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

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EESTI STANDARDI EESSÕNA **NATIONAL FOREWORD**

Käesolev Eesti standard EVS-EN ISO 5167-4:2003 sisaldab Euroopa standardi EN ISO 5167-4:2003 ingliskeelset teksti. Käesolev dokument on jõustatud 06.06.2003 ja selle kohta on avaldatud teade Eesti standardiorganisatsiooni ametlikus väljaandes. Standard on kättesaadav Eesti standardiorganisatsioonist.	This Estonian standard EVS-EN ISO 5167-4:2003 consists of the English text of the European standard EN ISO 5167-4:2003. This document is endorsed on 06.06.2003 with the notification being published in the official publication of the Estonian national standardisation organisation. The standard is available from Estonian standardisation organisation.

Käsitlusala: This part of ISO 5167 specifies the geometry and method of use of Venturi tubes when they are inserted in a conduit running full to determine the flowrate of the fluid flowing in the conduit	**Scope:** This part of ISO 5167 specifies the geometry and method of use of Venturi tubes when they are inserted in a conduit running full to determine the flowrate of the fluid flowing in the conduit

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Võtmesõnad: diaphragms, differential devices, dimensions, flow, flow calculation, flow measurement, flow measurements, flows, fluids, mathematical calculations, measurement, mounting, nozzles, orifice plates, pipelines, specification (approval), specifications, venturi tubes

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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 : 2003)

Mesure 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 : 2003)

Durchflussmessung von Fluiden mit Drosselgeräten in voll durchströmten Leitungen mit Kreisquerschnitt – Teil 4: Venturirohre (ISO 5167-4 : 2003)

This European Standard was approved by CEN on 2003-02-20.

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CEN

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Foreword

International Standard

ISO 5167-4 : 2003 Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full – Part 4: Venturi tubes,

which was prepared by ISO/TC 30 'Measurement of fluid flow in closed conduits' of the International Organization for Standardization, has been adopted by CMC as a European Standard.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, and conflicting national standards withdrawn, by September 2003 at the latest.

In accordance with the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard:

Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, the Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland, and the United Kingdom.

Endorsement notice

The text of the International Standard ISO 5167-4 : 2003 was approved by CEN as a European Standard without any modification.

NOTE: Normative references to international publications are listed in Annex ZA (normative).

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Introduction

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

ISO 5167 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 within specified limits of pipe size and Reynolds number.

ISO 5167 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.

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 for the measurement are known as "secondary devices". ISO 5167 covers primary devices; secondary devices[1)] will be mentioned only occasionally.

ISO 5167 is divided into the following four parts.

a) Part 1 of ISO 5167 gives general terms and definitions, symbols, principles and requirements as well as methods of measurement and uncertainty that are to be used in conjunction with Parts 2 to 4 of ISO 5167.

b) Part 2 of ISO 5167 specifies orifice plates, which can be used with corner pressure tappings, D and $D/2$ pressure tappings[2)], and flange pressure tappings.

c) Part 3 of ISO 5167 specifies ISA 1932 nozzles[3)], long radius nozzles and Venturi nozzles, which differ in shape and in the position of the pressure tappings.

d) This part of ISO 5167 specifies classical Venturi tubes[4)].

Aspects of safety are not dealt with in Parts 1 to 4 of ISO 5167. It is the responsibility of the user to ensure that the system meets applicable safety regulations.

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1) See ISO 2186:1973, *Fluid flow in closed conduits — Connections for pressure signal transmissions between primary and secondary elements*.

2) Orifice plates with "vena contracta" pressure tappings are not considered in ISO 5167.

3) ISA is the abbreviation for the International Federation of the National Standardizing Associations, which was succeeded by ISO in 1946.

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

1 Scope

This part of ISO 5167 specifies the geometry and method of use (installation and operating conditions) of Venturi tubes when they are inserted in a conduit running full to determine the flowrate of the fluid flowing in the conduit.

This part of ISO 5167 also provides background information for calculating the flowrate and is applicable in conjunction with the requirements given in ISO 5167-1.

This part of ISO 5167 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, each of these devices can only be used within specified limits of pipe size, roughness, diameter ratio and Reynolds number. This part of ISO 5167 is not applicable to the measurement of pulsating flow. It does not cover the use of 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 part of ISO 5167 deals with the three types of classical Venturi tubes:

a) cast;

b) machined;

c) rough welded sheet-iron.

A Venturi tube is a device which consists of a convergent inlet connected to a cylindrical throat which is in turn connected to a conical expanding section called the “divergent”. The differences between the values of the uncertainty of the discharge coefficient for the three types of classical Venturi tube show, on the one hand, the number of results available for each type of classical Venturi tube and, on the other hand, the more or less precise definition of the geometric profile. The values are based on data collected many years ago. Venturi nozzles (and other nozzles) are dealt with in ISO 5167-3.

NOTE 1 Research into the use of Venturi tubes in high-pressure gas [$\geqslant$ 1 MPa ($\geqslant$ 10 bar)] is being carried out at present (see References [1], [2], [3] in the Bibliography). In many cases for Venturi tubes with machined convergent sections discharge coefficients which lie outside the range predicted by this part of ISO 5167 by 2 % or more have been found. For optimum accuracy Venturi tubes for use in gas should be calibrated over the required flowrate range. In high-pressure gas the use of single tappings (or at most two tappings in each plane) is not uncommon.

NOTE 2 In the USA the classical Venturi tube is sometimes called the Herschel Venturi tube.

2 Normative references

The following referenced documents are indispensable for the application 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 4006:1991, *Measurement of fluid flow in closed conduits — Vocabulary and symbols*

ISO 5167-1:2003, *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full — Part 1: General principles and requirements*

3 Terms and definitions

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

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. In a Venturi tube a static pressure difference exists between the upstream section and the throat section of the device. Whenever the device is geometrically similar to one on which direct calibration has been made, the conditions of use being the same, the flowrate can be determined from the measured value of this pressure difference and from a knowledge of the fluid conditions.

The mass flowrate can be determined by the following formula:

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

The uncertainty limits can be calculated using the procedure given in Clause 8 of ISO 5167-1:2003.

Similarly, the value of the volume flowrate 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 flowrate, which is a purely arithmetic process, is performed by replacing the different items on the right-hand side of Equation (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 Equation (1) 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.