

# InTech



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JANUARY 2021

## Flow & Level

Measurements for  
Quality Improvement

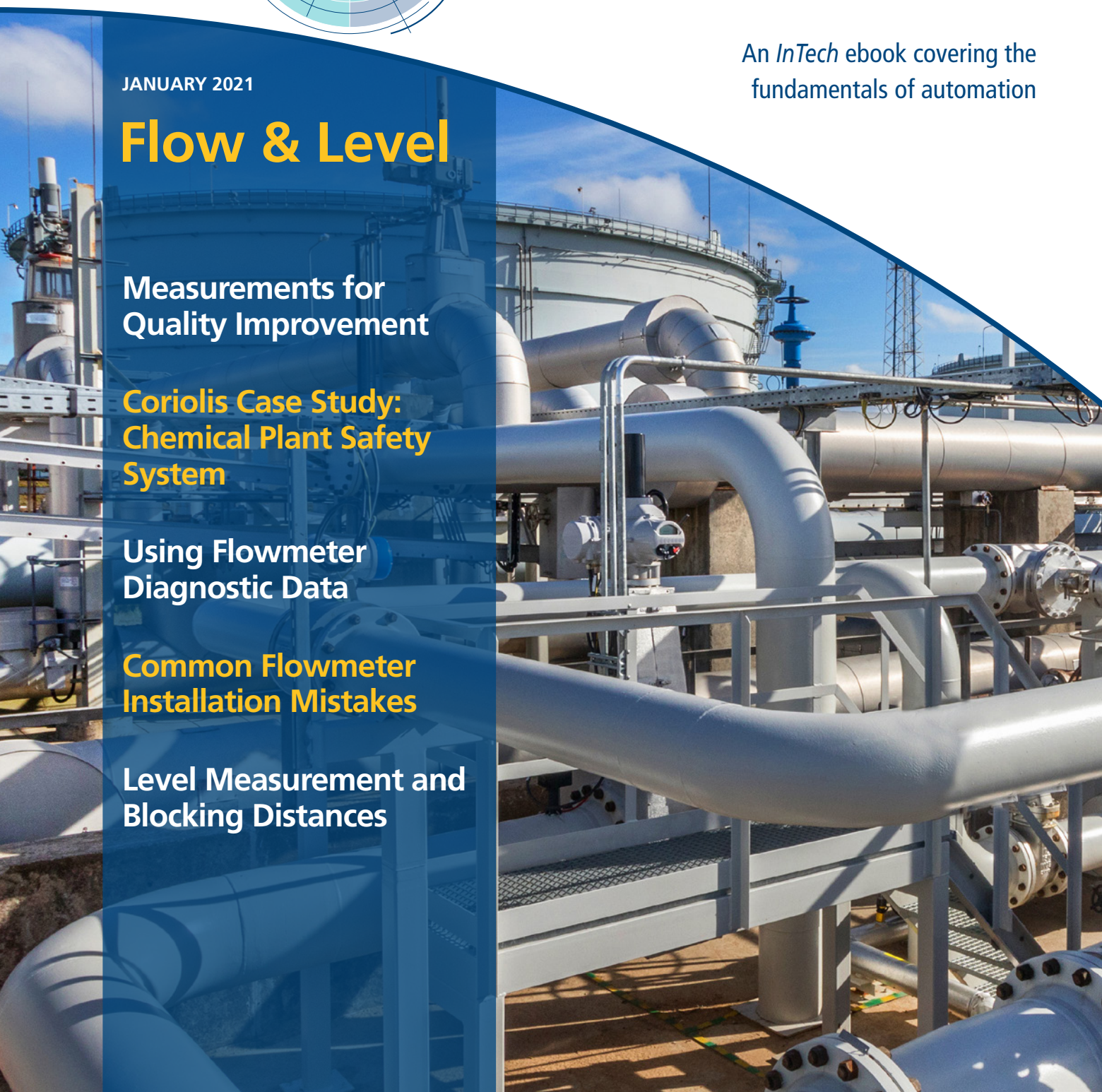
Coriolis Case Study:  
Chemical Plant Safety  
System

Using Flowmeter  
Diagnostic Data

Common Flowmeter  
Installation Mistakes

Level Measurement and  
Blocking Distances

An *InTech* ebook covering the  
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## Introduction

Flow-measurement instruments ensure the accurate amount and movement of fluids in many applications. This edition of *InTech Focus* explains the basics of the effective use of various types of flowmeters to ensure food-product quality, improve reliability and uptime of chemical plants, and accurately measure the bulk movement of natural gas. You'll also find tips for avoiding common installation mistakes, and how to handle aggressive media like acids or alkalis.

*InTech Focus* is an electronic periodical from ISA, brought to you in conjunction with Automation.com. This series of electronic magazines focuses on the fundamentals of essential automation components, such as instrumentation, final control elements, HMI/SCADA, and more. Readers will learn how to choose them, apply them, calibrate them, and optimize their contribution to efficient operations.

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# Using Flowmeter Measurements to Improve Quality



Figure 1. Hours can elapse from the time a sample is taken to its analysis.

Food plants make extensive lab-based quality measurements to ensure product quality. Coriolis flowmeters can make some of these measurements in real time, saving time and money.

By Adam Booth, Endress+Hauser

Depending on the product under scrutiny, food and beverage plant managers may have to meet the requirements of the Food and Drug Administration, European Union, and perhaps other agencies. Applicable regulations may include cGMP, GFSI, ISO, HACCP, SQF, SID, and others.

These requirements and regulations specify proper ingredients, procedures, and sanitary conditions. In many cases, compliance with these regulations requires lab analyses during and after production.

To perform a lab test (figure 1), technicians periodically take a grab sample, take it to an on-site facility for analysis, and communicate the result to plant personnel. Operators and maintenance personnel then make adjustments and corrections to improve control of the process, or to make repairs when required.

