Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full - Part 4: Venturi tubes (ISO 5167-4:2022)

EESTI STANDARDI EESSÕNA   NATIONAL FOREWORD

See Eesti standard EVS-EN ISO 5167-4:2022 sisaldab Euroopa standardi EN ISO 5167-4:2022 ingliskeelset teksti.	This Estonian standard EVS-EN ISO 5167-4:2022 consists of the English text of the European standard EN ISO 5167-4:2022.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation and Accreditation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 29.06.2022.	Date of Availability of the European standard is 29.06.2022.
Standard on kättesaadav Eesti Standardimis-ja Akrediteerimiskeskusest.	The standard is available from the Estonian Centre for Standardisation and Accreditation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile standardiosakond@evs.ee.

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EUROPEAN STANDARD

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EN ISO 5167-4

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English Version

Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full - Part 4: Venturi tubes (ISO 5167-4:2022)

Mesurage de débit des fluides au moyen d'appareils déprimogènes insérés dans des conduites en charge de section circulaire - Partie 4: Tubes de Venturi (ISO 5167-4:2022)

Durchflussmessung von Fluiden mit Drosselgeräten in voll durchströmten Leitungen mit Kreisquerschnitt - Teil 4: Venturirohre (ISO 5167-4:2022)

This European Standard was approved by CEN on 21 May 2022.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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Ref. No. EN ISO 5167-4:2022 E

European foreword

This document (EN ISO 5167-4:2022) has been prepared by Technical Committee ISO/TC 30 "Measurement of fluid flow in closed conduits" in collaboration with CCMC.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2022, and conflicting national standards shall be withdrawn at the latest by December 2022.

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

This document supersedes EN ISO 5167-4:2003.

Any feedback and questions on this document should be directed to the users' national standards body/national committee. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Endorsement notice

The text of ISO 5167-4:2022 has been approved by CEN as EN ISO 5167-4:2022 without any modification.

Contents

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).

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

For an explanation of 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 www.iso.org/iso/foreword.html.

ISO 5167-4 was prepared by Technical Committee ISO/TC 30, *Measurement of fluid flow in closed conduits*, Subcommittee SC 2, *Pressure differential devices*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/SS F05, *Measuring instruments*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition of ISO 5167-4 cancels and replaces the first edition of ISO 5167-4:2003, which has been technically revised.

The main changes are as follows:

— The use of single pressure tappings on Venturi tubes is permitted.

— The discharge coefficient and uncertainty are given in Clause 5 for a Venturi tube with a machined convergent section for $Re_D > 10^6$.

— Flow calibration of Venturi tubes is included.

— There is improved wording of the rules for spacing of multiple fittings but no change in actual requirements.

A list of all parts in the ISO 5167 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

ISO 5167, consisting of six parts, covers the geometry and method of use (installation and operating conditions) of orifice plates, nozzles, Venturi tubes, cone meters and wedge meters when they are inserted in a conduit running full to determine the flow rate of the fluid flowing in the conduit. It also gives necessary information for calculating the flow rate and its associated uncertainty.

ISO 5167 (all parts) is applicable only to pressure differential devices in which the flow remains subsonic throughout the measuring section and where the fluid can be considered as single-phase, but is not applicable to the measurement of pulsating flow. Furthermore, each of these devices can only be used uncalibrated within specified limits of pipe size and Reynolds number, or alternatively they can be used across their calibrated range.

ISO 5167 (all parts) deals with devices for which direct calibration experiments have been made, sufficient in number, spread and quality to enable coherent systems of application to be based on their results and coefficients to be given with certain predictable limits of uncertainty. ISO 5167 (all parts) also provides methodology for bespoke calibration of differential pressure meters.

The devices introduced into the pipe are called primary devices. The term primary device also includes the pressure tappings. All other instruments or devices required to facilitate the instrument readings are known as secondary devices, and the flow computer that receives these readings and performs the algorithms is known as a tertiary device. ISO 5167 (all parts) covers primary devices; secondary devices (see ISO 2186) and tertiary devices will be mentioned only occasionally.

