ABB MEASUREMENT & ANALYTICS | WHITE PAPER

CoriolisMaster - Coriolis mass flowmeter

ABB Enhanced Coriolis Control (ECC)

The CoriolisMaster solution for 2-phase applications and demanding measuring media

Measurement made easy

CoriolisMaster FCH400
CoriolisMaster FCB400

Introduction

One of the most common reasons for measuring errors in Coriolis mass flowmeters is the measurement of liquids with significant gas content.

ABB Enhanced Coriolis Control (ECC) offers new regulation and filter methods to keep the measurement signal as stable and precise as possible, even in difficult conditions.

Additional Information

Additional documentation on CoriolisMaster - Coriolis mass flowmeter is available for download free of charge at www.abb.com/flow.
Alternatively simply scan this code:

The problem

— 01 Homogeneous gas distribution (left) and inhomogeneous distribution / surge (right)

One of the most common reasons for measuring errors in Coriolis mass flowmeters is the measurement of liquids with significant gas content. Why is this the case?

The reason lies in the measuring principle. Coriolis mass flowmeters cause the meter tubes to vibrate, so the medium to be measured flows through the meter tubes and the flowmeter utilizes a universal physical effect:

> Every mass moving in a moving system experiences a Coriolis force and is deflected.

In the case of Coriolis mass flowmeters, the vibrating pipes are deflected and the vibration at the inlet of the device is phase-shifted at the outlet of the device. The size of this phase shift is proportional to the mass flow of the medium.

It's clear so far, but how do gas bubbles make things so difficult in this context?

Each modern Coriolis mass flowmeter has a specific amount of energy available to make pipes vibrate and to keep them vibrating.

This is best achieved when the pipes together with the contained medium vibrate in the resonance frequency. A change in the density of the fluid changes the resonance frequency of the pipes, an effect which is more or less incidentally used to measure density.

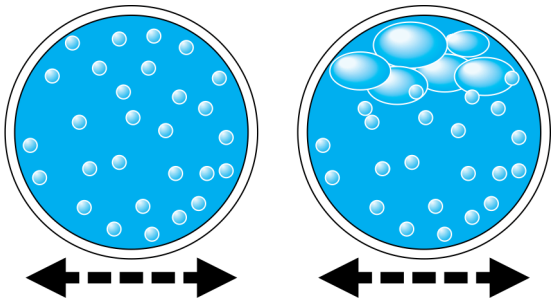
In the case of gas bubbles in the medium, two effects can now occur:

- For one thing, gas bubbles damp the vibration, since they absorb energy due to the compressibility of gas.
- Yet on the other hand, they change the density of the medium in the pipe and with it, the resonance frequency.

If the pipes no longer vibrate in resonance, substantially more energy is needed to maintain the vibration.

Given the additional damping and higher energy needs, the devices quickly reach their limits. Not only do significantly higher inaccuracies occur, but also the measurement can be completely stopped.

If in addition the gas content is not homogeneously distributed, but rather conglomerates or occurs as a surge, the impacts are all the more serious.



01

In addition to issues with gas content, it's easy to imagine that the quickly changing densities of liquids, be it due to high solid material content, rapid changes of empty conduit states or full pipe states or other corresponding density changes, can also have a negative effect on the stability of the vibration and can also bring about measuring errors.

Basically, these problems can be alleviated by applying four different approaches:

1. Avoid such issues at the outset by introducing appropriate measures in the process.
2. Apply significantly more energy to maintain the vibration of the pipes.
3. Rapidly re-adjust of the resonance frequency in the Coriolis device.
4. Use modern filtering technologies with the measurement signal.

Approach (1) is certainly the ideal way to go and is always the best method. However, if this should not be possible, the other methods remain as an option, whereby applying increased energy (2) is usually prohibited in explosion proof areas or requires very costly mechanical protection.

Therefore, this leaves us with approaches 3 and 4 in a modern Coriolis mass flowmeter.

ABB Enhanced Coriolis Control – ECC

— 02 Vibration control in a Coriolis mass flowmeter

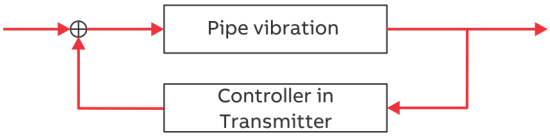
— 03 New ECC control system

— 04 Breakdown of vibration amplitude with gas content in the measuring medium

— 05 Density measurement with standard approach (black) and with use of ECC (red)

In a modern Coriolis mass flowmeter, the pipe vibration of the device is controlled by a control algorithm and the frequency of the vibration is always maintained in the resonance point.

