ABB MEASUREMENT & ANALYTICS | APPLICATION NOTE

VortexMaster and SwirlMaster

Natural gas measurement in power plants, boilers and incinerators

Highly accurate natural gas measurement through integrated calculation methods.
In accordance with ISO 12213-2 (AGA8 DC92) or ISO 12213-3 (SGERG 88, AGA8 Gross Method 1)

Measurement made easy

VortexMaster and SwirlMaster
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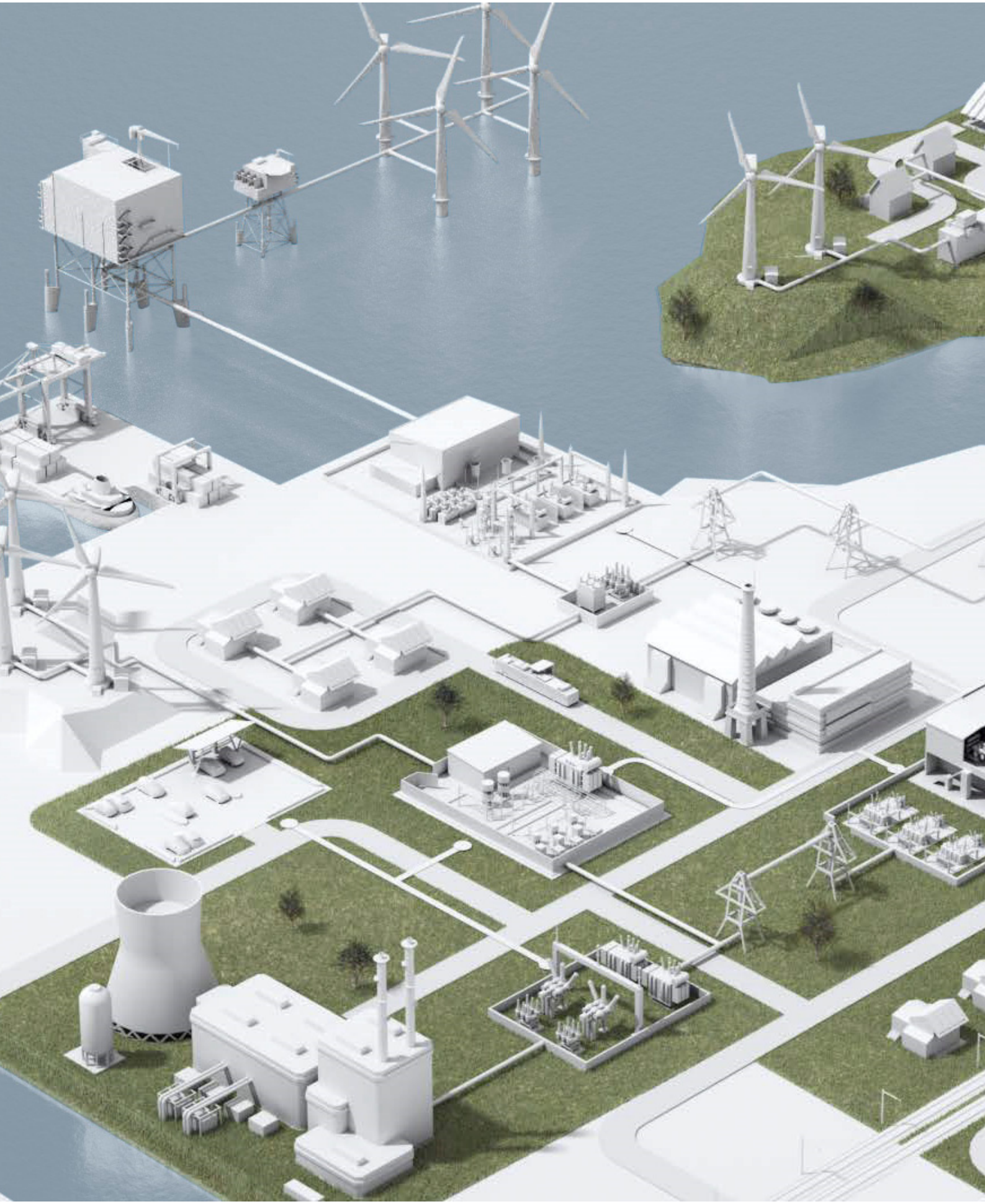
Introduction

Natural gas as a fossil fuel is used in many applications such as gas or steam turbines for power generation or as direct fuel in process boilers, furnaces or in the production of hot water. Compared with other fossil fuels, natural gas is considered clean as its combustion results in fewer residues and lower carbon dioxide emissions.
Due to legal requirements such as ISO 50001 for monitoring the energy efficiency of power plants, it is increasingly important to measure and record the energy flows in installations.