This presents problems because lab analyses are not done in real time, are time consuming and labor intensive, and raise the possibility for manual errors. Even if it takes 30 minutes to grab a sample, analyze it, and report the results—this information represents where the process was 30 minutes ago—not now. The result could be a spoiled batch.

If the measurement had been done inline, a sudden deviation would be detected. Inline measurements can also be used to enable automatic closed-loop control, which is not possible with manual measurements. A typical closed-loop control strategy uses an inline measurement as the process variable input to a proportional, integral, derivative (PID) controller. The controller output drives some type of a regulating device, such as a control valve. The PID controller continually and automatically adjusts its output to maintain the desired value close to the set point.

Often overlooked by many in the industry is the ability of Coriolis flowmeters to be used for quality control. This article shows how Coriolis flowmeters can be used in the food industry to monitor processes and reduce or eliminate the need for lab analyses.

### Testing required

Checking for product purity and quality is important, but so is meeting the expectations of consumers for proper taste and texture. For example, cold and hot wort measurements in a brewery are important to ensure best quality and yield, as well as for the taste.

Viscosity measurements can test for consistency of the batter coating for beans, onions, meat, and poultry. Measuring the Brix of tomato paste can help control the amount of paste to be added during cutting.

A single Coriolis flowmeter (figure 2) can measure a number of parameters simultaneously, including density, concentration, viscosity, Brix, Plato, volume, mass flow, and temperature—often eliminating the need for multiple instruments.

For example, the flowmeter's highly accurate density function can be used to measure Brix and Plato values to ensure the quality of ingredients. Viscosity readings provide continuous measurement to minimize the chance of producing off-spec product.

Diagnostics built into a Coriolis flowmeter can help identify process problems. For example, entrained air in a line can affect product quality. An operator needs to know if external air is being drawn in through a leaking seal, a cavitating pump, or an empty balance tank.

Figure 2. A Coriolis flowmeter, such as this Endress+Hauser Promass, makes multiple measurements that can be used for inline quality control.



A Coriolis flowmeter does not operate properly with large amounts of entrained air, so it has diagnostics to detect this condition. In an Endress+Hauser Coriolis meter, a diagnostic value shows that tube oscillation is in a good range, indicating no entrained air. If air appears in the line, the diagnostic value will change (figure 3), setting off an alarm to the operator.

A Coriolis mass flowmeter measures the density and flow rate of fluids simultaneously as they flow through its tubes (figure 4). These devices are based in principle on the Coriolis effect, which is the deflection of the path of a fluid within its tubes. An excitation coil oscillates the tubes at the first node of their resonance frequency, and the frequency of oscillation changes with the density of the fluid.

Initially, when there is no flow, the tubes oscillate synchronously, but as fluid begins to flow, the sensors on the inlet and outlet bends begin to oscillate nonsynchronously with a phase shift. Measuring the oscillation frequency provides data to determine flow, mass flow, density, concentration, etc.

The flowmeter has resistance temperature detectors (RTDs) installed to measure the temperature of the fluid. RTDs also measure the temperature of the tubes, required because tube elasticity changes with temperature. The changes in elasticity will impact how the tubes bend and therefore the density measurement, so temperature compensation factors are needed for density calculation.

The applications described below cover measuring concentration, viscosity, and density, but these are only some of the possible on-line quality measurements possible with Coriolis flowmeters.

Figure 4. Measuring deflection of the flow tubes in a Coriolis flowmeter allows the meter to measure flow, mass flow, density, concentration, and other parameters.

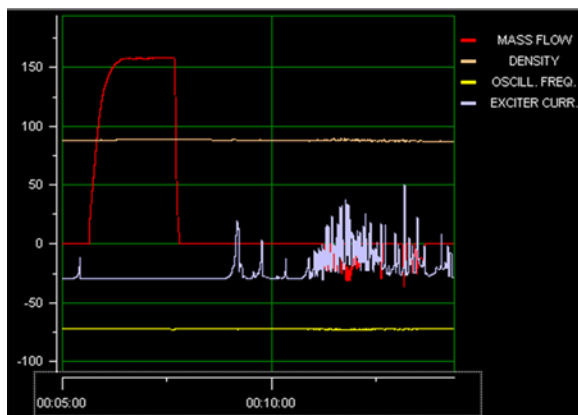
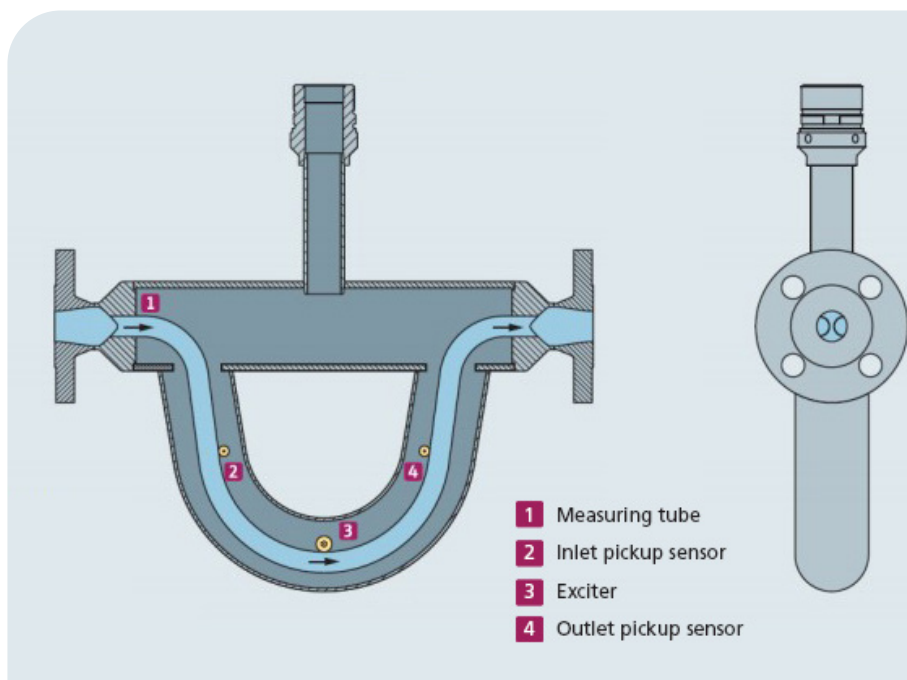


Figure 3. Diagnostics in a Coriolis flowmeter can determine if entrained air is present (purple trace in the figure). This data can be used as an operator alarm and to help during setup.



