ABB MEASUREMENT & ANALYTICS | WHITE PAPER

CoriolisMaster mass flowmeter

Diagnostics, verification and proof test

Automatic in situ verification of accuracy for CoriolisMaster mass flowmeters.

By Frank Frenzel and Reinhard Poft

Measurement made easy

Using ABB's VeriMass technology for self-calibration of CoriolisMaster mass flowmeter

Introduction

Users often question whether their measuring devices are working properly and within specified measurement accuracy. The new CoriolisMaster flowmeter models by ABB include technology for integrated online diagnosis and accuracy verification. This technology constantly monitors the oscillating meter tube within the flowmeter for erosion and coating deposits.

Self-monitoring technology avoids costly downtime needed for proof testing and provides other significant cost savings. It permits compliance with increasingly strict quality standards and legal requirements for verification of flowmeter accuracy.

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01 Oscillating meter tubes inside a Coriolis flowmeter

Coriolis and VeriMass technology

Aside from measuring highly accurate mass fluid flowrates, the Coriolis technique offers numerous other advantages. The Coriolis metering principle is independent of the fluid's density, temperature and conductivity, making it very flexible to use. It's also independent of the flow velocity profiles. So, it does not require upstream and downstream straight runs of piping. As a bonus, the flowmeter provides a measurement of fluid density within the tubes. It also includes a temperature sensor to compensate for dimensional and elasticity changes of the tubes with fluid temperature. Lastly, these flowmeters can measure nearly zero flow, where other measurement methods don't work or result in significant measurement errors.

Self-monitoring capabilities greatly augment the above capabilities. The special metering tubes within the CoriolisMaster flowmeter are mechanically balanced. Balancing the meter tubes minimizes the energy for their oscillation. The amount of energy required is reflected in the electric current needed to drive the tube oscillations.

Each measuring device leaves the factory with extremely well-balanced meter tubes and minimized driver current consumption.

Any mechanical change of the meter tubes caused by erosion or deposit formation affects the balancing of the meter tubes. This leads to higher driver currents to maintain the same level of oscillation. This fundamental principle, called VeriMass technology, can be used to detect tube changes and can serve as in-situ verification of accuracy. Imbalances of the meter tubes most frequently cause measured value errors. The detection of these factors constitutes a major step in Coriolis mass flow measurement technology.

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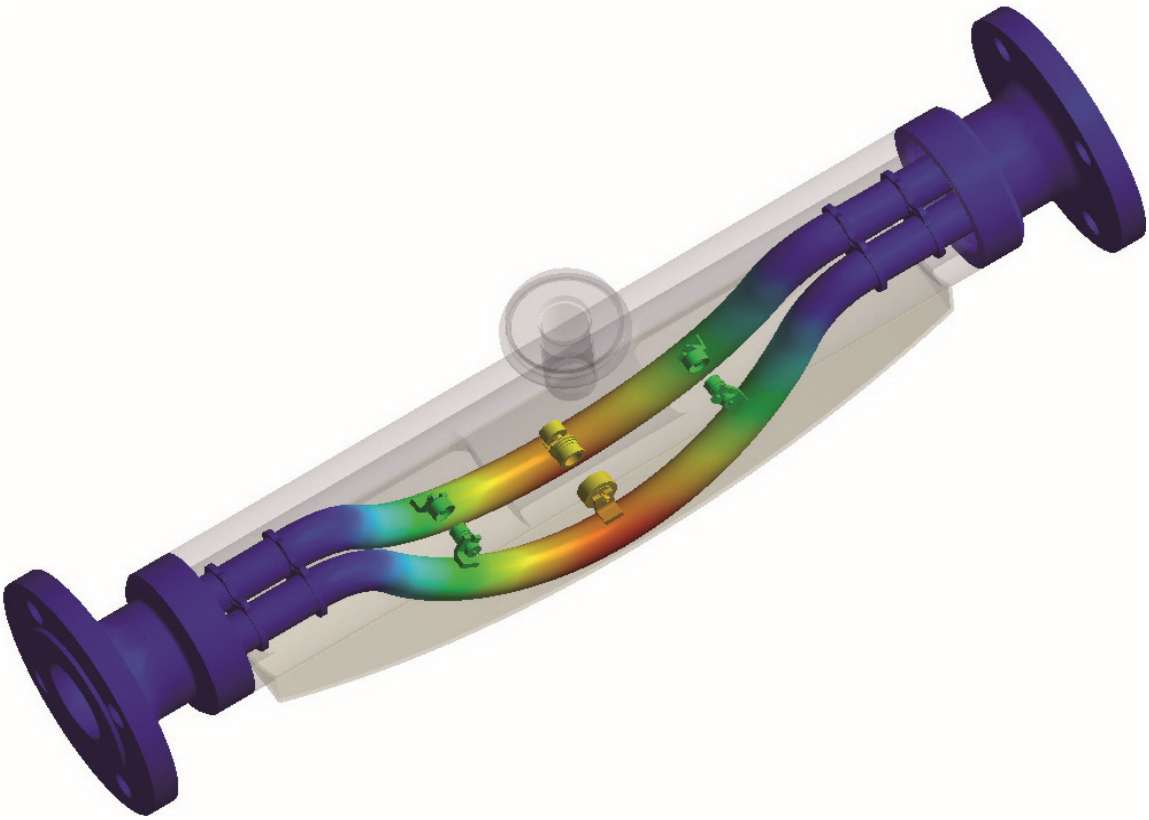