Natural gas is a naturally occurring mixture of gaseous hydrocarbons with varying compositions which can vary widely even after the gas treatment, depending on the origin.

The major component of natural gas is methane which is also the energy source of the gas. Further constituents are longer chain hydrocarbons, carbon dioxide, nitrogen, hydrogen sulfide, ethane, propane, butanes, pentanes, carbon dioxide and water vapor.

Due to the varying compositions an accurate measurement is very challenging. Measuring systems, such as thermal mass flowmeters, which are often used in the burner control because of their high measurement dynamics react strongly to different compositions with measurement errors of up to ±5 %. Therefore, a measurement method is preferred that, regardless of the gas composition, delivers accurate and reliable measuring results.



VortexMaster and SwirlMaster

Natural gas measurement in power plants, boilers and incinerators

— 01 Interior view of a vortex flowmeter

— 02 Operating principle of a vortex flowmeter

Solution

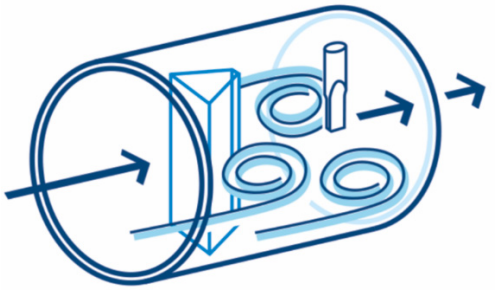
The vortex and swirl flowmeters of the latest generation offer a good alternative. They are highly accurate and completely independent from the measuring medium and provide, when sized appropriately, measurement dynamics that are fully sufficient for these applications.

Pressure and temperature effects are compensated in the device, whereby the gas flow is measured and shown in standard units. Generally for process gases, the compensation of pressure and temperature is performed through a calculation formula for ideal gases (according to Gay-Lussac).
The accuracy of the measurement and conversion is improved by specific procedures for the natural gas calculation in accordance with ISO 12212-2 / AGA8 or ISO 12212-3 / SGERG88. Internal counters simultaneously totalize the measured operating volumes and the calculated standard volumes that are compensated to standard units, and show them via HART, Modbus communication or LCD display.
ABB as a systemic manufacturer offers all the necessary components which can be delivered preconfigured if so requested.

Instrumentation

Vortex flowmeters

The vortex flowmeter VortexMaster works according to the vortex frequency principle. A solid body, also called "bluff body", is introduced into the flow. On the bluff body, vortex sheddings occur whose frequency is directly thereafter detected with a piezo sensor.



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Over a wide Reynolds numbers range, this frequency is directly proportional to the flow velocity. The exact ratio will be determined on the test bench individually for each flowmeter and deposited in the device in the form of calibration factors. Using flow velocity and pipe cross-section the volume flow rate is calculated.