## Checking concentration makes beer better

Breweries make concentration measurements, which are needed to control the sugar content of their wort to determine the alcoholic strength of the beer. The amount of sugar content correlates to degrees Plato (°P); for example, 1°P wort will contain 1 gram of sugar per 100 grams of wort.

A Coriolis flowmeter provides an accurate density and temperature measurement, both of which are needed to determine the degrees Plato. A Coriolis flowmeter also has integrated formulas that use the measured density and temperature to calculate concentration.

In a brewery, after the grains are malted and milled, the mash goes into a lauter run, a vessel used to separate the mash from the wort. Density and concentration measurements are made as the wort leaves the lauter run.

There are multiple methods to measure sugar content, both manual and automated (see Additional Resources box). However, the manual measurement is usually taken after the lautering process is complete, whereas an inline measurement allows for real-time correction of the process, often by automated means via closed-loop control. The end result is reduced waste from bad batches, and reduced time and labor by not having to manually sample the wort.

## Validating viscosity

Fruit processing plants need a history of raw fruit temperature, density, Brix, viscosity, flow rate, and total flow volume. A Coriolis flowmeter measures density, so it can calculate Brix, proportional to the amount of sucrose content in water. This measurement provides a picture of the condition and quality of incoming fruit. For example, hard fruit that is still in solid chunks will show a low Brix. In contrast, a high Brix measurement could indicate overripe, mushy fruit with very little intact solids. Operators or the control system can use the Brix measurement to determine how to process the incoming fruit.

Viscosity of the fruit product is measured to determine end product quality. Viscosity describes the flowing properties of a fluid, and it depends on the forces acting between molecules. The more viscous a fluid is, the stronger the intermolecular forces. As a result, larger internal resistance has to be overcome to move the fluid or apply a force to it. Viscosity is an indirect measurement of product consistency and quality.

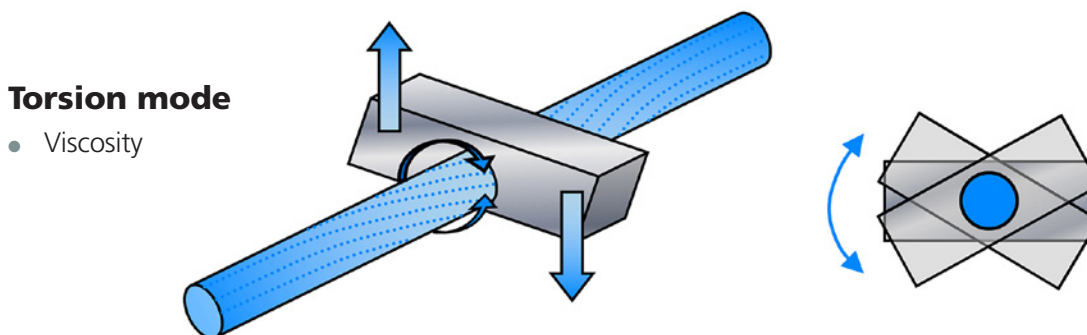


Figure 5. Viscosity is calculated as a function of shear rate and viscosity.





Figure 6. Ice cream is injected with air before freezing to give it a creamy texture.

A Coriolis flowmeter can use two simultaneously driven frequencies for measuring mass flow and viscosity. The torsional or viscosity mode uses a higher frequency to induce a shear rate on the fluid (figure 5) with the shear force on the inside of the tube being a function of shear rate and viscosity. By measuring the drive current, viscosity can be calculated.

In new Coriolis flowmeters, two eigenmodes are stimulated by an exciter on the measuring tube: the bending mode and the torsion mode. The bending mode determines fluid density and mass flow, while viscosity is calculated based on the torsion mode.

Viscosity is usually measured in a lab, under lab conditions. The advantage of measuring viscosity directly in the process is that it is a true reflection of the process conditions and avoids the delay of taking samples to the lab. This allows for live corrections of the process if viscosity is outside the product's tolerances, often by automated means.

### Ice cream overrun

Food products are often foamed with gases to achieve the desired consistency. This occurs, for example, when ice cream is produced (figure 6). Gas is injected during the freezing process, trapping microbubbles into the ice cream to give it a creamy texture. This process works with high-fat as well as low-fat ice cream.

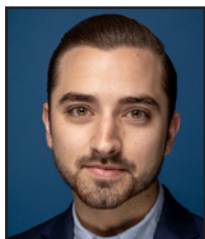
Gas content is a significant factor in the overall quality of the final product and is an important process parameter. The increase in volume of the final product caused by the injected gas is known as overrun. Depending on the product, the overrun can be between 20 percent and 120 percent for ice cream or frozen products.

A Coriolis flowmeter can be used to make this measurement. For example, the Endress+Hauser Promass Q with Multi-Frequency Technology enables continuous monitoring of the overrun. The density of the liquid ice cream is measured as it is being transferred to the freezers.

Ice cream plants typically inject air, manually measure density, and adjust the process accordingly. Air injection also needs to be adjusted if the recipe, freezer temperature, or air pressure changes. A Coriolis flowmeter provides the measurement online, saving sampling time and allowing immediate and automatic adjustment of air injection (see Additional Resources box).

### Adding instrumentation

This article only covered how Coriolis flowmeters can be used for inline quality monitoring in food plants. Although Coriolis flowmeters are extremely capable, adding additional instruments—such as pH meters, colorimeters, dissolved oxygen sensors, and other in-line analysis devices—can help a food plant analyze and control even more of its processes in real time.



