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talkline

Leader in Innovation

Endress+Hauser

People for Process Automation

Index

Season's Greetings

We wish you a Merry Christmas and a Happy New Year with an abundance of success in 2018!

Mistletoe, rose hip and star anise have valuable ingredients which have been used in medical treatment for centuries. The life sciences industry is striving to develop modern active ingredients using the latest scientific insights and highly innovative processes. We support them in every aspect of this fascinating field.

Endress+Hauser

Our valued friends, customers and business partners

Dear Reader,

Surprising how fast a year can come and go. Seemingly, just weeks ago we were welcoming the arrival of 2017. Yet here we are, already bidding 2017 farewell! Time sure does fly. As 2017 has been another busy year full of challenging goals, I remind you all to be sure you make time to be in the moment; take time to notice and enjoy the changing season. All too often, our work lives command so much of our time and attention that we forget to prioritize our personal lives accordingly. Striking the right balance between work and personal life is as important now as it has ever been. I sincerely wish all of you a wonderful end to the year both personally and professionally. When we strike a healthy balance between our work and personal lives, they both tend to thrive.

The same can be said for working towards continuous improvement in our places of work. We have been actively working to improve how we serve our customers (I have mentioned this in each issue of *Talkline* this year), and how we can streamline the process of serving you more effectively and efficiently, in a sustained manner. We have learned a lot so far and the journey promises even more insights and continuous improvement. Our goal remains unchanged: eliminate any inefficiency or waste that does not add value to you and your success.

In this, our fourth and final issue of *Talkline* for 2017, we walk through the basics of calibrating pressure transmitters. Learn when to calibrate, how to calibrate, and who should do it. You'll also find valuable information on flow monitoring in process cooling applications, and learn how you can improve efficiencies while optimizing your process. We top it all off with an article on radar level measurement for high-temperature and pressure environments—an informative read to help you learn about radar behavior in such critical applications and the solutions available to overcome such obstacles.

We previously shared news of our Process Training Unit (PTU), and the type and nature of courses offered there. Have a look and consider how we can help you meet your training and learning objectives in the coming months. We can also customize courses for specific learning objectives. Take advantage of the PTU and get state-of-the-art training. This is the only training facility of its kind in Canada! Plan some relevant training for your team in 2018.

As we bid farewell to 2017, I'd like to remind you that there are many ways to connect with us. Whether via social networks such as LinkedIn, Twitter, Facebook and Instagram, or by contacting us directly, you can keep up-to-date with our work, our events and various business developments. Look to Endress+Hauser when seeking a partner to help you become as efficient and competitive as possible. To you and yours our sincere wishes for a healthy, safe and happy holiday season!

Sincerely,

Anthony Varga
President and CEO


Endress+Hauser
TRES PALACIOS

Basics of calibrating pressure transmitters

Pressure transmitters need to be calibrated on a regular basis for maximum performance. When do you do it? How do you do it? And who does it?

By Keith Riley, Ehren Kiker and Duane Muir, Endress+Hauser

Pressure transmitters used in the process industries are very durable and reliable instruments. Even so, they still require periodic maintenance and calibration to ensure optimal performance. This is an area of confusion for many, with these and other questions typical:

- Are we calibrating our transmitters too often, resulting in excessive downtime and unnecessary maintenance expense?
- Are we calibrating our transmitters too infrequently, resulting in quality issues and possible loss of product?
- Are we calibrating our transmitters correctly?

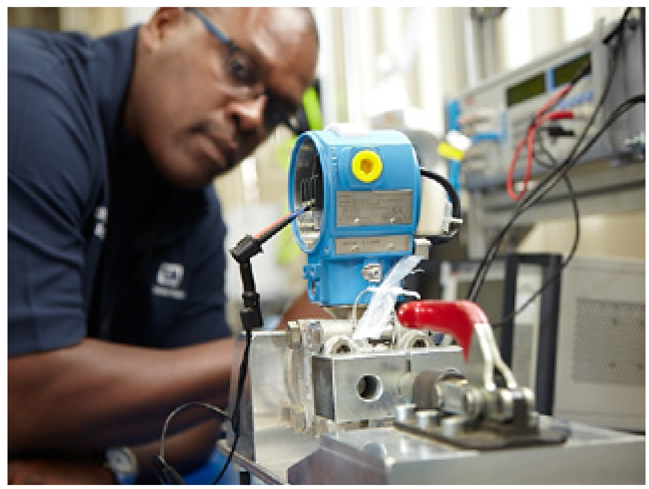
As with most things in life, there is no "one size fits all" answer. However, there are simple best-practice guidelines, which can be modified to fit specific applications. This article helps answer the basic questions facing process plant personnel with regard to calibration.