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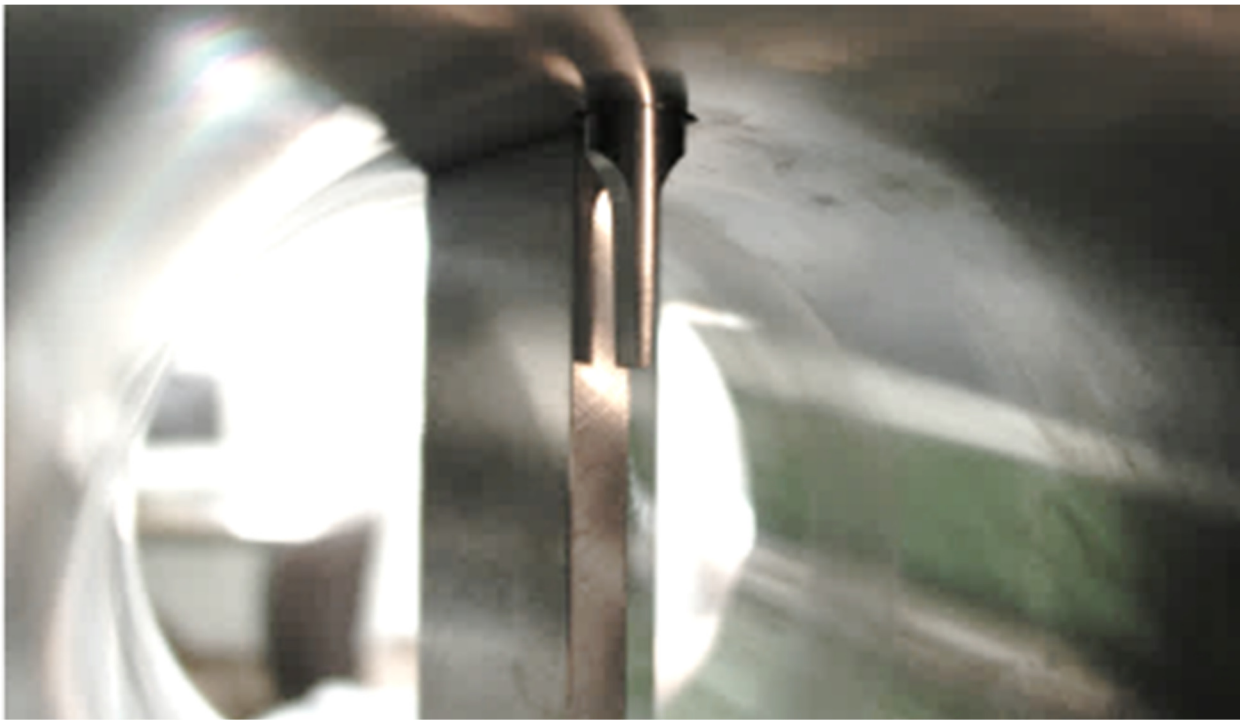

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01 Operating principle of a swirl flowmeter

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02 Cross section of a swirl flowmeter

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03 SwirlMaster installed without straight inlet and outlet sections

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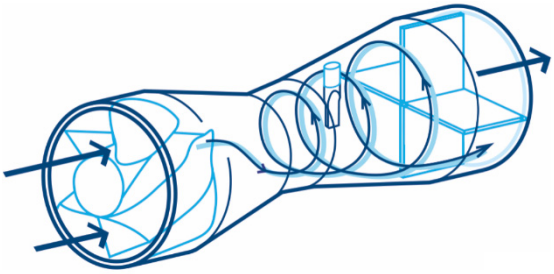
04 Examples of installations with inlet and outlet sections

Swirl flowmeters
The swirl flowmeter SwirlMaster operates on a similar principle. Instead of a bluff body a fixed rotary body, called “inlet guide body” is used which causes the measuring medium to rotate. Here, the rotational frequency is decisive for determining the flow velocity.



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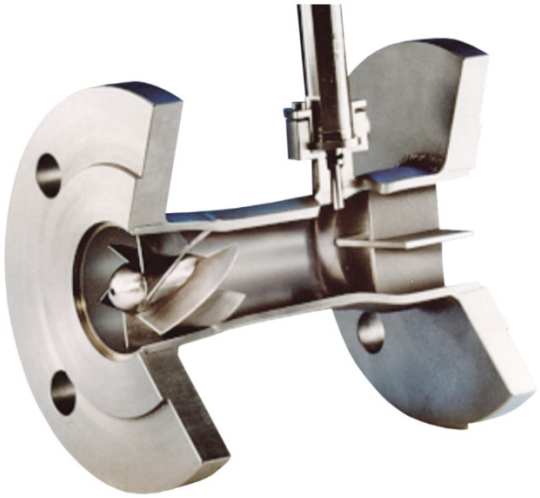
The swirl measurement method is characterized by higher accuracy and less sensitivity to disturbances in the flow profile, thereby requiring significantly shorter inlet and outlet sections.



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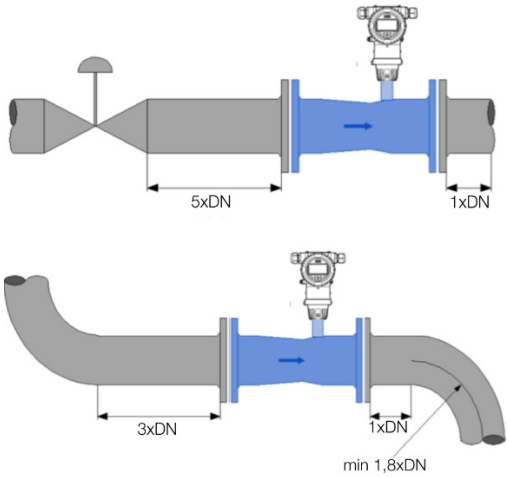
Another advantage of this measurement method are the measuring ranges of the nominal diameter. These are designed for today's industry standard medium velocity of about 1.5 to 60 m/s, and therefore offer very good measurement dynamics. This makes pipe reductions in the upstream and downstream sections often unnecessary.