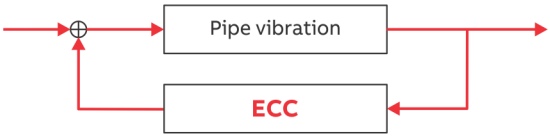
The analog measured values are digitized in the process and correspondingly prepared in a DSP.



02

In the case of gas bubbles, the control system may not be able to re-adjust the resonance frequency fast enough, leading to breakdowns in the amplitude of the vibrations as illustrated in Figure 04.

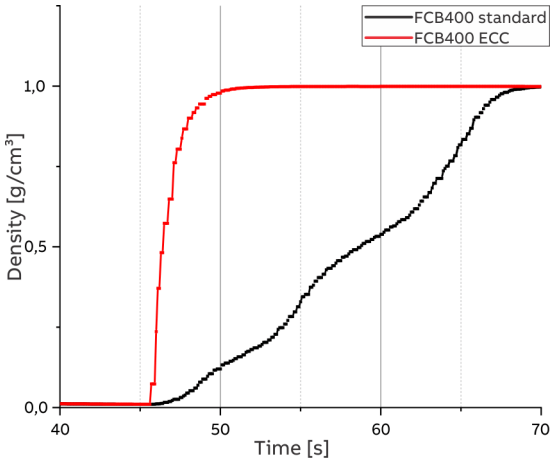
Following years of research and development with 'ECC', ABB is now introducing a new considerably quicker and improved form of frequency control.



03

Thanks to state-of-the-art control strategies, we manage to quickly control the vibration that always maintains resonance frequency in the pipes and other difficult conditions.

Since the vibration always remains in resonance, a minimum amount of energy is always needed, and even with gas bubbles or in other difficult conditions, there is always a sufficient energy reserve available to guarantee precise and stable measurement.

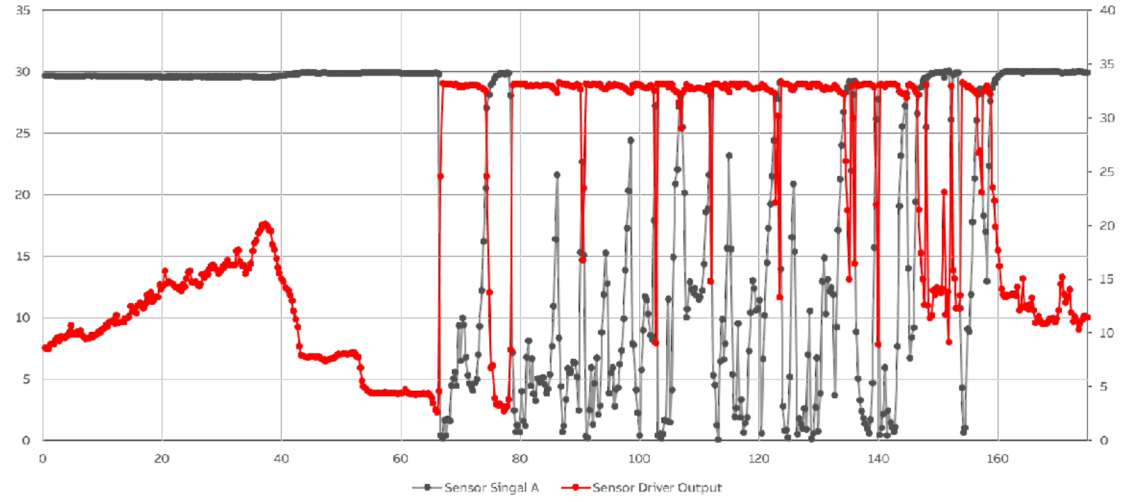


05

You can see the difference in Figure **05**:

The transition from empty conduit to a water-filled pipe takes considerably longer with the standard approach than with the new ECC solution.

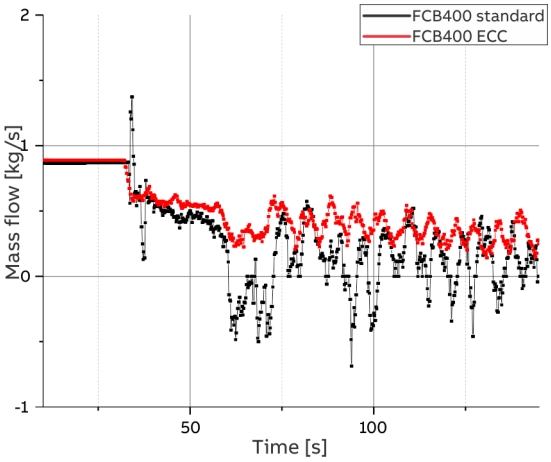
This means that not only will measurement behavior with gas content significantly improve, but density measurement will also be extremely quick.