How Often?

Each process plant has to determine correct calibration intervals based upon historical performance and process-related requirements. Factors you need to consider that may influence this decision are:

- Are there any local, national, safety or environmental regulations that must be observed?
- What is your reason for requiring calibration: quality, safety or standard maintenance?

Process conditions:
- Is there a homogeneous process fluid with a stable pressure/temperature?
- Will the process conditions fluctuate significantly?
- Is there risk of buildup, corrosion or abrasion to the pressure transmitter?
- Will heavy vibration be present?



Ambient conditions:
- Will the pressure transmitter be installed in a well-controlled environment with low humidity, normal/stable temperatures, and few contaminants such as dust or dirt?
- Is an outdoor transmitter exposed to widely varying weather conditions or high humidity?

If you have no significant history or regulatory requirements to guide you in developing your calibration procedures, a good place to start is with the following general guidelines.

- Direct mounted pressure transmitters installed inside in a controlled environment on a process with stable conditions should be calibrated every four to six years.
- Direct mounted pressure transmitters installed outside on a process with stable conditions should be calibrated every one to four years, depending upon ambient conditions.

If a remote diaphragm seal is employed on a pressure transmitter, the calibration interval should be reduced by a factor of two, i.e., a four- to six-year interval is reduced to two to three years. This is because a remote diaphragm seal will employ more fill fluid than a direct mounted configuration. Consequently it will experience more mechanical stress from process or ambient temperature fluctuations. Most remote diaphragms are flush faced where the diaphragm/membrane is susceptible to physical damage (dents or abrasions) that can cause offset or linearity issues.

If the process regularly experiences significant pressure swings or over pressurization events, reducing the calibration interval by a factor of two is a good rule of thumb.

How Accurate?

How good is good enough? In other words, what is the Maximum Permissible Error (MPE) for your calibration?

Many make the mistake of adopting the manufacturer's reference accuracy as their calibration target. Unfortunately, this means they will have a MPE that is too tight, with a high rate of non-conformance in their calibration process. In the worst case with a very tight tolerance MPE, it may not be possible for their field or lab test equipment to calibrate some of their transmitters.

A manufacturer's reference accuracy is based upon tightly controlled environmental conditions seldom if ever duplicated in a plant environment. Using that reference accuracy for a calibration target also fails to take into account the long term stability of the instrument.

Over time, all instruments will experience slight accuracy degradation due to aging and simple wear and tear on mechanical components. This needs to be considered when establishing the MPE. In general, unless there are mitigating circumstances, it is better to set a reasonable MPE achievable with standard field and lab test equipment.

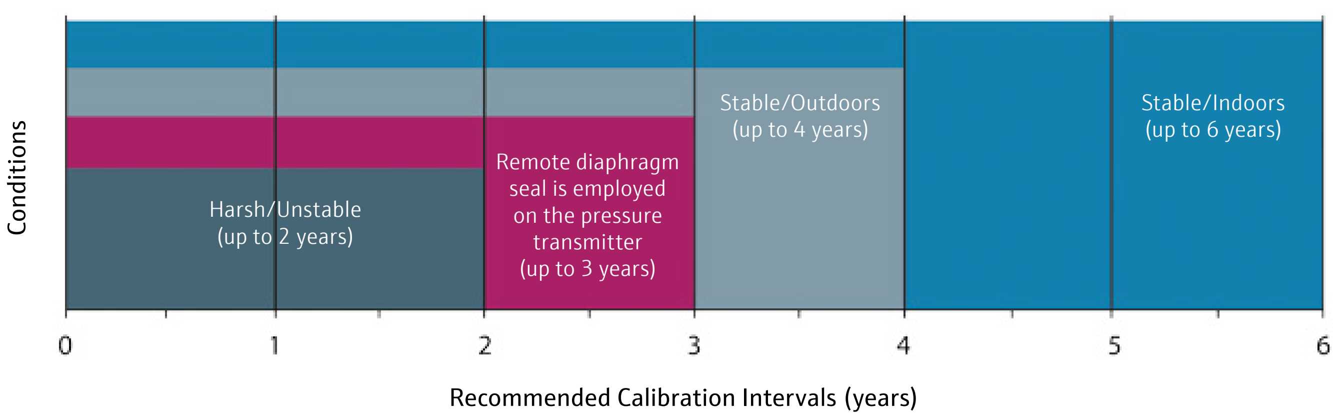
Test equipment starts with an accurate pressure source to simulate the transmitter input. The corresponding output is measured with a multimeter for a 4-20mA transmitter, or with a specialized device for smart transmitters with digital outputs such as HART, Foundation Fieldbus, Profibus or EtherNet/IP.

