INTERNATIONAL STANDARD

ISO 12764

First edition
2017-08

Measurement of fluid flow in closed conduits — Flowrate measurement by means of vortex shedding flowmeters inserted in circular cross-section conduits running full

Mesurage du débit de fluide dans les conduites fermées — Mesurage du débit par débitmètres à effet vortex insérés dans les conduites de section circulaire remplies au droit

Reference number
ISO 12764:2017(E)

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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 procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 30, *Measurement of fluid flow in closed conduits,* Subcommittee SC 5, *Velocity and mass methods.*

This first edition of ISO 12764 cancels and replaces ISO/TR 12764:1997. In general this document reflects the current state of vortex shedding flow meter methodology, with advancements that have occurred since the original TR was published. In particular:

— the terms “systematic measurement error” and “measurement uncertainty” are more clearly defined;

— the terms “rangeability”, “lowest local pressure”, “response time” and “fade” have been removed;

— 6.1.1.4 and 6.1.2 have been added;

— Clause 8 and Clause 9 have been revised;

— Annex A has been revised;

— a new Annex B has replaced the previous version;

— Annex C has been incorporated into 7.2 and updated.

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Introduction

This document is one of the series of International Standards and Technical Reports covering a variety of devices that measure the flow of fluids in closed conduits.

The term “vortex shedding flowmeter”, commonly referred to as a “vortex meter”, covers a large family of devices with varying proprietary designs. These devices have in common the shedding of vortices from an obstruction (called a bluff body) which has been deliberately placed in the flow path in the meter. The natural laws of physics relate the shedding frequency of the vortices (f) to the fluid velocity and hence the volumetric flowrate (q_V) of the fluid in the conduit. The vortices can be counted over a given period of time to obtain total flow.

The vortex shedding phenomenon has become an accepted basis for fluid flow measurement. Meters are available for measuring the flow of fluids from cryogenic liquids to steam and high pressure gases. Many vortex shedding flowmeter designs are proprietary and, therefore, their design details cannot be covered in this document.

Insufficient data have been collected and analysed to be able to state, in this document, an expected uncertainty band for this type of vortex-shedding flowmeter.

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Measurement of fluid flow in closed conduits — Flowrate measurement by means of vortex shedding flowmeters inserted in circular cross-section conduits running full

1 Scope

This document

a) describes the use of vortex shedding flow meters for liquids, gases, and steam, including a glossary and a set of engineering equations used for specifying performance,

b) provides technical information to assist the user in selecting, specifying and applying vortex shedding flowmeters, including influence effects,

c) describes typical construction and provides recommendations for inspection, certification, and material traceability,

d) describes availability of diagnostics associated with vortex shedding flowmeters,

e) provides calibration guidance,

f) does not apply to insertion type vortex shedding flowmeters,

g) applies only to closed conduits running full,

h) applies only to fluid flow that is steady or varies only slowly with time, and

i) applies to fluids considered to be single-phase.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4006, *Measurement of fluid flow in closed conduits — Vocabulary and symbols*

ISO/IEC Guide 99:2007 (JCGM 200:2012), *International vocabulary of metrology — Basic and general concepts and associated terms (VIM)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4006 and ISO/IEC Guide 99:2007 (JCGM 200:2012) and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

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3.1 Definitions specific to this vortex flowmeter standard

3.1.1
***K*-factor**
ratio of the meter output in number of pulses to the corresponding total volume of fluid passing through the meter during a measured period

Note 1 to entry: The variations in the *K*-factor can be presented as a function of either the pipe Reynolds number or flowrate at a specific set of thermodynamic conditions. The mean *K*-factor is commonly used and is defined by the following formula:

$$K_{\text{mean}} = \frac{K_{\text{max}} + K_{\text{min}}}{2}$$

where

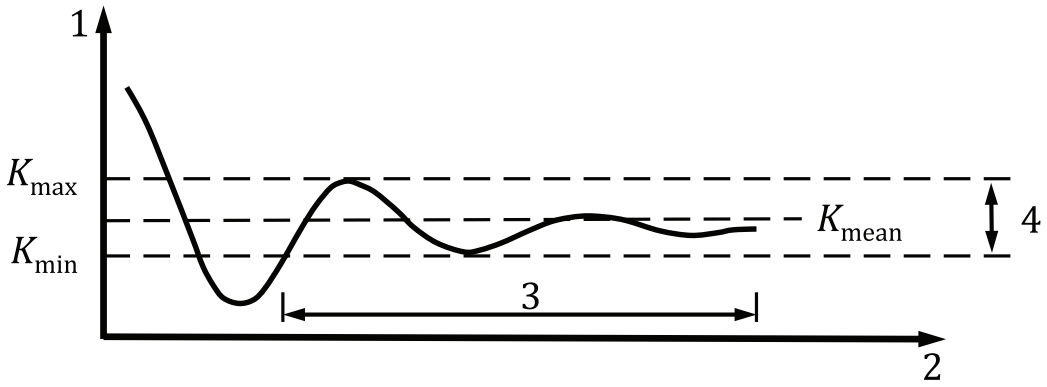
K_{max} is the maximum *K*-factor over a designated range;

K_{min} is the minimum *K*-factor over the same range.