Aspects of safety are not dealt with in ISO 5167-1 to ISO 5167-6. It is the responsibility of the user to ensure that the system meets applicable safety regulations.

Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full —

Part 4:
Venturi tubes

1 Scope

This document specifies the geometry and method of use (installation and operating conditions) of Venturi tubes[1]) when they are inserted in a conduit running full to determine the flow rate of the fluid flowing in the conduit.

This document also provides background information for calculating the flow rate and is applicable in conjunction with the requirements given in ISO 5167-1.

This document is applicable only to Venturi tubes in which the flow remains subsonic throughout the measuring section and where the fluid can be considered as single-phase. In addition, Venturi tubes can only be used uncalibrated in accordance with this standard within specified limits of pipe size, roughness, diameter ratio and Reynolds number, or alternatively they can be used across their calibrated range. This document is not applicable to the measurement of pulsating flow. It does not cover the use of uncalibrated Venturi tubes in pipes sized less than 50 mm or more than 1 200 mm, or where the pipe Reynolds numbers are below 2×10^5.

This document deals with the three types of classical Venturi tubes:

a) "as cast";

b) machined;

c) fabricated (also known as "rough-welded sheet-iron").

A Venturi tube consists of a convergent inlet connected to a cylindrical throat which is in turn connected to a conical expanding section called the divergent section (or alternatively the diffuser). Venturi nozzles (and other nozzles) are dealt with in ISO 5167-3.

NOTE   In the USA the classical Venturi tube is sometimes called the Herschel Venturi tube.

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 5167-1, *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full — Part 1: General principles and requirements*

ISO 5168, *Measurement of fluid flow — Procedures for the evaluation of uncertainties*

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1)   In the USA the classical Venturi tube is sometimes called the Herschel Venturi tube.

ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4006 and ISO 5167-1 apply.

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

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

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

4 Principles of the method of measurement and computation

The principle of the method of measurement is based on the installation of a Venturi tube into a pipeline in which a fluid is running full. A static pressure difference exists between the upstream section and the throat section of the device. Venturi tube geometries and designs have been extensively tested across a wide range of flow conditions and shown to have a reproducible value of the discharge coefficient, C, within a given uncertainty. Uncalibrated Venturi tubes of one of these geometries and designs, within that same range of flow conditions, can be used to determine the flow rate from the measured value of this pressure difference and from a knowledge of the fluid conditions.

The mass flow rate can be determined by Formula (1):

$$q_m = \frac{C}{\sqrt{1-\beta^4}}\, \varepsilon\, \frac{\pi}{4} d^2 \sqrt{2\Delta p \rho_1} \tag{1}$$

The uncertainty limits can be calculated using the procedure given in ISO 5167-1:2022, Clause 8.

Similarly, the value of the volume flow rate can be calculated since

$$q_V = \frac{q_m}{\rho}$$

where ρ is the fluid density at the temperature and pressure for which the volume is stated.

Computation of the flow rate, which is an arithmetic process, is performed by replacing the different items on the right-hand side of Formula (1) by their numerical values. Table A.1 gives Venturi tube expansibility factors (ε). They are not intended for precise interpolation. Extrapolation is not permitted.

The diameters d and D mentioned in Formula (1) (since D is required to calculate β) are the values of the diameters at working conditions. Measurements taken at any other conditions should be corrected for any possible expansion or contraction of the primary device and the pipe due to the values of the temperature and pressure of the fluid during the measurement.

It is necessary to know the density and the viscosity of the fluid at working conditions. In the case of a compressible fluid, it is also necessary to know the isentropic exponent of the fluid at working conditions.

5 Classical Venturi tubes

5.1 Field of application

5.1.1 General

The field of application of the classical Venturi tubes dealt with in this document depends on the way in which they are manufactured.