The test equipment you intend to use should be traceable to the National Institute of Standards and Technology. As a general recommendation, your reference equipment should be at least three times more accurate than the pressure transmitter being calibrated.

Performing the Calibration

Once your calibration interval and MPE have been established, you are ready to perform the actual calibration procedure on your pressure transmitter. The best practice recommendation from Endress+Hauser is:

1. Mount the transmitter in a stable fixture free from vibration or movement
2. Exercise the sensor/membrane before performing the calibration. This means applying pressure and raising the level to approximately 90% of the maximum range. For a 150 psi cell that would mean pressurizing it to 130-135 psig. Hold this pressure for 30 seconds then vent. Your overall results will be much better than if you calibrate "cold."
3. Perform a Position Zero Adjustment (zero the transmitter). This is important because the fixture used for calibration may be different than how the transmitter is mounted in the process. Failing to correct for this by skipping this step can result in non-conformance.
4. Begin the calibration procedure. Typically this means three points up (0% / 50% / 100%) and then three points down. The 4-20mA output should be 4mA, 12mA and 20mA at the three points (or the correct digital values for a smart transmitter). Each test point should be held and allowed to stabilize before proceeding to the next. Normally that should take no



more than 30 seconds. More points can be used if you require a higher confidence in the performance of the instrument.

5. Compare the results of your pressure transmitter to your reference device.
6. Document the results for your records.

The calibration should be performed in as stable an environment as possible because temperature and humidity can influence the pressure transmitter being tested as well as the pressure reference.

If the results of your calibration are within the MPE, do not attempt to improve the performance of the transmitter.

One mistake many end users make is to regularly perform a sensor trim adjustment of their pressure transmitter—even on new units from the manufacturer. A sensor trim corrects the digital reading from the sensor after the A/D conversion. Performing a sensor trim on a new transmitter is essentially a single point calibration under current plant environment conditions, as opposed to sticking with the original factory calibration.

Factory calibrations of pressure transmitters are performed in a tightly controlled environment and incorporate up to as many as 100 test points. Performing a sensor trim on a new pressure transmitter under field conditions will result in a unit that operates at less than optimal capacity. A sensor trim should only be performed by a qualified technician under the manufacturer's guidance.

Who Should Perform the Calibrations?

Even with the sophisticated calibration and reference equipment currently available, there is no substitute for a properly trained technician when it comes to calibrating pressure transmitters. Not only does the technician need to be trained on the mechanics of the calibration process, he or she also needs to be equally qualified in completing and maintaining the documentation. Repeatability is the key and in the world of calibration, if it isn't properly documented, it didn't happen.

Occasionally there are some calibrations that cannot be performed in a standard maintenance shop by maintenance technicians. For these cases, an ISO17025 accredited organization is required. Not only can an ISO17025 accredited organization perform more stringent calibrations, they provide other value as well:

- Accredited labs can simplify the calibration audit process.
- The process and methodology used by an accredited lab is extremely repeatable, thus producing a high level of confidence in the results from an auditor's perspective.
- Annual audits of the accredited lab ensure they are consistently performing at a high level for their registered scope of work.

Summary

The "correct" calibration cycle for a pressure transmitter will depend on the purpose of the calibration and the application. The same pressure transmitters employed in different operating units or processes at the same plant may require different calibration intervals.

Even more important than the calibration interval of the instrument are:

- Establishing correct and realistic MPEs
- Following correct calibration procedures
- The training of the person performing the calibration
- Proper documentation of calibration results.

Following these guidelines and using judgment based on actual plant operation conditions will help establish proper calibration practices, saving money while maintaining acceptable performance.


11.2

Flow monitoring in process cooling applications

Process cooling and refrigeration systems can consume too much energy from leaks and poor operation. Monitoring key parameters can identify problem areas and improve efficiency.

By Ravi Jethra, Endress+Hauser

Cooling and refrigeration are required in all types of process industries. In this article, we'll look at ways to monitor flow (Figure 1) to improve efficiency and detect operating problems.

Process cooling systems

In direct cooling systems, the medium which requires cooling (air) is in direct contact with the evaporator. Examples include air conditioning, cooling chambers and cooling tunnels.

Indirect cooling systems use a secondary medium—a refrigerant—to transport cooling energy to the point of use. Examples include cooling down milk, beer, soup or chocolate using contact cooling with plates, dipping cooling methods or a heat exchanger.

In breweries, air coolers keep hops at a certain temperature. Direct cooling is done within production processes, such as preparing hops for fermentation or beer aging. Dairies also use direct cooling within processes such as pasteurization, yoghurt preparation, cream and butter processing.