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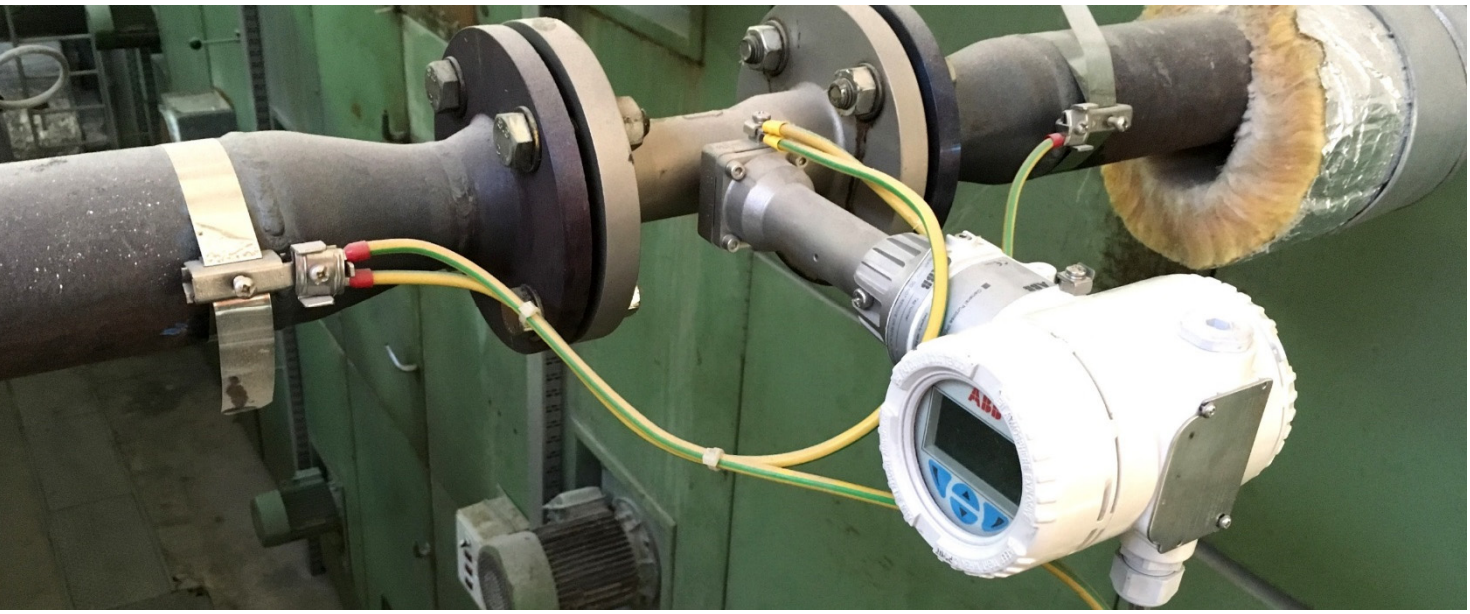
Depending on the involvement in the process, versatile installation options emerge:

- No pipe reductions are necessary
- No additional flow straightener is required
- 3 x DN inlet / 1 x DN outlet section sufficient or even no inlet / outlet section required
- Installation 5 x DN possible after control valves



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01 Installation example with remote pressure transmitter

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02 Legend

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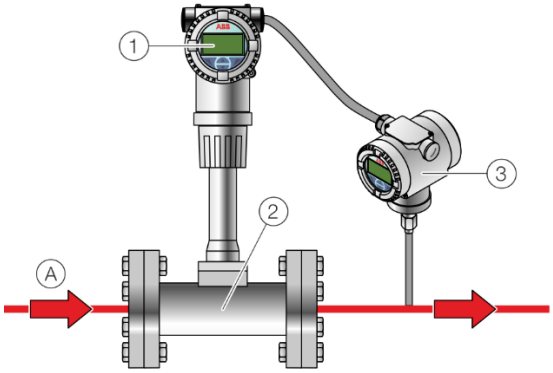
03 VortexMaster- / SwirlMaster transmitter with connected sensor for pressure compensation

