Better flowmeter management with EDDL

Water and wastewater plants, that use intelligent magnetic flowmeters, benefit from accurate and reliable measurement, more reliable empty pipe detection, and low maintenance costs for calibration thanks to the embedded Smart Meter Verification. Enhancements to the Electronic Device Description Language (EDDL) make use of these features to manage flowmeters easily

Magnetic flowmeters can be managed from the same universal device management software as a plant's other devices, like pH and dissolved oxygen analysers, electric actuators, and variable speed drives. Continuous health monitoring from a central location is made possible using bus technologies and wireless communications, so operator rounds to check local displays in the field can be eliminated. Expert know-how is made available to help in the interpretation of diagnostics for faster problem resolution.

Principle of operation

The magnetic flowmeter is based on the principle of Faraday's Law: A conductor moving through a magnetic field induces a voltage proportional to the velocity of the conductor. In the case of a magnetic flowmeter, two coils located at the top and bottom of the flowtube are driven by the transmitter to generate a pulsed magnetic field of consistent strength. The induced voltage is proportional to the velocity of the conductive liquid passing through the flowtube. A saddle-style coil design reduces the length of straight upstream and downstream piping required. The induced voltage is picked up by electrodes on either side of the flowtube and measured by the transmitter. The flowtube is calibrated in the factory obtaining a "calibration number" (K-factor) keyed into the transmitter. The velocity is calculated from the induced voltage and the calibration number. Volumetric flow is obtained by multiplying by the flowtube cross-section area.

Magnetic flowmeters are suitable for conductive liquids. They are used across all industries including municipal and industrial water and wastewater treatment where they measure flow of sludge, chemicals, and treated water.

Lower cost of calibration

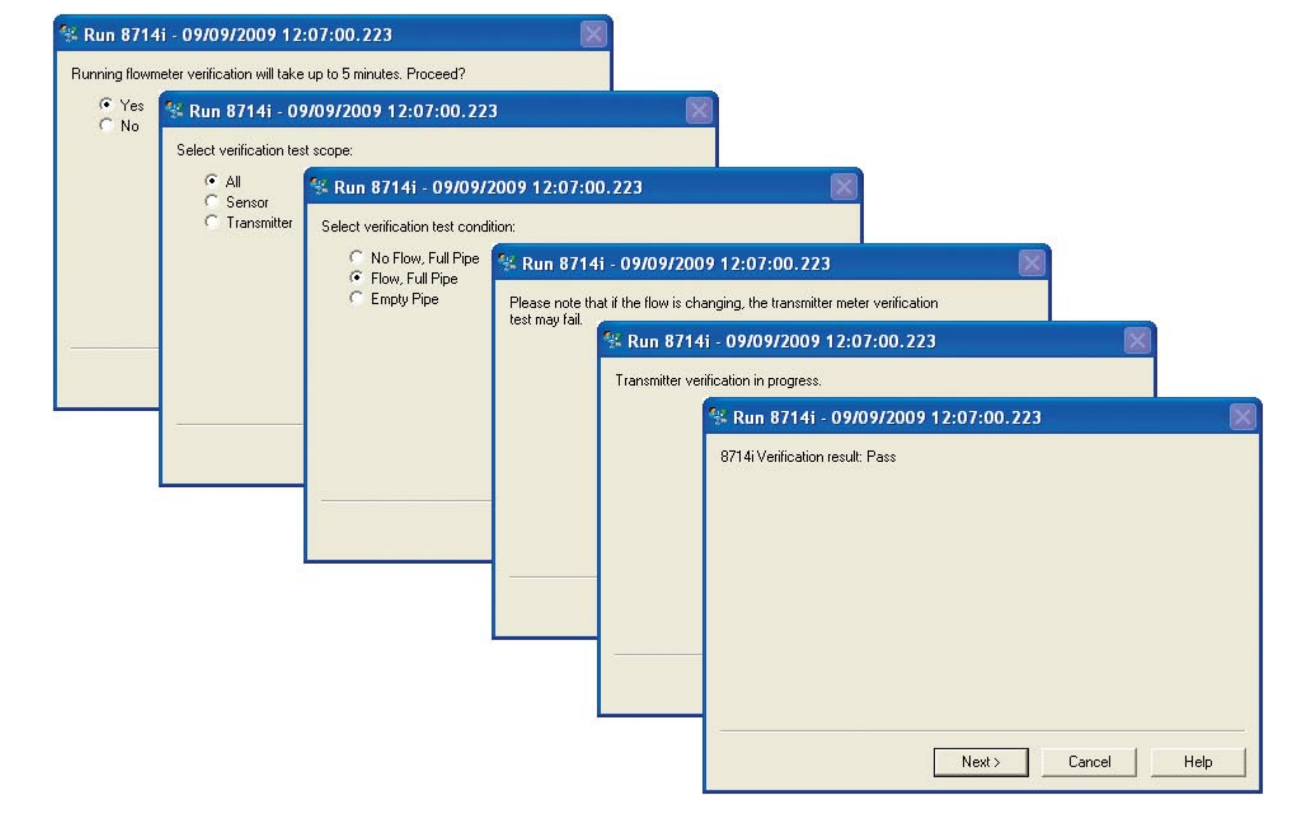
Over time, temperature cycling and vibration cause mechanical shifts in flowtube coils, which in turn leads to changes in the magnetic field. Moisture and coating on the electrodes can also change the flowtube's response and cause measurement to drift out of calibration. The A/D conversion of the induced voltage in the transmitter may drift.