The chemical industry use direct and indirect cooling for many different processes, such as separation of gases, condensation of gases, dehumidification of air, solidification of solute, storage as liquid at low pressure, removal of heat of reaction, and cooling for preservation.

The life science industry needs cooling systems for product cooling, preservation, cooling production tanks, cleaning stations and room cooling. Blood plasma and antibiotics are manufactured by freeze-drying process where water is made to sublime at low pressure and low temperature.

Figure 1: Process cooling and refrigeration systems consume large amounts of energy. Installing flowmeters and other instrumentation helps analyze problems and find leaks

Refrigeration and cooling energy accounts for a huge proportion of overall energy costs in many industries. A small reduction in energy consumption can lead to significant cost savings. The first step in setting up an effective measurement program is knowledge about system characteristics at different operating conditions.

Need to know

Assuming that a plant engineer is familiar with cooling systems and knows what needs to be measured to obtain

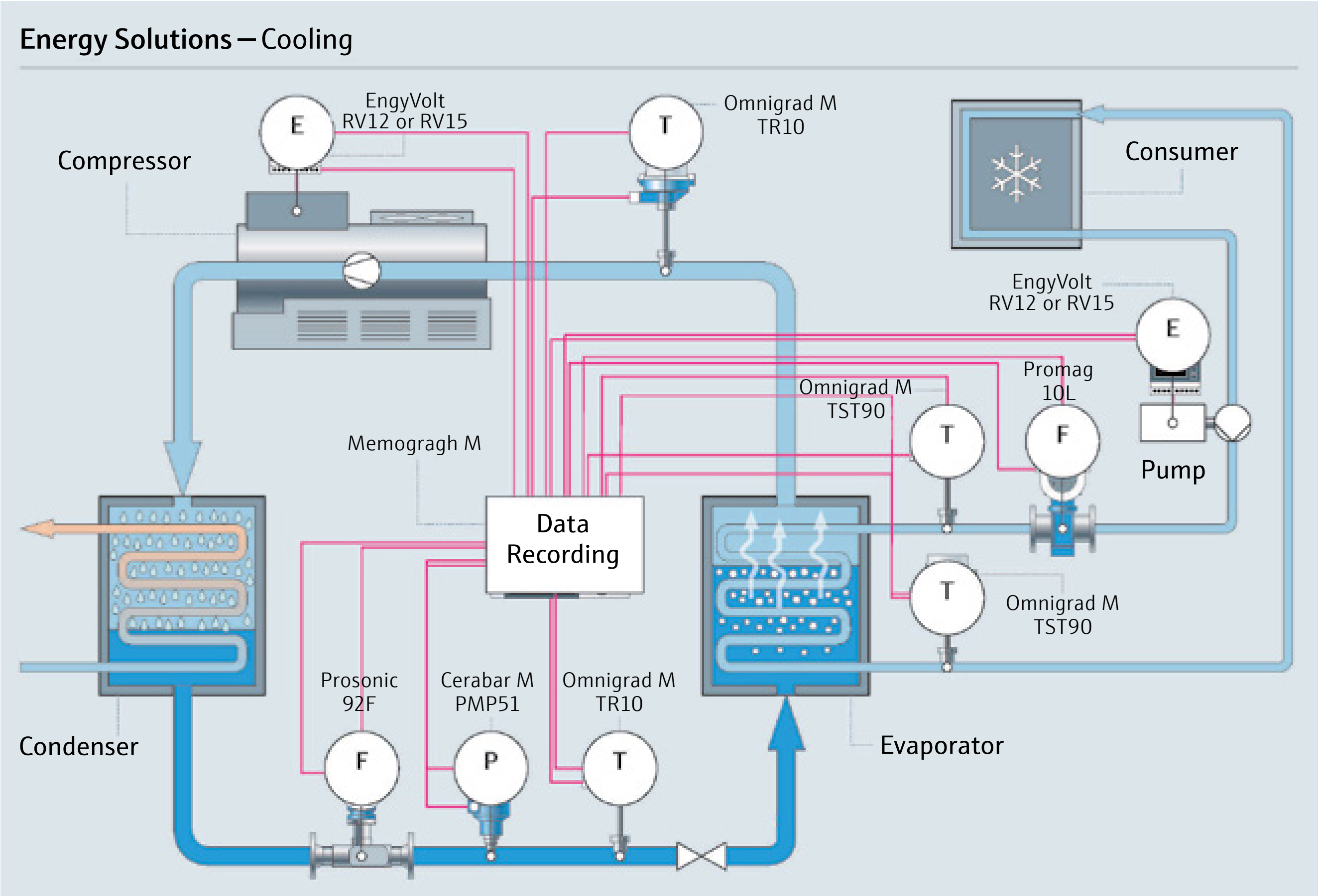


Figure 2: Typical cooling system and instrumentation. F = flow, P = pressure, T = temperature and E = electrical energy instruments

the necessary information, instruments and data acquisition systems can be employed. Such a measurement system will help determine:

- How efficient is the cooling system
- How efficient are each of the cooling compressors and pumps
- Are there any leakages within the cooling system
- What loads significantly affect cooling costs
- How to keep the cooling system at the ideal point of operation
- How to reduce start/stop cycles

Analyzing the performance of a cooling system also helps to:

- Benchmark efficiency of cooling systems compared to similar systems or industry values
- Determine the cost of refrigeration
- Assess a system's ability to meet added loads
- Quantify benefits of system modifications and improvements
- Verify predicted performance

Measurement requirements

Efficient refrigeration requires more than efficient components—it depends mainly on system configuration and operation. As refrigeration systems are typically custom engineered for each application, individual analysis of the supply and demand side is necessary to find the ideal point of operation.

It's important to define the right measurements to help evaluate cooling system efficiency, system leakages and energy consumption. Typical measurements (Figure 2) needed on a cooling system include:

- Volume or mass flow (typically after condenser, i.e., in liquid phase)
- Temperature in liquid line (after condenser and before expansion valve)
- Temperature in gas line (after evaporator)
- Electrical power consumption of compressor, fans, pumps
- Pressure at condenser outlet, before expansion valve
- Pressure at evaporator outlet

Making Measurements

Flow measurements in a cooling system typically are made:

- Flow in liquid line, temperature of liquid, temperature of gas, and pressure of gas and liquid to calculate cooling energy flow in primary circuit
- Flow and temperature in feed line, and temperature in return line to calculate cooling energy flow in secondary circuit (e.g., cold water)
- Flow and temperature in feed line, and temperature of return line at consumers

For flow metering in a primary refrigerant circuit, an ultrasonic flowmeter is recommended as there is virtually no pressure drop. Other types of flowmeters can cause a pressure drop which can lead to problems in the system. A clamp-on ultrasonic flowmeter works very well.

In some cases a vortex flowmeter can be used. It's important to ensure the wetted materials are selected properly for use with refrigerants such as NH_3.

For flow metering a heat transfer medium such as water, almost any flowmeter will work, including electromagnetic, Coriolis mass flow and differential pressure devices.

In indirect cooling, measurement of the flow rate of a coolant such as glycol in a secondary cooling circuit in the return line after a consumer may be needed. This measurement along with the temperature differential can be used to calculate the cooling efficiency.

Other measurements needed include:

- Electrical energy consumption of the compressor (including fans)
- Heat input of absorption chiller
- Electrical energy consumption of pumps in the distribution system
- Pressure of cooling fluid and process fluid at various points throughout the system to ensure there are no leaks and thus ensure system integrity

Processing the Data

Acquiring the data requires installing instrumentation on the various components in a cooling system. Processing the data requires specialty software that can either be developed by the plant or an outside expert, or is available in a data acquisition system such as the Endress+Hauser Memograph M RSG45 Data Manager, a data-acquisition system for small process-control applications.

Figure 3: A small data acquisition system, such as the Endress+Hauser Memograph M with built-in cooling system software, can calculate and display vital trends and results

The Memograph M adapts quickly and easily to every cooling system application. Measured process values are clearly presented on the display and logged safely, while limits are monitored and analyzed. Via common communication protocols, the measured and calculated values can be easily communicated to higher-level systems and individual plant modules can be interconnected.

The Memograph M comes with an energy package for glycol-based refrigerant media. By comparing input variables such as flow, electrical energy and pressure, users can calculate overall balances, efficiency levels etc. These values are important indicators for the quality of the process and form the basis for process optimization and maintenance.

Summary

Installing instrumentation on process cooling and refrigeration systems and then processing the data with specialized software will help plant operators and maintenance people find problems, such as leaks. Analysis of the data can also calculate load factors, detect peaks in demand, reduce start/stop cycles or run the system at the most efficient time.

Radar level measurement in high temperature and pressure applications

By: Rob Vermuelen, Level Product Manager – Endress+Hauser

Radar technology in general has been introduced to the process industry as being a measurement technology using high frequency electromagnetic waves that are not being influenced by the gas phase it travels through and the temperature and pressure conditions in process vessels. As processes get more extreme in temperature and pressure it is time to have a closer look at radar behavior in those critical applications and the solutions available on the market that overcome the obstacles.