#### ABOUT THE AUTHOR

**Adam Booth** is the flow product marketing manager for Endress+Hauser. He graduated from Purdue University in 2016 with a degree in mechanical engineering technology. After graduation he joined Endress+Hauser's Rotational Engineering Development Program in 2016. Before his current role, Booth was a technical support engineer for Endress+Hauser. While in those roles, he developed expertise with Endress+Hauser's Flow portfolio and gained hands-on experience in the field.

#### Additional Resources

1. "[Inline Gravity Measurement](#)," *Brewer and Distiller International*, April 2016
2. [Promass Q: Overrun measurement: Measurement setup and formulae for calculating % overrun](#)



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# Chemical Plant Safety System Features Advanced Coriolis Meters

BASF plant increases uptime using entrained gas management and in situ verification.

By Al Dhanji, KROHNE, Inc.

**G**lobal chemical company BASF opted for new Coriolis meter technology as the centerpiece of the safety instrumented system (SIS) of its Freeport, Texas, plant. With its excellent price versus performance, smaller footprint, entrained gas management features, and in situ verification capabilities, the new flowmeter technology improves reliability and decreases downtime for critical process systems.

## Plant operators look to replace aging equipment

BASF's Freeport plant manufactures superabsorbent polymer (SAP), which absorbs and retains large amounts of liquids. The water-absorbing polymer has thousands of uses, ranging from diapers, masking tape, and artificial snow, to hot and cold therapy packs, motionless water beds, and even grow-in-water toys.

According to Daniel Siddiqui, BASF's instrumentation and electrical lead engineer for CPN and utilities and infrastructure, plant operators needed to replace flowmeter instrumentation for the SIS, an engineered set of hardware and software controls used on critical process systems. The previous mass meter equipment had reached the end of its lifespan, and BASF wanted to exchange it for newer technology. "BASF's standards call for replacing SIS equipment at end of life per manufacturers' recommendation," said Siddiqui. "The equipment had been showing deviations greater than specifications, and rather than recalibrating it we opted to replace it."

If you have a persistent problem with positioner life or control valve performance, consider a remotely mounted positioner option as a solution.

The plant's SIS was required to meet safety integrity level (SIL) 3, a measure of system performance and probability of failure for a safety-instrumented function, as defined in the IEC 61508 functional safety standards. Among other items, SIL 3 requires a SIS safety instrument with an override for any unusual conditions. Redundant flowmeter instruments are required to alert operators to any flow deviations and trigger a safety alarm. Every time the deviation is greater than 5 percent, the SIS shuts down the production line.

Operators knew selecting the right instrumentation was critical to minimizing any intermittent or false alarm trips that would shut down the production line. Apart from the economic burden from loss of production and wasted material, prematurely stopping under full load (rather than normally ramping down for shutoff) can introduce significant equipment wear and tear.

"The quote we received for replacement meters from the other vendors exceeded our budget; due to the nature of our process, we had to use an exotic material. We reached out to KROHNE, and the quote we got represented significant cost efficiencies compared to the other vendors." BASF tested the KROHNE meter at its central laboratory in Germany and approved it for SIS service. After reviewing a variety of options, BASF chose a design featuring two KROHNE OPTIMASS 6400 Coriolis twin bent tube mass flowmeters in series to create the required redundancy.

The flowmeters are available in sizes ranging from DN 08 to 250, and can be made in stainless steel 316L, Hastelloy® C22, and Duplex steel UNS S31803. The BASF installation includes two 2-inch meters. The external meter is made of 316 stainless steel, and the internal one is composed of Hastelloy.

Compliant with the User Association of Automation Technology in Process Industries (NAMUR), standard installation lengths are available; the OPTIMASS 6400 operates in high temperatures up to 752°F (400°C), as well as cryogenic applications down to -328°F (-200°C).

It also handles pressures up to 200 bar (2900 psi). It features the new MFC 400 signal converter, which offers fast, completely digital signal processing as well as enhanced diagnostic and status indications.

### **Price versus performance and entrained gas management**

Plant operators reviewing options determined that the price versus performance reliability of the OPTIMASS 6400 was superior to all other options. If operators obtained a reading showing a deviation or another issue with a process monitoring parameter, the meter helped identify the issue in advance, while still performing reliably under the abnormal conditions.

Beyond the purchase price advantage, the OPTIMASS 6400 adds extra value through unique and robust technical features, such as KROHNE's Entrained Gas Management (EGM) system. Entrained gas can disturb the sensitivity of the mass flow measurement of liquids, decreasing accuracy or even stopping measurement completely. The new Coriolis mass flowmeter technology ensures both stable and uninterrupted measurements with high gas content. The OPTIMASS 6400 provides a reliable indication of gas bubbles in the process by using a combination of various measurements to detect a two-phase flow. With values between zero and 100 percent gas or air content in the line, it maintains the mass flow and density measurements continuously and provides live measured values at all times. At the same time, it can report the two-phase status and output a preconfigured alarm, in accordance with NAMUR NE 107 requirements.

The smaller physical footprint of the meters selected was another benefit, and made installation easier. For example, the KROHNE devices fit into the existing space without major piping modifications, while other vendors' meters would have required significant piping modifications.

With the OPTIMASS 6400, a proprietary isolation system allows the meters to be close coupled or mounted flange to flange. The unique design ensures that tube vibration has no effect on performance when meters are flange-to-flange mounted. The flow through the meter moves the pipe, causing fluids to swirl, which creates a mechanical distortion between the pipe's inlet and outlet. The sensor upstream of the oscillator picks up this vibration before the outlet. With other designs, tube vibrations migrate through the piping, causing errors if the meters are close coupled.

In addition, for the same pressure drop, BASF could select a smaller diameter because of the lower pressure drop through the meter compared to other options. This was a real cost advantage to the customer. One other benefit BASF noted was optimizing the stocking of spare parts, ensuring that all meters received have the required entrained gas capability. "We got excellent support from KROHNE and were able to get two meters, which allowed us to stay under our approved budget," explains BASF's Daniel Siddiqui.

