ABB FLOW APPLICATION

Steam Balancing with the VortexMaster and SwirlMaster

Introduction

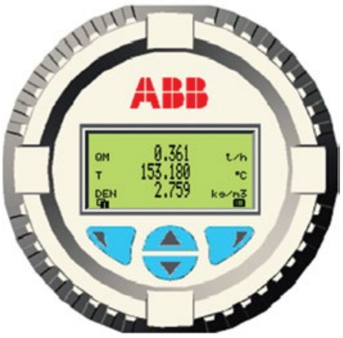
Calculating mass and energy flow without installing additional heat computers

Steam is used in nearly all industries for transmitting energy or for cleaning purposes. In times of limited resources and rising energy prices, economic and optimal usage of energy sources is becoming increasingly important.

The necessary prerequisite for this is reliable measurement of the amount of energy. This can only be achieved by accurately measuring the volumes, taking the parameters of temperature and pressure into account.

Functionality

The **VortexMaster FSV450** and **SwirlMaster FSS450** flowmeters not only offer the possibility of processing the pressure and temperature effect in the device, but also simultaneously perform the complex calculations of mass flow and energy flow and provide internal counters for these process variables.



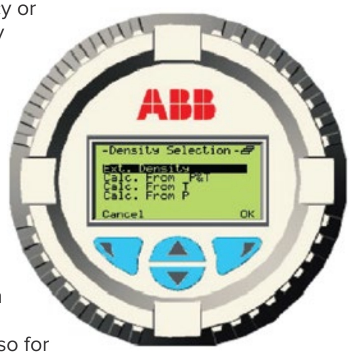
In addition to energy usage, steam consumption is also counted in mass and volume units. The current counter values are made available online to users via a HART communication. This allows e.g. evaluations of the energy efficiency to be carried out at any time.

In addition to the 4-20mA / HART current output, the devices offer a binary output, which means the energy flow can also be processed as a pulse value or standardised frequency in a control system.

Vortex and swirl flowmeters use a vortex frequency procedure to measure the volumes and operating conditions in the traditional sense.

In the case of the VortexMaster, the medium is swirled over a defined swirl body in a targeted manner. With the SwirlMaster, the medium is rotated by an inlet guide body.

This measurement method is characterised by increased accuracy and lower sensitivity to disturbances in the flow profile. This means significantly shorter inlet and outlet sections are required.



The detected vortex frequency or rotational frequency is directly dependent on the flow velocity in the device. An integrated temperature sensor in the flowmeter also detects the steam temperature.

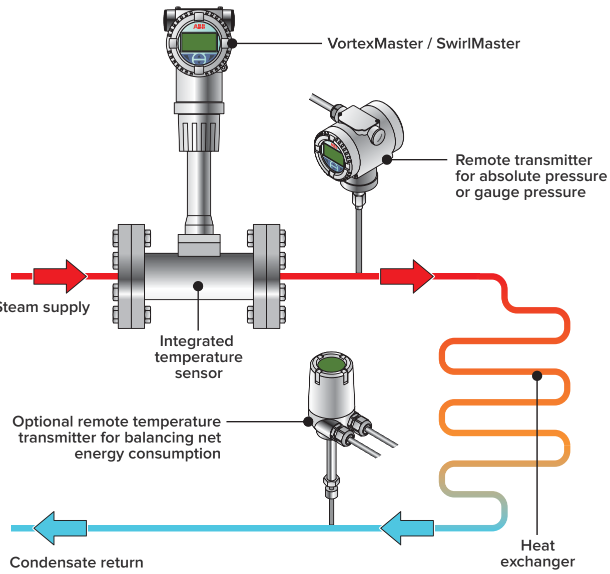
For saturated steam measurement, these two measurements would be perfectly adequate to perform mass or energy balancing. For overheated steam, and also for monitoring the steam state (wet steam/ saturated steam/hot steam), the pressure in the piping also needs to be considered. The flowmeter can therefore correctly detect the steam state, precisely calculate the density and energy content of the steam. If there is a wet steam state, the flowmeter warns the user via the LCD display and HART communication.

The user should avoid wet steam states, because the water that condenses from the steam is deposited on the piping, where it collects and often leads to damaging water hammer effects in the system.

As an accurate measurement of the proportion of steam and condensate is not possible in this scenario, the integrated measurement computer performs calculations using saturated steam values based on the internal temperature measurement.

Energy flows are calculated in accordance with IAPWS standards (The International Association for the Properties of Water and Steam).

Typical installation for measuring medium temperatures of up to 280°C



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User Benefits

The integrated solution described overleaf has these advantages:

- Minimal installation costs
- Elimination of external temperature measurement via a separate transmitter and power supply unit
- Full saving of costs for the external measurement computer, including installation costs
- Increased system accuracy by directly applying the provided pressure measuring signal, which is usually already available for safety purposes
- Direct detection of the steam state and warning of wet steam states where the proportion of steam and condensate cannot be measured accurately

VortexMaster vs SwirlMaster

	VortexMaster FSV450	SwirlMaster FSS450
Accuracy gases/vapours	±0.9% of measured value	±0.5% of measured value
Process connections/nominal diameters	Flange: DN 15 to 300	Flange: DN 15 to 400
	Wafer type: DN 25 to 150 (65mm installation length)	
Temperature range (medium)	Standard: -55 to 280°C (-67 to 536°F) High temperature version: 55 to 400°C (-67 to 752°F)	Standard: -55 to 280°C (-6 to 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 to 20mA / 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 to 5 x DN behind the flowmeter	

Example Calculation

Initial state:

Description	Value
Saturated steam absolute pressure	6 bar (290psi)
Temperature	159°C
Resulting density for the mass calculation	3.1817kg/m3

Change of state - overheating of the steam to avoid condensate build-up:

Description	Value
Overheating	2°C
Resulting density for the mass calculation without consideration of the pressure	3.3383kg/m3
Resulting density error or measurement error	5%

Additional charge calculation based on a 5% measurement error:

Description	Value
Sample costs	£60 / MWh
Energy flow	3 t/h = 2300kW
Piping	DN 100
Load	50%
Additional charges resulting from the 5% error - density error or measurement error	£5000/month

Pressure measurement and compensation will ensure the steam state is monitored reliably and correctly and the errors shown are virtually eliminated.

The 0.5% increase in accuracy when using SwirlMaster as compared to traditional vortex flowmeters can mean saving up to £500 per month in the case of the example described. The slightly higher investment costs for this technology will therefore be amortised in the first few months after commissioning.

VortexMaster installed in an insulated steam pipe

Balancing net energy consumption is also possible if energy from the process is transmitted back in the form of condensate. Here, the transmitter directly calculates the energy that is used by the process. For this purpose, a remote temperature transmitter can be connected to the flowmeter along with the existing pressure transmitter, either via HART communication or a passive analogue 4 to 20mA signal.