Radar signals

All radar technologies available on the market that are used to measure level use the Time-of -Flight principle. This means that the radar measurement device measures the elapsed time between emitting and receiving of a pulse consisting of a bundle of high frequency electromagnetic waves. The frequency of the waves vary between 1 GHz for guided wave devices and 6 and 26 GHz for free space radars.

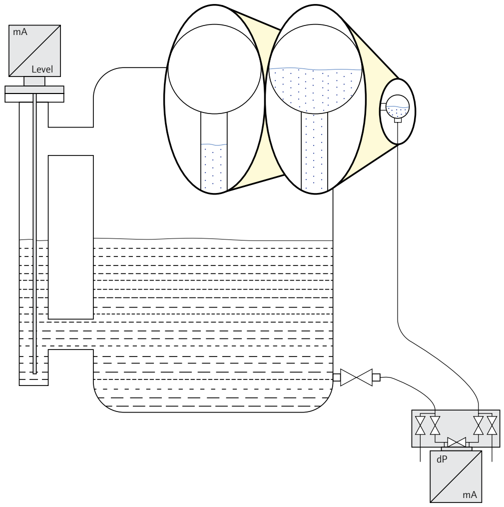
Speed of radar signals

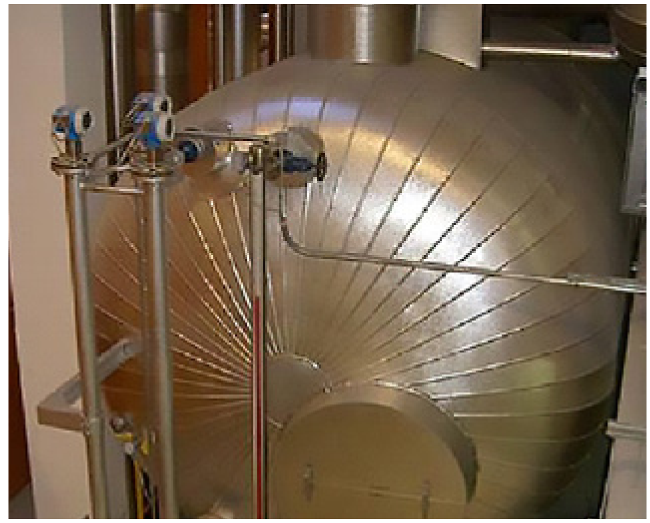
Radar signals travel at the speed of light when traveling through a vacuum. This speed however can be influenced when not traveling through a vacuum. Pressure and temperature of a specific gas phase or liquid has some influence on the speed of radar signals. The amount of influence depends on how polarized those gasses are—in other words, how much the dielectric constant changes. Hydrocarbon vapors show little effect even under high temperature and or high pressure process conditions. But a high polar steam does. The Dielectric constant (Dc) of steam at 212˚F is 1.005806. But at 691˚F it is already 3.086.

The change in speed of radar signals traveling through steam

In a typical steam application the level of the water in a condenser or boiler is of utmost importance. Radar measurement devices are used more and more in these

Gas phase	Temperature		Pressure							
	˚C	˚F	1 bar 14.5 psi	2 bar 29 psi	5 bar 72.5 psi	10 bar 145 psi	20 bar 290 psi	50 bar 725 psi	100 bar 1,450 psi	200 bar 2,900 psi
Steam (water vapor)	100	212	1.005806							
	120	248	1.005227	1.010601						
	152	306	1.004476	1.009048	1.023424					
	180	356	1.003950	1.007964	1.020432	1.042934				
	212	414	1.003458	1.006960	1.017743	1.036765	1.079856			
	264	507	1.002840	1.005705	1.014456	1.029597	1.062307	1.192220		
	311	592	1.002418	1.004851	1.012252	1.024933	1.051729	1.147384	1.424747	
	366	691	1.002036	1.004082	1.010283	1.020834	1.042799	1.116952	1.282623	3.086361