Functionality

VortexMaster as well as SwirlMaster primarily measure the operating volume flow. The measured operating volume considers neither the pressure nor the temperature of the measuring medium. In general, the user is, however, especially with natural gases, interested in the measurement of the standard volume or the mass. The conversion can take place directly in the flowmeter if the necessary state variables are measured or known. Depending on which measured variable is to be calculated, VortexMaster and SwirlMaster can be configured using the multi-variable measurement of volume flow and temperature, and taking into account the operating pressure. At constant pressure, or if the pressure is read via the flow input (type FSx450) or HART, the integrated flow computer can calculate and show the following measured variables using the integrated state equations and tables according to internationally accepted standards:

- Volume flow
- Mass flow
- Standard volume flow



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Pos.	Description
A	Measured medium
1	Flowmeters VortexMaster / SwirlMaster
2	Integral temperature sensor
3	Remote transmitter for absolute or gauge pressure

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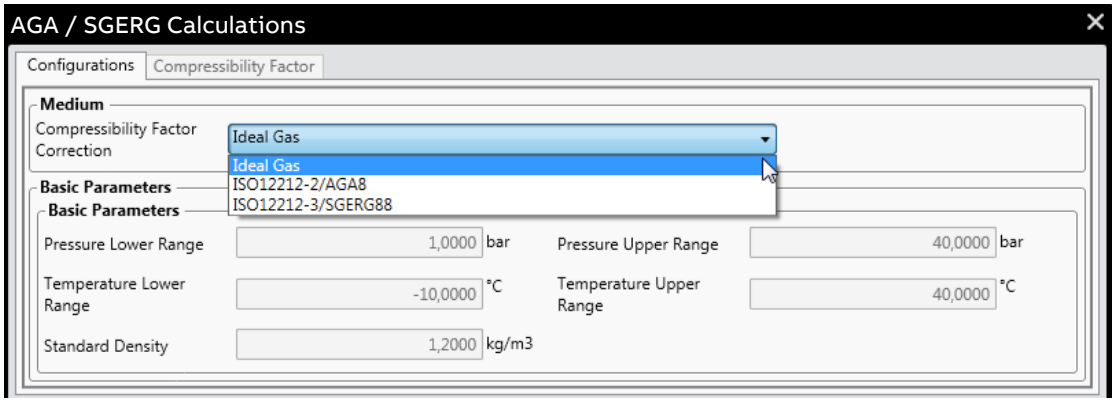
The equations stored in the transmitter to calculate the compressibility and thus the density and the mass flow of natural gas can be selected and parameterization by the user. The following standards are available:

- ISO 12213-2 (includes AGA8-DC92)
- ISO 12213-3 (includes SGERG-88 and AGA Gross Method 1)

Both calculation methods require a different number of process and gas parameters. To ensure the accuracy and clarity, the parameter input is easily performed using the DTM or EDD.

— 01 Selection screen of the calculation method in the Field Information Manager (FIM tool)

— 02 Input screen for the gas composition for the calculation in accordance with AGA8 in the Field Information Manager (FIM tool)



