Advances boost reliability, cost-effectiveness of next-generation magflow devices

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Introduction

Magnetic flowmeters are incredibly versatile. In industries including water and wastewater processing, pulp and paper, chemicals, metals, and mining, they are counted upon to measure many of the world's heaviest, highest volume, most abrasive, and dirtiest fluid flows. On the other hand, in applications involving pharmaceutical, food, dairy, or beverage production, their simple design and high measurement accuracy make them essential to the dispensing, blending, and production of high-value, high-quality ingredients and products for human consumption.

At the heart of every magflow meter is a basic idea. Magflow meters operate based on Faraday's Law of magnetic induction. It states that the voltage induced in a circuit is proportional to the time rate of change of the magnetic flux linking that circuit — in this case, the rate at which a liquid flows through a magflow meter.

Magflow meters use an electromagnetic coil to create a magnetic field across the flowtube. When a conductive fluid flows through that magnetic field, it produces a voltage signal that is read by sensors on the tube wall. The faster the fluid flows, the greater the voltage. A transmitter component converts the voltage to a measurement of flow rate.

The challenge of preventive maintenance

Though the fundamentals of magnetic flow measurement will never change, there have been significant recent advances in the technology that process operators can use to install, operate, validate, and maintain magflow measurement devices. To understand the difference that these technological advances can make, start by considering how process operators might respond to these operational challenges:

- Imagine a large magflow meter measuring the flow rate of a 36-inch wastewater pipe. After years of reliable operation, flowmeter readings begin to vary in an unusual manner, a possible indication that something is wrong. But what? Are the readings an anomaly or indicative of an instrument problem?
- Consider a mining or chemical process operation where a magflow device must measure highly corrosive liquids that are capable of damaging both the flowtube and the electrodes that measure flow. What factors might account for unusual readings in this application? When and how could a process operator gain enough information to justify a shutdown for investigation?
- Picture a pulp-and-paper operation, where process liquids carry a substantial volume of solids, solids that can accumulate in a flowtube liner or become trapped around the sensors. When process flow characteristics begin to fluctuate beyond typical limits, what factors might a process operator consider to determine what might be wrong?

In situations like these, there are few good answers. Often, diagnosis and resolution of flow-related operating challenges like these require process operators to undertake a costly maintenance exercise involving steps like these:

1.) Shut down the process.

2.) Remove, drain, and clean the suspect flowtube.

3.) Acquire and install a replacement flowtube.

4.) Inspect and test the suspect flowtube.

    a.) Inspect grounding rings and electrodes for wear, coating, or damage that could cause a fault.

    b.) Inspect for internal pipe damage or corrosion.

    c.) Bench-test flowmeter, including electrodes, magnetic coil, wiring, and transmitter for performance.

5.) If the meter passes the test, then reinstall. If not, then repair.

6.) Recalibrate.

7.) Reinstall if needed.

The process of diagnosing, repairing, and recalibrating magflow meters generally means that the suspect flowmeter has to be taken to a lab, or even sent back to the factory. And, until this process is completed, there is no way for process operators or managers to know whether a flowmeter problem actually existed or whether the downtime and lost production were due to another cause. Historically, the only way to limit the potential for problems like these was through periodic shutdown, inspection, and repair. While this is predictable, it is still costly.

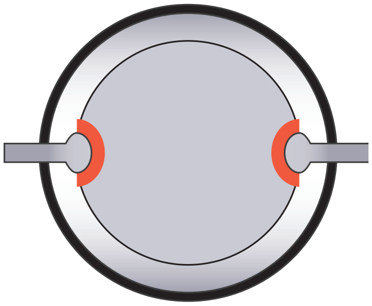

Figure 1. Advanced diagnostics can detect when an electrode is coated or fouled by undesirable substances.

The role of advanced diagnostics

Now, consider a different way to identify, diagnose, and address flow measurement challenges: What if it was possible to continuously test and validate the performance of a magflow meter — the flowtube and electrodes, the transmitter and onboard electronics — without guesswork, without having to shut down the process line, and without having to take the magflow device out of service?