### In situ verification reduces down time due to calibration requirements

Safety instrument meters must be verified regularly, and operators are required to establish a proof test interval. Using the OPTICHECK on-site verification tool, BASF can fulfill third-party requirements for independent verification of instruments. The company connects the tool online, while the meter is in service, to verify the flowmeter is performing within  $\pm 1$  percent of the factory calibration. The baseline can be historic repair data from the factory or on-site test results after performing a full verification. OPTICHECK also has detailed reports for proof test documentation of safety loops.

In situ verification enables the operators to keep the meter operating longer, rather than having to pull the meter out of line, package it, send it off to get calibrated at a predefined interval, and installing it back in service after calibration.

### Meter performance since startup

Plant operators started up the new Coriolis meter technology for the SIS in February 2020. According to Siddiqui, the system has been operating well, providing accurate readings and offering increased confidence in the SIS application. "With the new equipment, the plant is even safer," said Siddiqui. "By using the KROHNE meters we did not compromise safety, but at the same time we were able to maximize cost efficiencies, which allowed us to come in under budget. Of the BASF approved vendors, KROHNE's proposal was the most cost effective, because free startup support was provided."



#### ABOUT THE AUTHOR

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# Flowmeter diagnostic data

Ultrasonic flowmeter diagnostic features improve accuracy, repeatability, and reliability.

By Joel Nava, SICK

**A**ccurate and repeatable measurements are essential to quantify the bulk movement of gas from wellhead to flame tip. In natural gas applications, ultrasonic flowmeters generally offer better performance, greater reliability, and lower capital and ownership costs than other flowmeters.

Ultrasonic flowmeters from SICK operate according to the principle of ultrasonic transit time difference measurement. This allows conclusions to be made about the gas volume flowing through based on the sound velocity transfer time. Measurement is carried out in a direct path layout to keep disturbing effects, such as gas flow turbulence, dirt, moisture, or interfering noises, as low as possible. Two ultrasonic transducers are positioned opposite each other in a defined angle to the gas flow and operate alternately as sender and receiver. As a result, ultrasonic flowmeters are more reliable and require less maintenance than mechanical flowmeters.



The development of various meter types has also brought the progression and development of the data that comes along with them. Diagnostic data has come a long way since the introduction of flowmeters decades ago. In this article, we will discuss traditional diagnostic data parameters and some new ultrasonic diagnostic features and enhancements that will improve your flow measurement accuracy, repeatability, and reliability.

### Traditional diagnostic methods

Five main traditional diagnostic parameters have been around for a long time—since meters were first developed. They are:

#### Automatic gain control (AGC)

AGC is the amplitude of the received signal that depends on pressure, meter size, and specific damping influence. An increased AGC value indicates a weaker received signal. A weaker signal could indicate that you have contamination in the line. For example, there may be some buildup in front of the transducer or possibly some liquid in the line.

#### Signal-to-noise ratio (SNR)

SNR is the ratio between the received signal and a noisy signal. It is an indication of the acoustic signal quality. Any time your SNR gets below 30 decibels, you may want to investigate what caused the SNR to drop so low. It is usually an indication of buildup in front of a transducer or noise resonating in the line and interfering with the transmitted signal.

#### Acceptance rate

The acceptance rate is the ratio between valid measurement signals and the signals being transmitted. It is often indicated in a percentage of how many of the transmitted signals are being received on the other side and indicates the measurement plausibility. For example, if you send out 100 signals between a pair of transducers and are able to receive 100 signals without any rejections, then the acceptance rate is 100 percent. An acceptance rate of 100 percent is often not required. However, the higher your percentage is, the higher your measurement plausibility.

#### Speed of sound

Speed of sound is an independent measurement value specific to gas composition, pressure, and temperature. It is an indication of the quality of the signal run-time measurement. In general, the speed of sound measured for each path should be within 0.2 percent of one another. If not, it is an indication something is interfering with the signal, or dimensional data has been entered incorrectly.

#### Flow profile and symmetry

Flow profile and symmetry is a reflection of the flow distribution from the top to the bottom of the pipe. A blocked flow conditioner could cause some issues with accuracy in the meter. This measurement is a quick way of identifying whether or not you have a good profile.

## What's new in ultrasonic diagnostics?

### Condition-based indicator (CBI)

The condition-based indicator (CBI) is an additional diagnostic indicator based on a diametrical virtual path. The path is fully integrated into a four-path or an eight-path meter. This helps measure transit time in upstream and downstream applications.

With the next generation of meters, CBI offers the sensor signal transmission in one measurement path. By redesigning the transducers, the sensor can send one signal from measuring path two to measuring path three and from path three to path two. This cross-sectional measurement enables signals to measure the velocity more accurately through the center of the meter in the virtual path. With this, you can set up a tolerance to alarm off the virtual path before the four-path or eight-path meter gives you an alarm, so you can do more comparisons between the two measurements.

The dimensionless CBI factor is calculated from the mean gas velocity of the diametrical paths and the mean gas velocity of the four-path meter or eight-path meter with this calculation:

$$CBI_{\text{average}} = (VOG_{D1} + VOG_{D2}) / VOG$$

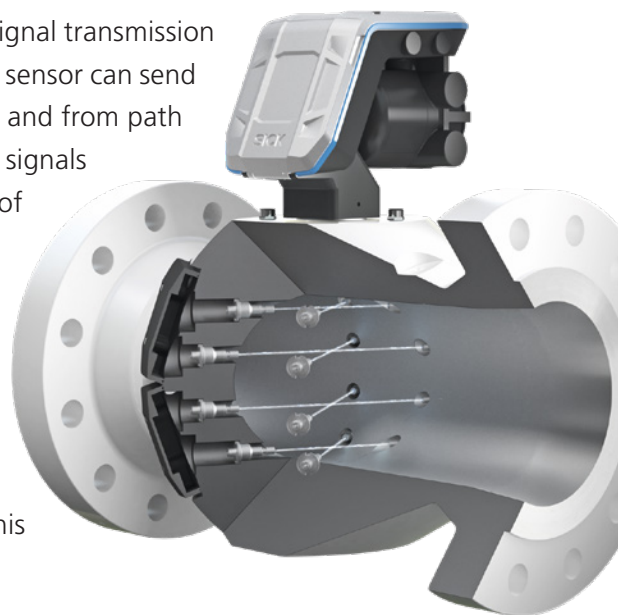
No additional hardware is required for the diametrical measurement and calculation of the CBI. This is due to the latest generation of the ultrasonic sensor with a new sensor head design along with advanced signal processing electronics.