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02 Control room

Learning the baseline driver current

VeriMass uses this basic principle and monitors the driver current to detect possible changes of the meter tubes. The major challenge for the use of this kind of verification is the elimination of any short-term process effects. These effects can be accommodated by a learning technique.

After installation of a CoriolisMaster mass flowmeter, users can document the initial baseline driver current. The user defines an initial calibration period, during which the measuring device 'learns' the standard behavior of the flowmeter in the specific application. VeriMass technology monitors the driver current to determine its initial baseline, while eliminating any short-term effects. This self-calibration period adapts VeriMass to demanding processes such as high viscosity liquids, temporary gas phases in liquids or liquid drops in gases.

The initial calibration duration can be a few minutes up to several weeks. But for well-behaved processes the self-calibration period rarely requires more than a few days following installation. The noisiness of the driver current signal during the self-calibration period sets the tightness of the alarm threshold. Smoother processes will be monitored with tighter alarm thresholds than noisier processes. This avoids possible false alarms.

The self-calibration period also defines the verification monitoring time. At the end of each monitoring period VeriMass compares the newly found current level to the initial baseline. Verification monitoring repeats automatically with no further interaction by the user. If a new current baseline exceeds user-defined tolerances, VeriMass sets off an alarm.

VeriMass technology works best for diagnosing errors caused by coating and / or erosion of the oscillating tubes. In the case of liquids, it suits processes with changing densities as well as those with only small viscosity changes and temporary gas bubbles. VeriMass can handle changes of different fluids with significantly different viscosities if the changes were present during the initial calibration period following installation. Liquids with erratic viscosities including changes of 50 mPas or more are NOT good application candidates. VeriMass technology also works well with gases having occasional liquid drops.

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03 Example CoriolisMaster Verification Report. Measurement device status summary would indicate GOOD

Operating VeriMass

Users can set up VeriMass locally by navigating the menu on the LCD display of the CoriolisMaster flowmeter. More convenient, however, is setup using the CoriolisMaster Device Type Manager (DTM) or ABB's new Field Information Manager using FDI packages. The DTM and FDI packages include a rich and user-friendly graphical interface to make device configuration, maintenance, diagnostics and troubleshooting fast and easy. Users connect to the CoriolisMaster flowmeter via a host computer, HART commissioning device, or directly to a PC.

VeriMass technology thus offers automatic monitoring / testing of the Coriolis meter tubes for possible erosion or deposit formation. ABB has developed and tested this innovative procedure to be a 'user-friendly' method to detect the most frequent sources of errors in Coriolis flowmeters. A report generation function supplements the benefits. The procedure includes monitoring of all key measuring device parts that affect the accuracy of the measuring device.

The CoriolisMaster flowmeter DTM offers all the interaction capabilities provided by the local display. Additionally, the DTM can generate verification reports. The user can enter date and identification details of the operator who checks the verification, and generate two types of reports. A short report focuses on the erosion and coating monitor, including alarm status, event log, and alarm history. The longer, more complete, report version shows the flowmeters parametrization. The VeriMass option is available for all FCB100 and FCB400, as well as FCH100 and FCH400 CoriolisMaster models.