Thanks to a host of technical advances, this scenario is now possible. Continuous self-testing, advanced diagnostics, and even external process monitoring features are now available in the latest generation of magnetic flowmeters, including the new Foxboro® MagPLUS Flowmeter from Schneider Electric. The advanced, multi-level diagnostic and monitoring capabilities of the latest magflow meters include:

Flowtube diagnostics

Continuous self-tests on the flowmeter are performed to ensure that the flowtube is properly applied, installed, and measuring within specifications. Continuous, real-time diagnostics can detect electrode fouling or scaling (Figure 1), electrode damage or leakage (Figure 2), liner wear or deformation, wire breaks, or other concerns that could disrupt measurement or process operations. If any measurement is drifting, diagnostics will indicate when readings exceed preset values and issue a timely warning to help prevent further drift.

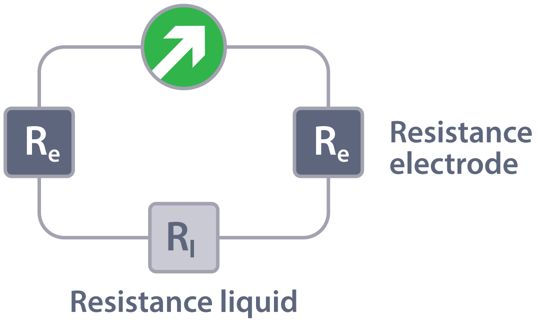

Figure 2. Improved diagnostics continually monitor electrode performance for changes that could signal electrode damage or leakage.

Transmitter diagnostics

The new generation of flowmeters also provides continuous checks for a variety of conditions to ensure proper conversion of voltage readings to fluid flow rate: internal diagnostics monitor transmitter accuracy, linearity, microprocessor and memory functions, operation of the electromagnetic coil, internal temperature, and more. And while linearity malfunctions are rare, they can be very detrimental to accuracy, so this new technology confirms accuracy of linearity continuously in real time without varying current or interrupting operations.

Process monitoring capabilities

The latest magflow devices also offer a window into process conditions, enabling operators to monitor a variety of process factors and identify concerns that could affect measurement accuracy, indicate process problems, or cause process upsets. These factors include:

- Flow profile
- Conductivity limits
- Fluid temperature
- Presence of bubbles/entrained air
- Presence of solids
- Partial pipe fill

These advances in diagnostic and monitoring capabilities mean that, for the first time, process operators can be assured of magflow device operation and flow measurement accuracy in real time. They also ensure that, should something go wrong, operators will have access to real-time alerts and detailed diagnostic information to help pinpoint the problem. With the help of this information, they will be in the best possible position to take prompt corrective action to correct process faults, preserve product quality, and maintain safe operating conditions.

Trouble-free "virtual grounding" solutions

Effective magnetic flow measurement depends upon establishing and maintaining a ground to the process fluid, since the voltage changes that a magflow meter senses to measure fluid flow are always relative to the fluid ground reference. In cases where conductive metal pipes are used to transport fluids, establishing the fluid ground is easily accomplished by grounding the pipe. However, fluid grounding is more challenging to provide in situations where metal pipes have corroded due to age or wear, or when process conditions or fluid types dictate the use of plastic or specially lined pipes that are non-conductive.

Traditional fluid grounding for non-conductive pipes is accomplished by inserting conductive grounding rings upstream and downstream of the magflow device. These rings, whose materials must match the electrical potential of the wetted electrodes within the flowmeter, function by eliminating any voltage that exists in the process fluid (Figure 3). This ensures that the only voltage remaining is that generated by the flow of the liquid through the magnetic field in the flowtube — the voltage the meter depends on to precisely measure flow. (Note: In process operations where acidic or caustic flows necessitate the use of specialty magflow electrodes made of titanium, platinum, or tantalum, acquiring grounding rings of the same material can be quite expensive.)