### New diagnostics available with commissioning meter installation setup

The Commissioning Meter installation setup within FLOWgate™ software offers new selections on the installation page to identify additional devices upstream and downstream of the ultrasonic meter. Also, you can check any application-specific conditions relevant to the meter. When there is a failure with the meter, you can see warnings associated with the meter and can immediately run through the solutions assistant to help determine what is wrong with the meter.

The new Extended Diagnostics Solution Assistant indicates exactly what diagnoses have failed and tells you proposed actions to solve the problem, which could include pollution, external noise, or a blocked flow conditioner.

The assistant will also archive all diagnostics. The Archive Diagnostics page provides quick access to historical trends of data and events. The chart gives the user a way to analyze data from specific days to monitor activities that occurred during that time period. The archive can also be used in conjunction with the Fingerprint page to create a reference and limit trends. Archive data can be available indefinitely.



### New transducer design

Available to technicians out in the field, the latest generation of ultrasonic sensors can determine the CBI value due to the physical propagation of the ultrasonic signal generated by the sensors.

The generated signal radiates in the form of a sound beam with a defined angle based on the design of the sensor head. In addition, the sensors, along with new electronics, have up to 12 dB better noise immunity.



The chart shows the testing done to compare the FLOWSIC600-XT to a traditional classic meter. The traditional classic meter failed down to zero, but the XT meter continued to operate and offer flow measurement even under extreme conditions. The new, advanced sensor and the new electronics gave this noise immunity.

### PowerIn technology

The highly efficient energy concept of the FLOWSIC600-XT guarantees continuous power via an optional integrated backup battery in the event of a mains power failure. This ensures continuous measuring operation for up to three weeks. The backup battery is a special hermetically sealed battery that can be stored for over 10 years without capacitance loss.

If the external power supply fails, power consumption reduces to the minimum level:

- The standard measuring rate reduces from 10 Hz to 1 Hz.
- The RS485, Ethernet, HART, Encoder interfaces and the analog output are deactivated.
- The frequency and pulse outputs F0.0, F0.1, D0.2, and D0.3 as well as the infrared service interface on the display are available.

	Active I/Os for Ex-d and Ex-de (circuit: Open normally)					
Status output (DO) Frequency output (FO)	2x DO 2x FO	2x DO 1x FO	1x DO 2x FO	1x DO 1x FO	2x FO	Measurement without active I/O
4-path electronics	Approx. 1 week	Approx. 2 weeks	Approx. 2 weeks	Approx. 3 weeks	Approx. 1 month	Approx. 3 months
8-path electronics	Approx. 1 week	Approx. 2 weeks	Approx. 2 weeks	Approx. 3 weeks	Approx. 1 month	Approx. 2 months
1-path electronics	Approx. 2 weeks	Approx. 2 weeks	Approx. 3 weeks	Approx. 1 months	Approx. 2 months	Approx. 5 months

### Additional enhancements and features

**Fingerprint enhancement:** Capable of creating a diagnostic fingerprint from commissioning data or data recorded at the flow lab during calibration.

**Extended calibration ranges:** Option is available to extend the lower and upper calibration range for better rangeability. Extending the range will optimize operations during seasons of high or low demand nominations. For example, in winter, you may have high demands, and, in summer, you may have low demands. In the past, you had to get two devices to measure the different demand levels. Now, this could possibly be achieved by simply extending the high- and low-end calibration points.

**Internal pressure and temperature sensor:** The integrated pressure and temperature sensor is used for automatic corrections due to geometry and Reynolds effects.



Reduced and integrated backup battery provides power for up to three weeks.

### Greater accuracy, repeatability, reliability

New diagnostic data enhancements and features can give you a greater level of accuracy, repeatability, and reliability in your ultrasonic flow measurement applications. In summary, the new features available include:

- **Condition-based indicator:** Virtual path measures the velocity through the center of the meter and compares it to the average velocity of the main meter to evaluate meter performance.
- **Enhanced commissioning wizard and solution assistant:** In conjunction, the Solution Assistant can help field personnel with evaluating resolutions to errors or warnings that occur in the meter.

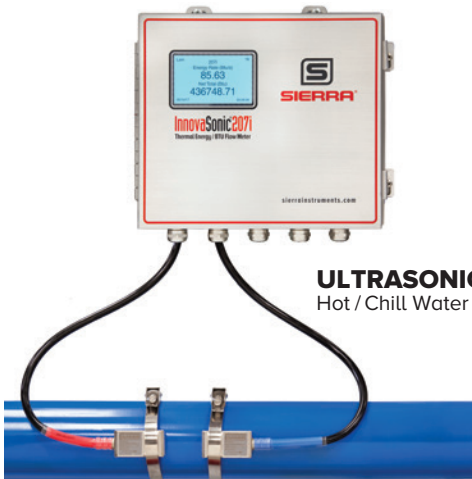
- **Archive diagnostics:** Quick access page to view events and data logs.
- **New transducer and electronics design:** Along with calculating CBI, transducers and new electronics have up to 12 decibels of increased noise immunity.
- **Extended calibration ranges:** Extended ranges can provide flexibility when designing a station or meter runs.
- **Integrated pressure and temperature sensor:** Provides live pressure and temperature values for corrections related to pipe expansion or Reynolds number effects.
- **Virtual and integration solutions** through our service and system integration groups.