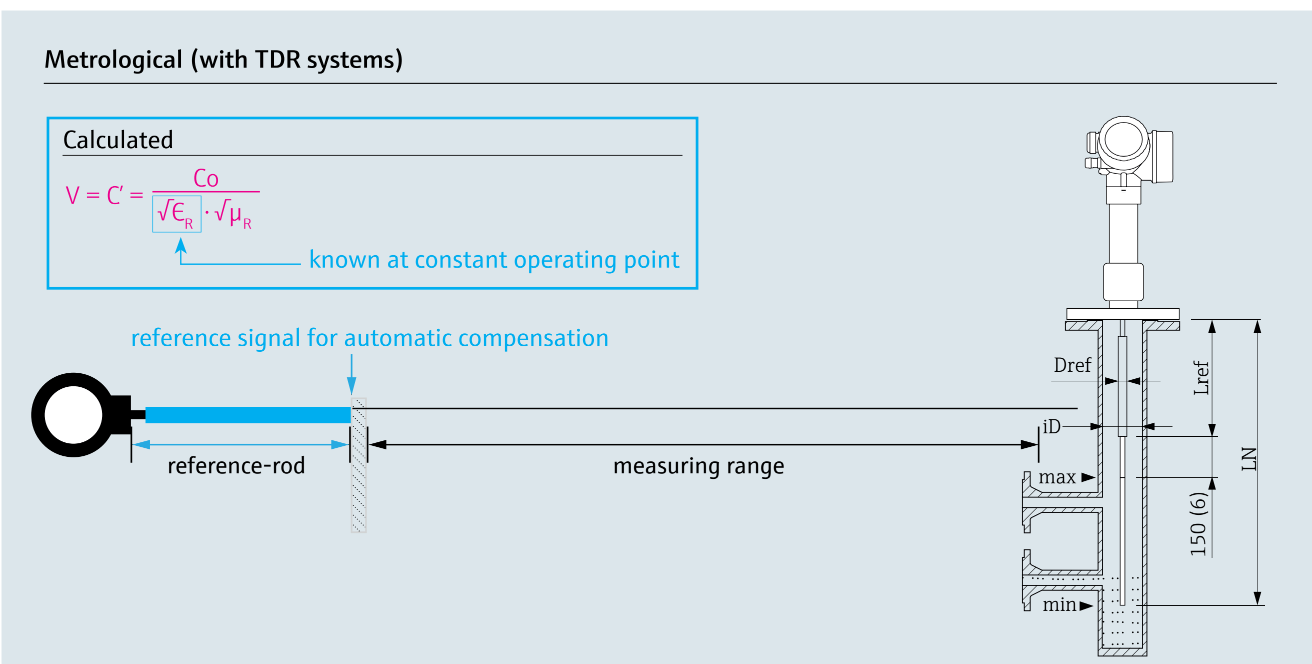


critical applications. They offer a great alternative with advanced diagnostics and insensitivity to build up and temperature fluctuations that bother the especially show significant errors due to a change in the density of water and evaporation in the compensating leg.

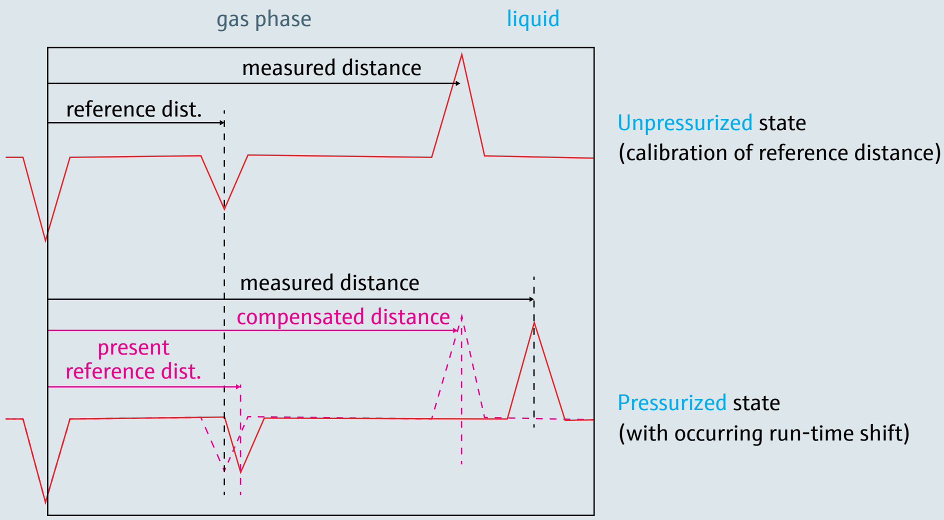
Steam is a highly polar gas, which means that the speed of radar signals in high pressure and temperature steam applications are subject to a reduction in speed. In a boiler for instance, this leads to a lower water level reading then there actually is. This can be dangerous and influences the performance of boilers and causes a reduction in the quality of steam. The error can easily be as large as 30-40% depending on the pressure and temperature of the steam and distance from the launch of the signal to the actual water level.

Overcoming the effects of process changes on radar speed

The simplest (but not the best) ways to overcome this problem is to put a fixed offset in the measurement device, by simply inputting the temperature or pressure and



Gas Phase Compensation: Function of automatic compensation



$$\text{compensated distance} = \frac{\text{reference dist.}}{\text{present ref. dist.}} \times \text{measured distance}$$

having the radar unit calculate the "offset." The problem with doing that is there will be rather big "errors" during the start-up of an installation. The normal operating conditions have not yet been met and thus the unit will be over compensating. One could also program a compensation table in a DCS or PLC and connect this to a pressure or temperature transmitter.

