ABB MEASUREMENT & ANALYTICS | APPLICATION NOTE

Steam balancing in the food and beverage industry

Swirl flowmeter for energy measurement

Determine energy from steam flows – Swirl flowmeter for installation with nearly no steadying lengths and an integrated energy calculator.

Measurement made easy

SwirlMaster FSS400

Introduction

If you hear the word steam, a pressure cooker or the water vapor you see when you boil an egg for breakfast immediately comes to mind. If you have already come into direct contact with steam at least last once, you know that large amounts of energy are transferred with it.

To this end, steam is also used in places like breweries. The various process steps need thermal energy which is transferred in the form of steam. A central boiler generates the steam which is transferred through piping to the parts of the installation. Energy in the form of heating oil or gas is needed to generate the steam.

In times of sustainability and increased awareness of energy usage, the steam should be supplied at a high level of efficiency.

In many installations, energy management systems are used already today to determine and optimize individual consumers and the total energy requirement.

Be it in breweries for the brewhouse or bottling, in dairy plants or in industrial bakeries, steam is used and the volumes need to be measured.

Depending on the size of the operation, it could very well make sense to monitor individual process steps and implement benchmarking.

First though, you need to get an idea of the actual consumption. To do that, a variety of measurement technologies and equipment will be used. In the following text, we will focus on a variant using a swirl flowmeter.

The problem

— 01 SwirlMaster measuring principle

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

The determination of the different steam volumes for the individual consumers often needs to be made in existing installations. In such cases, pipe runs are not always suited for measuring devices with long inlet and outlet sections. Any changes to pipe runs are costly and should therefore be avoided.

In addition to the flow rate process variable and depending on the steam state, it may be necessary to measure additional parameters, such as pressure or temperature.

This is the only way to distinguish between wet steam, saturated steam and overheated steam and determine the correct density.

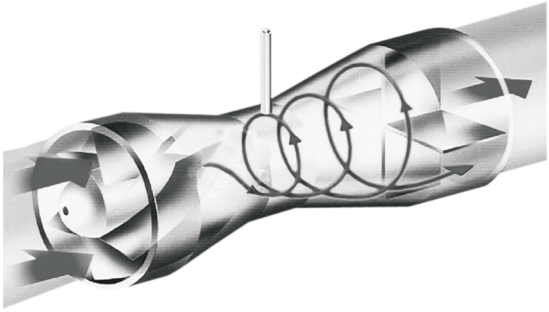
Density is absolutely necessary to measure mass and energy flow.

Yet you do not always have a central control cabinet available which can accommodate a computer to calculate process variables.

The solution

The SwirlMaster FSS400 from ABB is a solution to address the requirements mentioned above.

The device is related to the better-known vortex flowmeters.
Vortex flowmeters use a vortex frequency procedure to measure the volumes and operating conditions in the traditional sense.
The medium is swirled through a defined bluff body in the process.



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However, in the SwirlMaster the medium is deliberately set in rotation through an inlet guide body. This measurement method is characterized by increased accuracy and lower sensitivity to disturbances in the flow profile.

This in turn allows for shorter inlet sections typically 3 DN and outlet section 1 DN.
These values cannot be achieved using vortex flowmeters and they allow for a significantly easier integration of the SwirlMaster FSS400 in existing piping, even with confined spatial conditions.

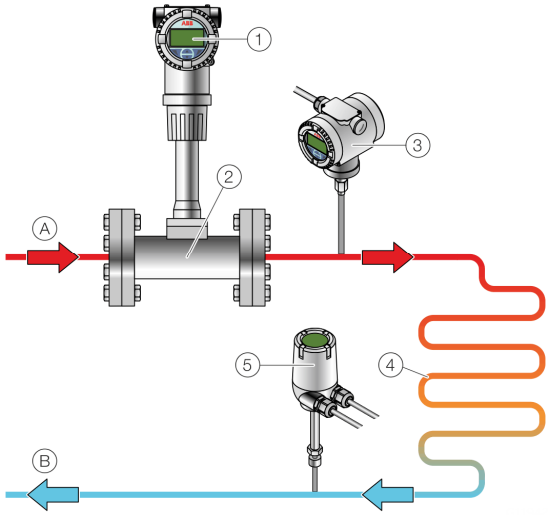
The detected rotational frequency is directly dependent on the flow velocity in the device.
An integrated temperature sensor in the flowmeter also detects the steam temperature.
For saturated steam measurement, these two measurements would be perfectly adequate to perform mass or energy balancing.

For overheated steam, and also for monitoring the steam state (wet steam / saturated steam / superheated 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 and warn the user if there is a wet steam state.
The wet steam state should be avoided, since it can lead to problems due to water hammer effects.

Energy measurement

Two operating modes are available for energy calculation in accordance with the international standard.
During the net consumption measurement, the energy flowing back as condensate is subtracted from the supplied energy volume.



A Steam supply
B Condensate return
1 SwirlMaster FSV400
2 Integrated temperature sensor
3 External pressure transmitter
4 Heat exchanger
5 Optional temperature transmitter for balancing net energy consumption

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Alternatively, the device can also identify the energy volume flowing through the device and thus determine the emission to open systems.
The measuring accuracy of the flowmeter naturally plays an important role when recording the energy volumes.
With a measured error of 0.5 %, the SwirlMaster sets standards here. Vortex flowmeters typically have a value of 1 %.
The effects of this difference are shown in the following example for saturated steam at 6 bar abs and 159 °C:

Additional cost calculation 0.5 % measurement error:	
Sample costs	€60 / MWh
Energy flow	3 t/h = 2300 kW
Piping	DN 100
Load	50 %
Additional costs resulting from a 0.5 % measurement error	€500.00 / month

Parameterization made easy
Naturally, the device is governed by the ABB common operating concept for measuring devices.

The use of HART communication for parameterization is also possible.

This can be done easily and quickly using the ABB Field Information Manager (FIM-tool).

Safe operation
Solutions for device verification of installed equipment are also available for the SwirlMaster. This offers the possibility of always being up to date on the device state, therefore allowing for predictive maintenance.

The electronic unit of the SwirlMaster FSS400 is backwards compatible and can also be used in older-design devices with upgrade kits.

Application advantages

The SwirlMaster FSS400 offers the user a number of ways to simplify steam measurement:

- Easy integration in existing installations thanks to short in- and outlet sections
- Operational safety thanks to verification and the option to upgrade older devices
- Simplified energy recording thanks to integrated computation functions; no additional devices for calculation are needed.
- Only one device for safe saturated steam energy measurement with the use of the integrated temperature sensor reduces the costs of cabling and installation.
- Integration of existing pressure sensors through 4 to 20 mA possible
- High measuring accuracy for steam measurement
- Easy operation in accordance with ABB common operation concept

ABB Limited
Measurement & Analytics
Howard Road, St. Neots
Cambridgeshire, PE19 8EU
UK
Tel: +44 (0)870 600 6122
Fax: +44 (0)1480 213 339
Email: enquiries.mp.uk@gb.abb.com

ABB Automation Products GmbH
Measurement & Analytics
Schillerstr. 72
32425 Minden
Germany
Tel: +49 571 830-0
Fax: +49 571 830-1806

abb.com/flow

ABB Inc.
Measurement & Analytics
125 E. County Line Road
Warminster, PA 18974
USA
Tel: +1 215 674 6000
Fax: +1 215 674 7183

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