Orifice plates and nozzles

Flow measurement using differential pressure

- Verified standardized way of measuring
- Exact measurements even for fast flowing steam and gas
- Absence of moving parts
- Robust and versatile design
- Reasonable price
Flow measurement using differential pressure

It is a flow sensor for fluids (gases, liquids and steam) based on measuring the differential pressure on the primary element. Primary element is centric orifice plate, nozzle or Venturi tube.

Measuring principle is based on the incorporation of the primary element in pipe sections where a full cross-section of fluid flows. Primary element causes differential static pressure between the front side and the back side of the primary element. The flow is then determined from the measured values of pressure changes (differential pressure), knowledge of the attributes of the flowing fluid, as well as from the circumstances in which the primary element is used.

Classic method of measuring flow through the throttle bodies is indirect: it is based on a quadratic dependence between fluid flow in pipelines and differential pressure across the throttle body built in the pipeline. The main advantages of this method are: a wide field of application, stable measurement accuracy and high reliability. The method is designed to measure Newtonian fluids (conductive, nonconductive, viscous and contaminated). By selecting the appropriate throttle body with specific conceptual solution can meet even the minimum size requirements for permanent pressure loss. It is generally known that the present method is the most appropriate way to measure the vapor flow and metering of natural gas at high operating pressures. But the advantage may also be used in many other applications.

Sensors of fluid flow series EC and ED are usually made up of three basic sections:

- Input section including required length or straight piping before the primary element
- Measuring section including a primary element in design of centric orifice plate with the relevant subscriptions pressure
- Output section including required length or straight piping behind the primary element.

Design of fluid flow sensor is in accordance with the relevant technical and installation requirements of normative documents CSN EN ISO 5167-1: 2003 and CSN EN ISO 5167 -2: 2003Orifice plates - EC type

Pic. 1 Orifice plates with pressure tappings
Use

Orifice plates are the most commonly used primary element for flow measurement based on the principle of differential pressure. It is due to their simple design, high accuracy and, last but not least, favorable price. Produced orifice plates are in accordance with the standard EN ISO 5167 – 2. Diameter range is defined by standard DN50 to DN1000.

Orifice plate can be supplied as a separate disc designed for the operating conditions. In this case, the user must ensure correct mounting and the extraction process, which is often problematic and therefore is often supplied orifice plates along with tappings (pressure or chamber) performed between flanges or welded-in. A welded embodiment is particularly suitable where there are high temperatures and pressures. Another option is to supply the test track, where is part of the pipeline.

Majority of orifice plate is centric. Inner hole must have a sharp measuring edge.

Concentric aperture is not suitable for dirty liquid. Eccentric and aperture orifice plate are designed so that particles can pass through the hole.

There are three types of subscription differential pressure - fillet, distance D before D/2 behind the orifice plate and flange offtekes where the distance from the orifice plate disk to the middle of offteke is defined as 25,4 mm.

Tappings may be terminated thread, pipe weld or flanged. It is also possible to equip condensation, cooling vessels and valves.

Orifice plates are normally manufactured from stainless steel class 17 in order to prevent corrosion, thereby changing the dimensions of the measuring part. The material may be modified based on specific application requirements. The standard allows the production of any material while maintaining the shape and dimensions in accordance with the values in it.

Calculation is performed according to ISO 5167 – 1. Typical uncertainty of uncalibrated orifice plates is + / -0.5%.

Orifice plates typically have a pressure drop of between 40 to 95% of the generated differential pressure. The actual permanent pressure loss depends on the ratio of the pipe diameter and the inner aperture.

Orifice plates can be best used for clean and non-corrosive liquids where there are sufficient stabilization piping and allowed higher pressure loss.
Orifice plate measuring track

For applications requiring high accuracy of flow measurement, it is recommended to include before and behind the measuring element stabilization pipings as a part of the measuring lines.

They can be delivered in between flanges or prepared for weld. Measuring track can be calibrated for maximum accuracy in accredited calibration laboratories.

Input section has a standard length 10D in which the pipes are machined to meet the parameters requirements of ISO 5167. Subsequent section has a standard length 4D. On request it is possible to make a track of any length.

Typical precision calibrated measuring line is in the range of 0.15 to 0.25%.