The right way —built-in dynamic compensation

The most accurate method is through the dynamic compensation circuit on a Levelflex guided wave radar. A reference signal at a known distance is used to compensate for the delay in speed of the radar signal measuring the water level. This is done dynamically—for example, when the reference pulse signal shows a small shift in time, the level signal will be compensated for this small shift. In converse, if the reference signal shows a large shift, then the level signal will be compensated for this large shift.

Conclusion

The use of radar signals in high temperature and high pressure applications in especially polar gasses is not as simple as it sounds. Under these conditions the speed of radar signals can change causing large measuring errors. An Endress+Hauser Levelflex guided wave radar offers a unique solution to compensate for changing radar signal speeds, offering peace of mind and confidence in the accuracy of your level process measurement.

Leader in innovation

Endress+Hauser receives the Swiss Technology Award for the Promass Q flowmeter

The Swiss Technology Award

The Swiss Technology Award recognizes innovative technology projects from businesses and universities. The prize, which has been awarded by organizers of the Swiss Economic Forum since 2007, identifies technology innovations and developments that make an important contribution to industry and society. From all the projects submitted, an interdisciplinary panel of experts select nine finalists, three each in the categories Inventors, Start-ups and Innovation Leaders. The awards are presented during the Swiss Innovation Forum in Basel.

With the Promass Q, Endress+Hauser has won the Swiss Technology Award in the Innovation Leaders category. The Coriolis-based flowmeter, developed especially for applications in the oil & gas and food & beverage industries, was cited for its outstanding measurement accuracy, even in difficult operating conditions. The prize was awarded on Thursday, November 17, 2017 during the Swiss Innovation Forum.

The Swiss Technology Award is considered Switzerland's most important innovation and technology prize. Endress+Hauser was one of nine finalists out of 60 applicants who were selected to present their product or technological innovation to the main jury. The winners were chosen and recognized in front of more than 1,000 guests from business, science and government during the Swiss Innovation Forum in Basel, Switzerland.

"With the Promass Q, we managed to combine state-of-the-art technology, innovative design and superior quality in a single instrument. We are proud that our efforts have been recognized with the Swiss Technology Award," says Dr. Martin Anklin, who is responsible for the development of Coriolis instruments at Endress+Hauser Flowtec in Reinach, the Group's center of competence for flow measurement technology.

Sustained innovation The Switzerland-based measurement and automation technology specialist places a high value on research and development. In 2016, global R&D investments at the Endress+Hauser Group were 7.8 percent of sales. The consistently high number of patent filings in all application areas of measurement technology furthermore illustrates the family-owned company's sustained innovation strength.

Promass Q—the specialist for demanding applications A high degree of measurement accuracy is extremely important in a wide range of industrial applications. In the past, however, this required an ideal environment with stable process conditions and single-phase, homogeneous media. With the Promass Q, Endress+Hauser guarantees unrivalled accuracy when measuring mass flow, volume flow and density, even under fluctuating process conditions.

With the Promass Q, Endress+Hauser has forged a new approach for precisely measuring gaseous media. The innovative multi-frequency technology (MFT) for Coriolis flow measurements makes it possible to actively compensate for measurement errors caused by entrained gas trapped in the medium, all in real-time. Integrated diagnostics and Heartbeat technology furthermore allow verification of the sensors, measurement tubes and measurement electronics while the process is running. This guarantees maximum product and process safety.

Real World Hands-on Training

Courses offered at our PTU® (Process Training Unit)

Our process instrumentation schools are designed to teach fundamental, theoretical and practical knowledge about instrumentation and application technology—with an emphasis on service and maintenance of instrumentation. Each course contains a balanced mix of lecture, discussion and opportunities to take a hands-on approach to learning.

Hands-on learning is facilitated by working instruments as demonstration units on the bench, in actual working conditions installed in a PTU or in portable training stands designed to simulate actual operating conditions. All instructors are seasoned professionals with years of real-world experience in measurement.

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March 12–16	AWWOA 43rd Annual Operators Seminar, Banff, AB
March 20–21	CsHm Calgary, Calgary, AB
March 13–14	Salon des TEQS, Quebec City, QC
April 15–17	WEAO Technical Symposium and OPCEA Exhibition, London, ON
April 22–25	MPWWA 38th Annual Training Seminar, Charlottetown, PEI
April 25–26	ISA Automation Expo & Conference, Edmonton, AB
July 18–19	Rockwell Automation on the Move, Vancouver, BC

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