04

… ABB Enhanced Coriolis Control – ECC

Due to these improvements and the energy reserves associated with them, measurements with gas content will considerably improve.



06

— 06 Mass measurement with standard approach (black) and with use of ECC (red)

— 07 ECC Filter technology

ECC – new filter methods

In addition to the new control system described in the previous section, the ABB ECC package offers new control and filter methods to keep the measurement signal as stable and precise as possible even in difficult conditions.

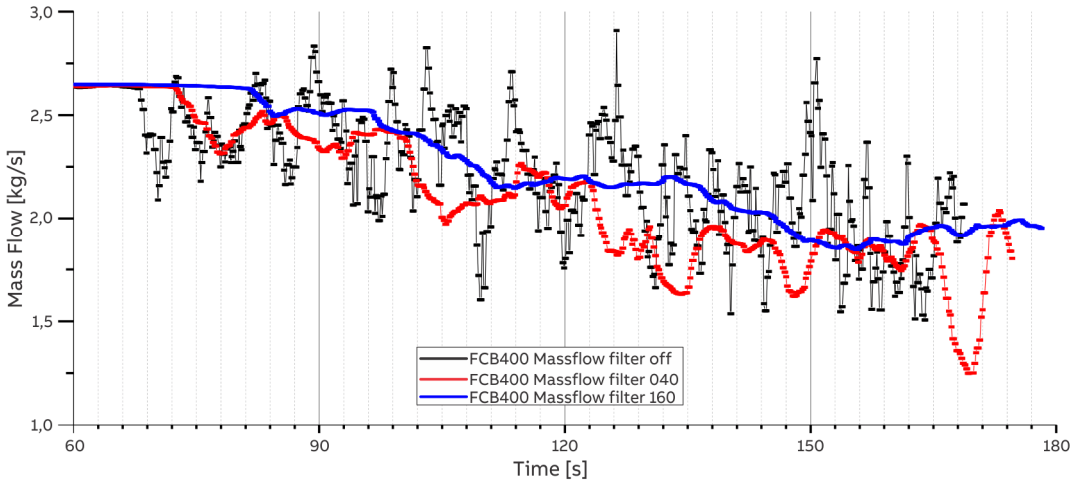
In time intervals that can be set by the user, the filters assess the measurement signals and select the most probable value. All other, mostly implausible values, are rejected.

The following time intervals are available for selection.

Filter 1	0.5 sec
Filter 2	1.0 sec
Filter 3	2.0 sec
Filter 4	4.0 sec
Filter 5	8.0 sec

In the process, unsteady measurement signals, caused by significant gas content, rapidly changing solid material content in liquids, or occurring during gas measurements with fluctuating pressure or gas density, can be considerably stabilized and therefore make them usable for process control or for evaluations.

The special advantage of the filter technology is in the fact that filtering is not achieved with the usual signal inertia of a damping, but rather a high dynamic is preserved.



07

ECC – Typical application fields

Application	Description	Sectors
Fillings	ECC considerably boosts accuracy during fillings with significant surge content at the beginning and end of the fill cycle.	Oil & Gas, Chemical, Food & Beverage, Paper and others
Multi-phase materials	ECC significantly increases accuracy in media with significant gas content or fluctuating solid material content.	Oil & Gas, Chemical, Food & Beverage, Paper and others
Flow measurement at the wellhead	ECC considerably increases measuring accuracy in typical multi-phase materials composed of gas content, liquids and solid materials.	Oil & Gas upstream
Quick filling	Due to the particular speed, the measuring system with ECC is especially suited for quick filling.	Chemical, Food & Beverage and others
Quick density changes	In liquids with quick density changes, ECC enables significantly quicker and therefore also more accurate density measurement.	Chemical, Food & Beverage and others
Demanding gas measurements	The use of special filter technology provides an exceptionally stable measurement signal, without the need to accept the inertia disadvantages of usual damping.	Oil & Gas, Chemical and others

Notes

Notes

ABB Measurement & Analytics

For your local ABB contact, visit:
www.abb.com/contacts

For more product information, visit:
www.abb.com/flow

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WP/CORIOLIS/ENHANCED_CORIOLIS_CONTROL-EN Rev. A 02.2021