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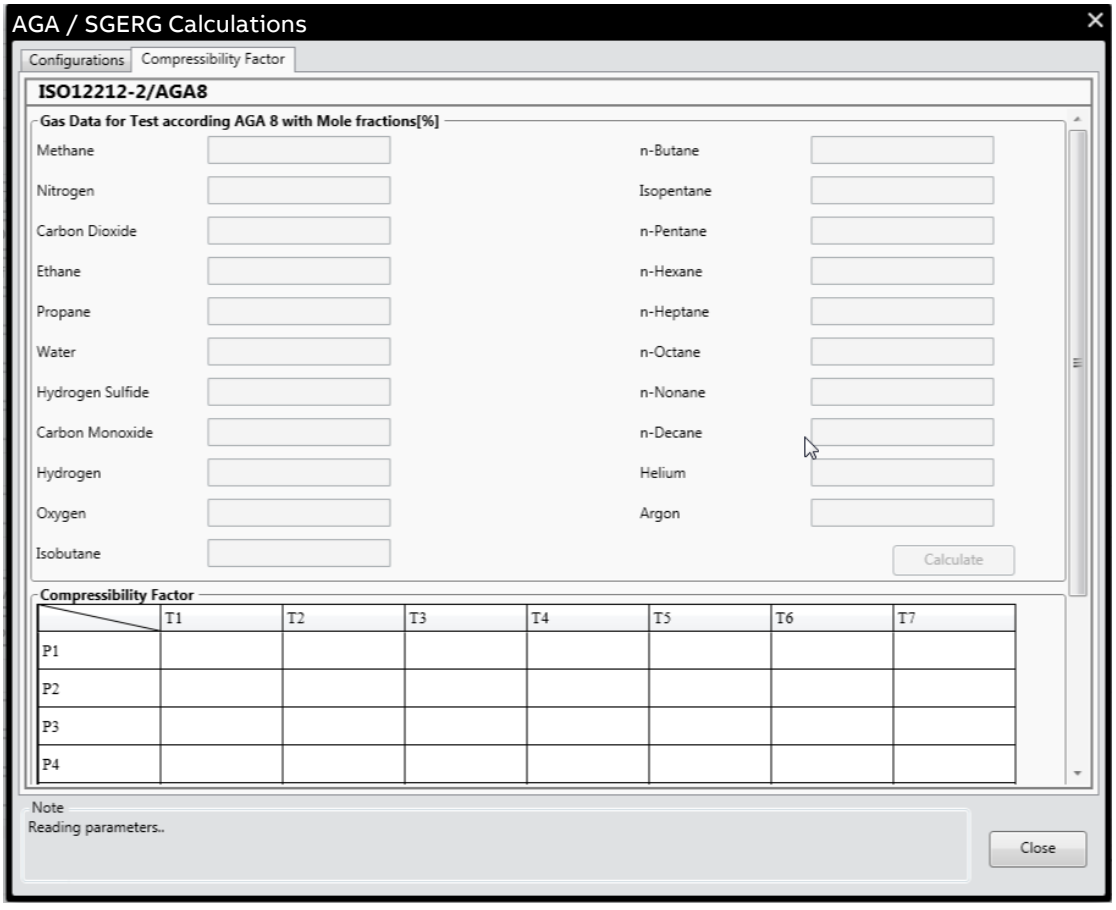
Here the calculation methods can be selected or changed. Using the "Basic Parameters", a scope for the process parameters pressure and temperature is defined. The operating data should be within this scope, whereby it can be chosen generously. In the example shown, the pressure can vary between 1 bar (absolute) and 40 bar (absolute) and the temperature between -10 °C and +40 °C.

Based on the gas composition and the previously defined limits for the operating conditions, the compressibility factors are calculated and stored in a table in the device. Based on current pressure and current temperature the correction factor valid for the application is calculated in the device is included into the gas equation.



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01 VortexMaster FSV400

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02 SwirlMaster FSS400

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	VortexMaster FSV400	SwirlMaster FSS400
Accuracy gases / vapors	± 0.9 % of measured value	± 0.5 % of measured value
Process connections / nominal diameters	Flange: DN 15 ... 300	Flange: DN 15 ... 400
	Wafer type: DN 25 ... 150 (65 mm installation length)	
Temperature range (Medium)	Standard: -55 ... 280 °C (-67 ... 536 °F) High temperature version: 55 ... 400 °C (-67 ... 752 °F)	Standard: -55 ... 280 °C (-67 ... 536 °F)
Transmitter housing	Aluminum, optional stainless steel 316	
Ex-certificates	IECEx, ATEX, NEPSI Zone 0/1/2/20/21, cFMus Class 1 Div 1 / Zone 0/1, cFMus Class 1 Div. 1 and Zone 0/1	IECEx, ATEX, NEPSI 0/1/2/ Zone 20/21/22 Certificates, cFMus Class 1 Div 1 / Zone 0/1
Communication	HART 7 or Modbus RTU-RS485 with 1200, 2400, 4800 or 9600 bps	
Outputs	4 ... 20 mA / HART or Modbus, digital output for pulses, frequency up to 10 kHz or contact output	
Input signals from external sensors	Pressure, temperature, density, methane content	
Unobstructed straight inlet section	15 x DN	3 x DN
Outlet section	5 x DN	1 x DN
Pressure measurement	3 x DN ... 5 x DN behind the flowmeter	

Technical data

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For the most accurate measurement of the volume flow in natural gases, the SwirlMaster FSS450 with internal temperature and pressure compensation in connection with the compression factor correction is ideal. The VortexMaster FSV450 provides a cheaper alternative to an accuracy of 1 % of the measured value in relation to the volume flow.

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