Best practice suggests that a retest of a Coriolis flowmeters calibration should be conducted once a year. Factory calibration is the most complex and costly, but provides the greatest testing depth. In this case the user removes the flowmeter and sends it to the manufacturer for review and recalibration. Less costly on-site calibration with a reference device allows for limited testing depth. Using the VeriMass diagnostic procedure on the other hand, together with onsite inspections, greatly simplifies and speeds calibration. And it makes possible testing depths of > 90 % at very little expense without need for a so-called 'proof test' recalibration either on site or at a test lab.

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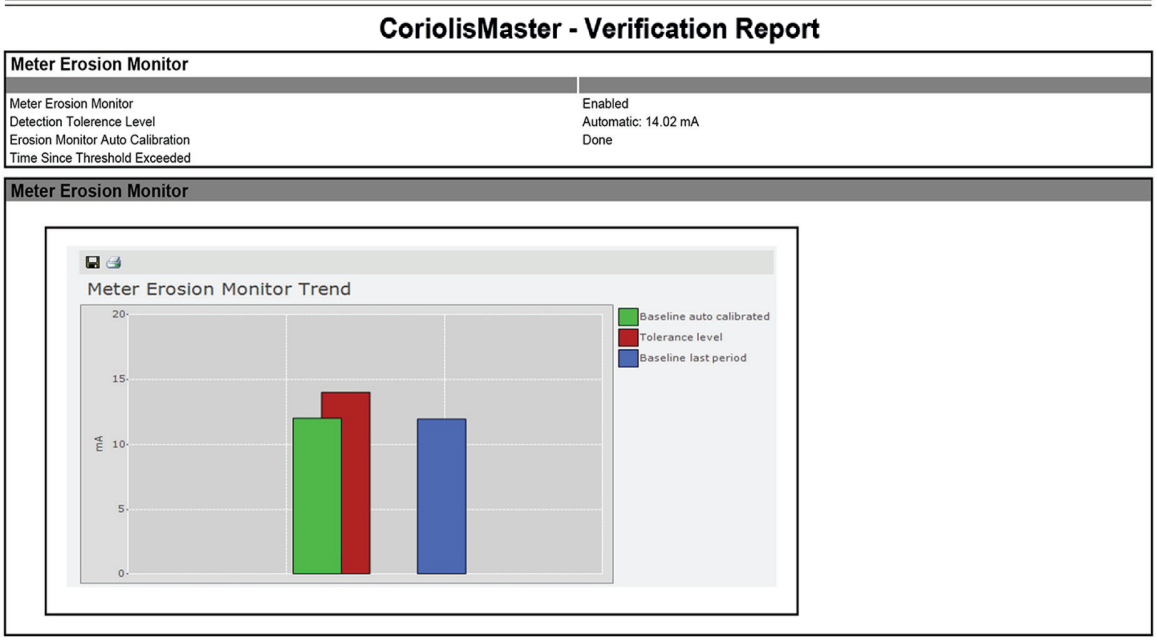

Other considerations

The IEC 61508-2 and VDI / VDE2180 industry standards state that flexibility in determining calibration test intervals, including prolonging these intervals, is possible with existing diagnostic coverage and operating experience. NAMUR NE79 also mentions the desirability of prolonging intervals between test times through improved automatic diagnosis procedures with a wide degree of coverage. Conclusion: prolonging test intervals through internal self-monitoring and online diagnosis is permitted by the standards.

Self-monitoring flowmeters have a variety of beneficial applications. Flowmeter usage for billing or allocation, such as for water, steam or gas lines, must guarantee accurate measurements. Applications subject to ISO 9001 Quality Management or ISO 50001 Energy Management also require this capability. Self-monitoring can also fulfill legal requirements, such as for Emissions Trading (TEHG) and for retesting protective devices in accordance with IEC 61508. All devices from the ABB CoriolisMaster family provide comprehensive internal self-monitoring functionality.

Aside from these applications, self-monitoring offers numerous benefits. The most obvious is easy and quick testing on installed equipment – no process disruption, no installation downtime, and no device removal. Yet users achieve a functional test from the sensed measured value through to the output signal with high testing depth. Users get regular verification of error-free operation with a clear pass / no-pass result. Calibration intervals may be prolonged without additional accessories. This in turn leads to increased productivity and installation efficiency.

Notes

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

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

ABB Automation Products GmbH
Measurement & Analytics
Dransfelder Str. 2
37079 Goettingen
Germany
Tel: +49 551 905-0
Fax: +49 551 905-777
Mail: vertrieb.messtechnik-produkte@de.abb.com

abb.com/flow

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