#### **ABOUT THE AUTHOR**

**Joel Nava** is market application engineer – flow metering systems at SICK. He has more than 40 years of experience working with flow measurement technology. Nava applies this expertise to assist with the engineering, R&D, and design of flow metering systems. He has been with SICK, Inc. for over seven years.

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# How to Avoid Common Flowmeter Installation Mistakes

Learn to optimize performance through proper installation and maintenance.

By Scott Rouse, Sierra Instruments

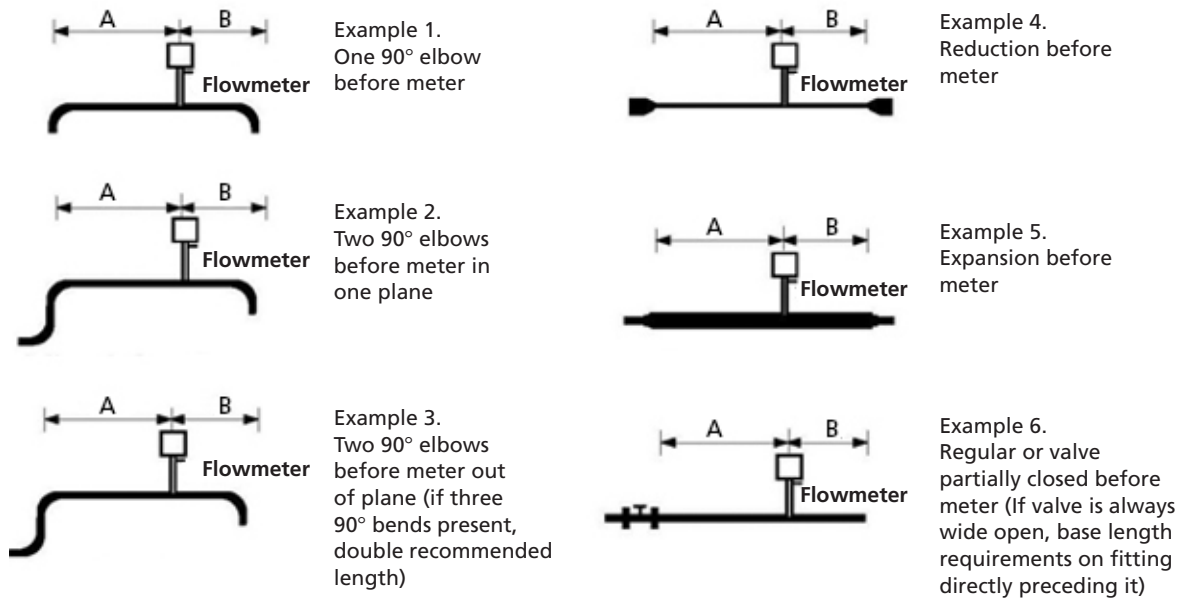
**P**lant and operation managers are constantly searching for ways to manage the flow energy in their facility to cut costs and increase their process efficiency. After the flowmeter purchase decision is made, correct installation and calibration are the next steps to maintaining the equipment over the lifetime of the product and reducing the cost of ownership to increase the cost savings of the overall facility. Let's look at some common installation mistakes and some other ways to lower costs and optimize your flowmeters' performance.

Once you have identified the right flowmeter for each type of fluid and [application](#), properly installing your flowmeter is critical for successful flow readings. Many times, if you think your flowmeter "doesn't work," it could just be that the meter was not installed properly. Here are some installation tips for thermal mass, vortex, and ultrasonic flowmeters.

To achieve accurate and repeatable performance for thermal mass flowmeters, the first tip is to install the flowmeter using the recommended number of straight-run pipe diameters upstream and downstream of the sensor. The chart below shows basic good plumbing practice for common upstream obstructions and meter locations.



Another solution for insertion flowmeters is to install flow conditioning plates in the flanges somewhere in the straight section, requiring 3 diameters of pipe run (two before, one after). This installation will totally disrupt the flow, creating a “flat” profile.



Straight Pipe Length Requirements at 1 ATM			
Piping Condition	Flow Conditioning		Orifice Plate (3)
	Upstream	Downstream	
Single 90° Elbow or T-Piece	1D	OD	28D
Reduction (4:1)	3D	OD	14D
Expansion (4:1)	3D	OD	30D
After Control Valve	3D	OD	32D
Two 90° Elbows (In Same Plane)	3D	OD	36D
Two 90° Elbows (Different Plane)	5D	OD	62D

### Avoid common mistakes

The second tip is to avoid the following mistakes when installing vortex flowmeters:

- Not having the proper upstream and downstream diameter. Unlike thermal flowmeters, vortex meters do not work with flow condition plates, so they must have a straight run of pipe to function at optimal levels. In most installations, you need a straight run of at least 10 diameters upstream and 5 diameters downstream.

- Installing the vortex meter backward. When installing a vortex flowmeter, make sure the orientation of your meter is in the direction of the flow, so your meter's flow sensor can measure your fluid accurately. Most vortex flowmeters have some type of flow direction indicator to help you point downstream.
- Measuring the incorrect fluid type in the pipe. In some situations, end users might be measuring steam flow and think they are producing saturated steam, but in fact, they have a 50 percent overheat and are measuring superheated steam.
- Do not shut down your steam flow to install a vortex flowmeter. Many insertion vortex flowmeters have a retractor to make hot tap installation much easier. This means you can install the insertion vortex flowmeter in large steam pipes with no process shutdown.

For ultrasonic flowmeters, consider clamp-on sensors for field flexibility and easy setup. With a portable ultrasonic flowmeter, you can use one in several locations throughout your flow process. Fieldwork calls for flexibility in your equipment. Look for liquid flowmeter clamp-on sensors with a high-powered ultrasonic pulse and digital signal processing that requires just one set of transducers for a wide range of pipe sizes and materials like metal, plastic, and concrete.