Alternatively, the average of several values of *K*-factor taken over the whole flow range of a meter can be calculated. The *K*-factor can change with pressure and thermal effects on the body of the meter; see Clause 11. The manufacturer of the meter should be consulted concerning the difference, if any, of the *K*-factor between liquid and gas and due to differences between pipe schedules of the adjacent pipe.

Note 2 to entry: It is expressed in pulses per unit volume.

Note 3 to entry: See Figure 1.



Key
1 *K*-factor
2 pipe Reynolds number
3 designated linear range
4 linearity (%)

Figure 1 — Typical shape of a *K*-factor curve

3.1.2
linearity
constancy of the *K-factor* (3.1.1) over a specified range defined either by the pipe Reynolds number or flowrate

Note 1 to entry: The upper and lower limits of the linear range are specified by the manufacturer.

Note 2 to entry: See Figure 1.

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3.1.3
cavitation
phenomenon following flashing, in which the pressure recovers above the vapour pressure and the vapour bubble collapses (implodes)

Note 1 to entry: Cavitation can result in measurement error as well as mechanical damage to the meter.

3.1.4
flashing
formation of vapour bubbles

Note 1 to entry: Flashing occurs when the pressure falls below the vapour pressure of the liquid.

3.2 Definitions related to measurement of fluid flow in closed conduits

3.2.1
pressure loss
irrecoverable pressure loss caused by the presence of a primary device in the conduit

3.2.2
Strouhal number
dimensionless parameter relating the vortex shedding frequency, *f*, generated by a characteristic dimension, *l*, to the fluid velocity, *v*, given by the following formula:

$$Sr = \frac{f \cdot l}{v}$$

where

f is vortex shedding frequency;

l is a characteristic length of the system in which the flow occurs;

v is the fluid velocity.

3.2.3
Reynolds number
dimensionless parameter expressing the ratio between the inertia and viscous forces given by the following formula:

$$Re = \frac{U \cdot l}{v}$$

where

U is the mean axial fluid velocity across a defined area;

l is a characteristic length of the system in which the flow occurs;

v nu (Greek alphabet) is the kinematic viscosity of the fluid.

Note 1 to entry: For pipe flows and closed pipe flow measurement, Reynolds number is usually based on the diameter of the pipe.

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3.3 Definitions related to the vocabulary used in metrology

3.3.1
systematic measurement error
systematic error of measurement
systematic error
component of measurement error that, in replicate measurements, remains constant or varies in a predictable manner

Note 1 to entry: A reference quantity value for a systematic measurement error is a true quantity value, or a measured quantity value of a measurement standard of negligible measurement uncertainty, or a conventional quantity value.

Note 2 to entry: Systematic measurement error, and its causes, can be known or unknown. A correction can be applied to compensate for a known systematic measurement error.

Note 3 to entry: Systematic measurement error equals measurement error minus random measurement error.

3.3.2
measurement uncertainty
uncertainty of measurement
uncertainty
non-negative parameter characterizing the dispersion of the quantity values being attributed to a measurand, based on the information used

Note 1 to entry: Measurement uncertainty includes components arising from systematic effects, such as components associated with corrections and the assigned quantity values of measurement standards, as well as the definitional uncertainty. Sometimes estimated systematic effects are not corrected for but, instead, associated measurement uncertainty components are incorporated.

Note 2 to entry: The parameter can be, for example, a standard deviation called standard measurement uncertainty (or a specified multiple of it), or the half-width of an interval, having a stated coverage probability.

Note 3 to entry: Measurement uncertainty comprises, in general, many components. Some of these can be evaluated by Type A evaluation of measurement uncertainty from the statistical distribution of the quantity values from a series of measurements and can be characterized by standard deviations. The other components, which can be evaluated by Type B evaluation of measurement uncertainty, can also be characterized by standard deviations, evaluated from probability density functions based on experience or other information.

Note 4 to entry: In general, for a given set of information, it is understood that the measurement uncertainty is associated with a stated quantity value attributed to the measurand. A modification of this value results in a modification of the associated uncertainty.

4 Symbols and subscripts

4.1 Symbols

Symbol	Quantity	Dimensions	SI units
A	effective area	L^2	m^2
A_p	manufacturer supplied constant	L^2	m^2
c_1, c_2	empirical constant	dimensionless	
D	diameter of meter bore	L	m
f	frequency of vortex shedding	T^{-1}	Hz
K	K-factor, meter factor = $1/K$	L^{-3}	m^{-3}
l	characteristic length	L	m
N	number of pulses	dimensionless	
NOTE Fundamental dimensions: M = mass, L = length, T = time, θ = temperature			

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