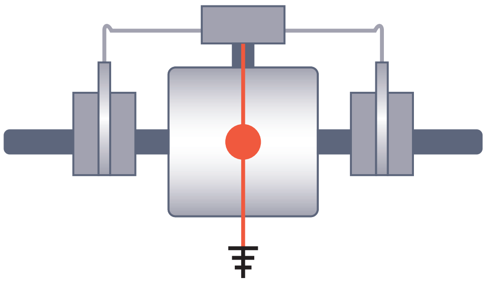

Figure 3. Traditional Grounding puts conductive rings in contact with the process fluid to eliminate voltages in the fluid.

To overcome the costs and limitations associated with installing and maintaining traditional fluid reference grounding, magflow device makers like Foxboro have developed a technology called virtual reference grounding. This technology, which is available in transmitters like Foxboro's IMT33A (part of the MagPLUS flowmeter product line) works with all types of piping and in a wide range of applications and circumstances. The technology simulates a fluid ground reference through the use of a microprocessor-driven algorithm that monitors and removes the floating voltage potentials in the moving process fluid. Removing these floating potentials from the flow signal (essentially the same potentials and "noise" that would be eliminated by a traditional earth ground), results in a steady, noise-free voltage signal used to read the fluid flow (Figure 4).

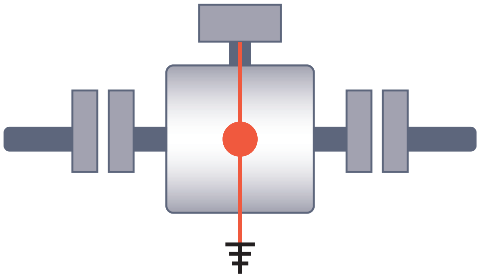

Figure 4. Virtual Grounding uses a microprocessor-controlled algorithm to cancel out floating voltage potentials in the process fluid.

Conclusion

The latest generation of magnetic flowmeters sets new standards for precision, performance, and cost effectiveness, but not by changing any of the fundamental elements of magnetic flow measurement. Instead, these magflow devices add value and improve performance by integrating continuous self-testing capabilities, advanced flowtube and transmitter diagnostics, and a range of process monitoring functions. Thanks to these advanced capabilities, process operators and managers can validate instrument performance — or identify, diagnose, and address many flow-measurement and operating challenges in minutes. The guesswork and cost long associated with routine shutdowns and traditional flowmeter troubleshooting and repair processes are virtually eliminated.

At the same time, the advanced diagnostic and monitoring capabilities of the latest magflow devices provide trend information and alerts that signal the need for preventive device or process maintenance that can prevent later, more serious, or costly problems. This kind of input lends itself to management strategies that strive for improved asset management, greater process utilization and uptime, maximal automation, and minimal staffing requirements.

Another advance, the development of virtual reference grounding as a transmitter-based feature, substantially reduces the time and resources needed to install and operate magflow measurement for a wide variety of process fluids and process piping types. It also provides a solution for extending the life and performance of metal piping systems where traditional grounding systems may be compromised by age, mechanical wear, or corrosion.

About Foxboro Field Devices

Schneider Electric's Foxboro Field Devices deals with the measurement and control of processes, such as flow, temperature, pressure, level and other applications. As a global specialist in energy management and market leader in industrial automation and software, Schneider Electric enables people to experience and transform efficiency where they live and work — from home to enterprise, across the grid and the city.

Focused on making energy safe, reliable, efficient, productive and green, Schneider Electric is building a world in which innovative individuals use collaborative solutions to make the most of their energy, while using fewer resources. Schneider Electric's market-leading software and services enable customers to monitor, control and automate their products and processes.

Foxboro has a network of sales, engineering, and service offices and facilities on all six continents ready to serve clients. This combination of global and local support gives clients the best of both worlds — and the foundation they need to remain competitive.

About Schneider Electric

Schneider Electric is the global specialist in energy management and automation. With revenues of $30 billion in FY2014, our 170,000 employees serve customers in over 100 countries, helping them to manage their energy and process in ways that are safe, reliable, efficient and sustainable. From the simplest of switches to complex operational systems, our technology, software and services improve the way our customers manage and automate their operations. Our connected technologies reshape industries, transform cities and enrich lives. At Schneider Electric, we call this Life Is On.

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