### In-situ calibration

The last tip is to remember that the measurement accuracy of your device is critical in determining efficiency, performance, and cost savings. So the more accurate your flowmeter is, the better data you have to make cost-saving decisions. Thermal mass flowmeters with in-the-field in-situ calibration validate the meter's accuracy without shutting down the facility.



#### ABOUT THE AUTHOR

**Scott Rouse** is product line director for [Sierra Instruments](#), a member of the TASI Group and makers of flow instruments, including all types of [flow controllers](#) for gas, liquid, and steam applications. This article first appeared in October 2020 in the official blog of Sierra, [Let's Talk Flow](#).

#### For More Information

Download the [Flow Energy Guide](#) for additional details on managing flow energy in your facility. You can also [watch videos](#) on how to measure air, gas, and steam better in your facility.



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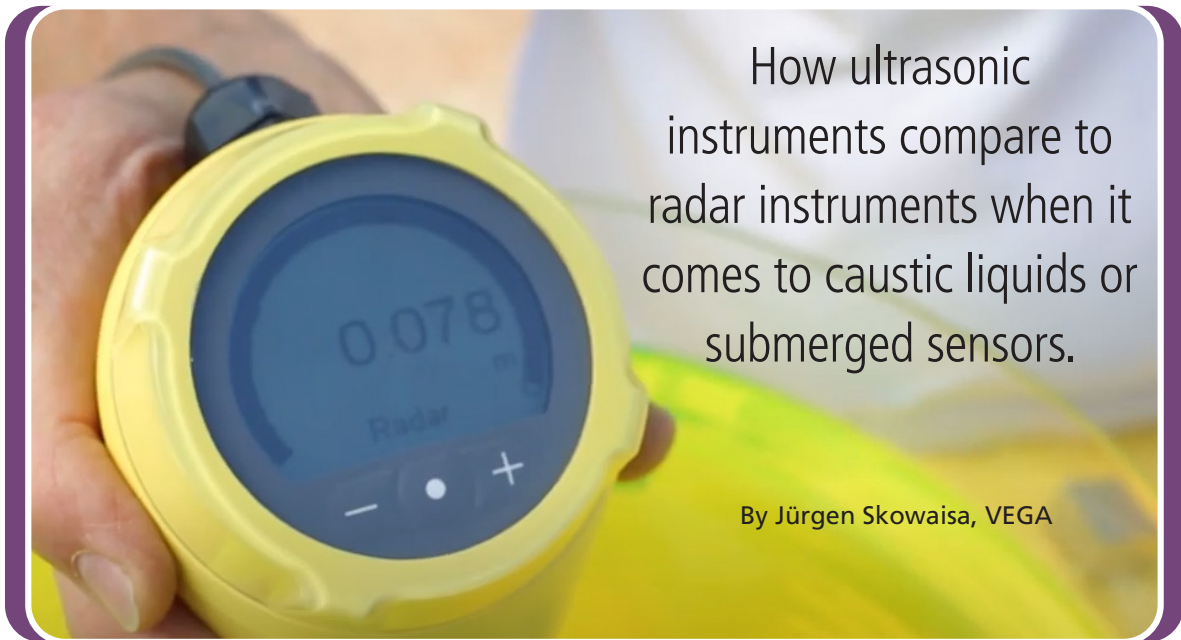
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# Level-measurement Technology and Blocking Distances



**T**his article discusses blocking distance and what happens when sensors become submerged. Submersion (or flooding) of the sensors can occur in some applications, so ultrasonic level measurement sensors are therefore often protected by mechanical flooding sleeves. However, such components can easily become contaminated and impair the reliability of the measurement. Radar level measurement sensors, on the other hand, have no dead zone, do not require protective sleeves, and measure reliably even in the case of submersion.

There are many containers that hold aggressive media such as acids or alkalis. Reliable measurement—right up to the antenna—is important here, such as for a chemical container filled with iron chloride, for example. The problem with ultrasonic flowmeters for such an application is that the sound transducer is a loudspeaker and microphone in one. While transmitting signals, it cannot receive any signals. This creates a blocking distance. Ultrasonic, therefore, is not necessarily suitable for applications where there is a high chance of overflowing.

We do not have this problem with radar sensors. A radar sensor can simultaneously emit and receive signals. This means there is no blocking distance, and you can measure levels that reach right up to the sensor itself.

Blocking distance affects the measuring point. That means that as I get closer and closer to the water surface with the sensor, the sensor displays an error message. In my demonstration, you see the error message when I reach a distance of about 25 centimeters. This means the ultrasonic sensor cannot detect the level at this close range correctly. The worst-case scenario could even be an overflowing of the container.

A radar sensor, on the other hand, measures the received signal even while it is transmitting, so it does not produce an error as it gets closer to the material. Because of this, the sensor can measure levels very close to the antenna. Even if the sensor is submerged, it still displays the maximum level. This means measurement with a radar sensor is much more reliable than with an ultrasonic device.



Jürgen Skowaisa demonstrates how a radar sensor can measure level through the plastic material of a typical container.

### Measuring through container walls

Radar sensors can also make a measurement through the walls of a plastic container. The microwave radar signals pass right through the plastic sheeting, allowing the sensor to measure the liquid surface with no direct physical contact with the medium. This is, of course, ideal for aggressive media, because you do not have to worry if the sensor has high chemical resistance or not.



This article was adapted from an episode of VEGA Talk “Radar vs. Ultrasonic,” a YouTube video series from VEGA. Subscribe to VEGA’s YouTube channel (<https://www.youtube.com/vegagrieshaberkg>) to never miss an episode.



#### ABOUT THE AUTHOR

**Jürgen Skowaisa** is a product manager with VEGA, a global manufacturer of sensors for measuring level, point level, and pressure for the process industry, as well as devices and software for integrating them into process control systems. VEGA Grieshaber KG, located in the Black Forest of Germany, is a worldwide company with presence in more than 80 countries. Its American office, VEGA Americas, is located in Cincinnati, Ohio, USA.

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