Nozzles – type ED
Use

Nozzle ISA 1932 is used for high speed, low viscous and where the risk of deterioration or destruction of normal orifice plate. Another nozzle advantage compared to the orifice plate is smaller necessity of the stabilization piping, less pressure loss, and higher throughput for the same beta ratio (d/D) - nozzle allows to measure approximately 50% higher flow rate than a orifice plate with similar computational beta and differential pressure. Nozzles are manufactured in accordance with the standard EN ISO 5167 – 3. Diameter range is defined by standard DN50 to DN500.

Nozzle consists of confusor (input section) with a rounded profile and cylindrical neck profile with a sharp finish. Its length depends on the beta ratio. The lower the ratio, the nozzle is shorter.

Fillet consumption uses either chamber or pressure tappings.

Connectivity to differential pressure tapings are the same as in the case of a orifice plate - can be terminated thread, pipe weld or flanged. It is also possible to equip condensation, seal pots and valves.

Nozzles are made of different materials, mostly of stainless steel class. 17, or from the pipe material, all depending on the specific measurement requirements, the nature of the media and so on.

Typical uncertainty of uncalibrated nozzles ISA 1932 is ± 0.8%.

Pressure loss depends on the ratio of beta and ranges between 40-95% generated by differential pressure.

The nozzle can be supplied complete with tappings and straight lengths for a welded or flanged connection.

In most cases nozzle for a custom fit uses welded joint, it is possible to fit between the flanges.

Pic. 4   Built-in nozzle for flange connection with condensing vessels
Evaluation of the measurement

for evaluating the pressure differential and conversion to the required data are used differential pressure transducers. We use transducers of the world's leading manufacturers that allow you to transfer to an accuracy of a fraction of a %. The output is a standard 4-20 mA, on customer request can be added digital communication (HART, Fieldbus, Modbus ....), local display and so on.

Limits of the use

Maximum working pressure of the medium: 40 MPa
Maximum working temperature of the medium: 560 °C
Working position: horizontal or vertical (in accordance with the principles set out in ISO 2186)

Internal pipe diameter D: 50 mm to 1000 mm
Minimum diameter of the aperture d: 12.5 mm
Diameter ratio β (d/D): 0,1 to 0,75

Marking type

Marking type is performed according to the following key:

Type/collection/connection/straight section before the orifice plate/straight section behind the orifice plate/number of valves on one branch of the impulse piping/condensate vessel/material designation of the primary element (including tappings and KN)/flange material

Example of the measuring track: EC/K/PDN50PN16B2/4X/2Y/1V/K/1.4541/1.4404

- Style (EC - orifice plate, ED - nozzle)

- Type of tappings
  - K - chamber tapping
  - B - pressure tapping
  - P - flange tapping- 1" before and behind the orifice plate
  - D - pressure tapping D before and D/2 behing the orifice plate

Note.: For B, P and D is the standard number of tappings 2 - one before and one behind the orifice plate, this case is not marked in the code. In the case of measuring track with a higher number of tappings is marking the total number of tappings - eg. P4

- Connection - determines the type of connection can follow specifying the designation
• P - between the flanges
• W - weld design
• PW - weld design, the primary element is connected between the flanges (they are supplied with seals and are from the same material as the connecting pipe)

- XX - indicates the length of the straight section before the orifice plate in multiples of D - comes with a measuring line straight section 2D before orifice plate - marking 2X

- YY - indicates the length of the straight section before the orifice plate in multiples of D - comes with a measuring line straight section 2D behind orifice plate - marked 2Y

Note.: If separate orifice plate/nozzle is supplied the marking of the straight lengths is omitted and replaced by that design:

- N - along with tappings in a standard width of 60mm for the connection between flanges
- P - separate disc
- 1V - indicates the number of valves on one branch of impulse piping - by default, each branch is equipped with one valve for PN <63, two valves for high pressure

- K - indicates impulse pipe fitting of the condensing vessels for measurement eg. flow of steam. If this marking is not in the code, measuring track condensing vessels does not contain

- Material of primary element (common and other accessories)

- Material Flange

**Ordering**

Before ordering, ask for our offer. We will need the following information:

• type of device
• flow rate to be measured during the operation (max, min)
• medium
• pipe material, material of the primary element
• flange design
• pressure
• temperature
• requirements at the transmitter output
• term of supply
• quantity