIP).

Care should be taken to avoid cross-contamination after cleaning fluids have been used.

Chemical compatibility should be established between the sensor wetted-materials, process fluid and cleaning fluid.

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E.2.4 Effects due to process conditions and fluid properties

E.2.4.1 General

Variations in fluid properties such as density and process conditions such as pressure and temperature, may influence the meter's performance. These effects have influences which differ depending on which parameter is of interest. See 5.3.

E.2.4.2 Application and fluid properties

In order to identify the optimum meter for a given application, it is important to establish the range of conditions to which the Coriolis meter will be subjected. These conditions should include:

a) the operating flow rates and the following flow characteristics:

— unidirectional or bi-directional,

— continuous, intermittent or fluctuating;

b) the range of operating densities;

c) the range of operating temperatures;

d) the range of operating pressures;

e) the permissible pressure loss;

f) the properties of the metered gas, including relative humidity, two-phase flow and corrosiveness;

g) the effects of corrosive additives or contaminants on the meters and the quantity and size of foreign matter, including abrasive particles, that can be carried in the gas stream.

E.2.4.3 Multiphase flow

Homogeneous mixtures of liquids in gas (wet gas) with high gas ratios, may be measured with reduced accuracy (satisfactorily in many cases). Multiphase applications involving non-homogeneous liquid/gas mixtures can cause additional measurement errors and in some cases can stop operation.

Multiphase applications involving solids/gas mixture may erode the tube(s) wall of the flow sensor and reduce meter performance and mechanical integrity. See also 3.6.4. Care should be taken to ensure that condensate droplets or solids are not trapped in the meter.

E.2.4.4 Influence of process fluid

Erosion, corrosion and deposition of material on the inside of the vibrating tube(s) (sometimes referred to as coating) can initially cause measurement errors in mass flow, and in the longer term, sensor failure.

E.2.4.5 Pulsating flow effects

Coriolis meters generally are able to perform under pulsating flow conditions. However, there can be circumstances where pulsations can affect the performance of the meter (see 3.3.8). The manufacturers' recommendations should be observed regarding the application and the possible use of damping devices. Pulsations up to acoustic frequencies in gas can also influence the meter's performance.

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E.2.5 Pressure loss

E.2.5.1 General

A loss in pressure will occur as the fluid flows through the sensor. The magnitude of this loss will be a function of the size and geometry of the oscillating tube(s), the mass flow rate (velocity), density and to a small extent, the dynamic viscosity of the process fluid. Manufacturers should specify the loss in pressure which occurs under reference conditions and should provide the information necessary to calculate the loss in pressure which occurs under operating conditions.

Acoustic noise can be generated within the flow sensor at high velocities (high pressure drop). This may adversely affect the meter's performance, see 3.5.

At a given mass flow rate, the pressure loss can be minimized by locating the meter at a higher line pressure (higher fluid density, lower velocity). This also reduces the risk of choked flow within the flow sensor.

NOTE If a meter is choked, the mass flow cannot be controlled by downstream valves (only by varying the upstream pressure).

E.2.5.2 Condensing conditions

Consideration has to be given if the gas has water vapour content (humidity), a content of other vapours, or a potential for condensing components from the gas. Pressure or temperature drop can cause liquids to condense from the gas to form droplets or films within the meter, hence causing multiphase conditions (see 3.4.3) as well as measurement errors.

E.2.6 Safety considerations for erosion

Fluids containing solid particles can cause erosion of the measuring tube(s) during flow. The effect of erosion is dependent on meter size and geometry, particle size, abrasives and velocity. Erosion should be assessed for each type of use of the meter.

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E.3 Mass flow measurement

E.3.1 Accuracy

The term accuracy, expressed as a percentage of the reading, is often used by manufacturers and users as a means for quantifying the expected error limits. For mass flow, the term accuracy includes the combined effects of linearity, repeatability, hysteresis and zero stability.

Linearity, repeatability and hysteresis are combined and expressed as a percentage of the reading. Zero stability is given as a separate parameter in mass per unit time. In order to determine the overall accuracy value, it is necessary to calculate zero stability as a percentage of the reading at a specified flow rate, and to add this value to the combined effects of linearity, repeatability and hysteresis.

Repeatability is often given as a separate parameter, expressed as a percentage of the reading. It is calculated in a similar way to accuracy.

Accuracy and repeatability statements are usually made for reference conditions which are specified by the manufacturer. These reference conditions should include temperature, pressure, density range and flow range.

Accuracy and repeatability can be different for gas applications than for liquid applications.

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