When a magnetic flowmeter is out of calibration, flow measurement becomes inaccurate, resulting in incorrect recording and reporting. Optimising control is difficult if the flow measurement is uncertain. For these reasons, water and wastewater treatment plants are required to periodically verify calibration to meet their own internal quality standards and satisfy government regulations. Calibrating too frequently is costly, time consuming, and disrupts the treatment process. If calibration is not done often enough, water quality can be negatively impacted. The ability to annually verify that the flowmeter is within required accuracy specification is in many cases required by law.

In the past, transmitter calibration was verified against a simulator. The flowtube was not verified at site. That is, the test was not complete. Even this simple test required the flowmeter to be powered down, and the wiring had to be disconnected before the simulator could be connected. Then electronics needed time to warm-up. The configuration of the transmitter had to be changed for the check, and then returned to operations settings. This process was disruptive and time consuming. Many water and wastewater treatment plants relied on outside contractors to perform this check on all their flowmeters, incurring high maintenance cost. LCR (inductance, capacitance, and resistance) meter and multimeter were used to check for outright failure of coil or electrodes, but did not detect shifts in characteristics that could be indicative of drift.

Traditional methods for a complete check of the flowmeter – including the flowtube – are expensive and labour intensive. They require a yearly shutdown, removing the flowtube, and

Figure 1: EDDL wizard guides the user step-by-step through flowmeter verification.



shipping it for proving to the manufacturer's flow lab. Typical turnaround time is approximately four weeks. Spare flowmeters of matching sizes and materials could be required to install on a rotating basis while the flowmeters are being calibrated in the flow lab.

Another option is to bring in a mobile prover rig and skilled technicians. This procedure is labour intensive and disruptive. The outside contract work is costly, increasing dramatically with line size.

A better solution is in-situ *Smart Meter Verification*, in which the complete performance of a magnetic flowmeter is verified. Electronics determine whether a magnetic flowmeter has experienced a change in magnetic field strength, coil resistance, or electrode resistance. The current characteristics for magnetic field strength and electrode resistance are compared to the baseline parameter values when the magnetic flowmeter was last fully calibrated. The baseline parameters for coil resistance are captured at installation. Test criteria can be set to the levels necessary to meet compliance requirements for the application. Deviation between the current values and the baseline values that exceed the test criteria indicate full calibration will be needed. If the change in flowtube characteristics is minor, the flowmeter passes the verification test and need not be calibrated. The meter verification report can be printed for submission to a regulatory agency such as environmental protection or pollution control, and filed for future reference.

Smart Meter Verification is embedded in magnetic flowmeters; no external equipment is required, and technicians need not take the meter out of line, so the plant keeps running. There is no need to power down the flowmeter, change the configuration of the transmitter, or connect a simulator. The *Smart Meter Verification* test procedure takes only a few minutes and can be run at any time – started remotely at the click of a button. No long-term trending is required.

Thanks to digital communication protocols such as HART®, Foundation™ fieldbus, or WirelessHART™, *Smart Meter Verification* can be triggered remotely from the maintenance station in the control room. The technician need not go to the field to connect equipment or press buttons on the local operator interface. Electronic Device Description Language (EDDL) makes it possible to initiate the *Smart Meter Verification* from any control system supporting EDDL (www.eddl.org), and today all leading systems do. EDDL wizards created by the flowmeter manufacturer guide the technician step-by-step; no specialised training is required. Percent completion is displayed throughout the procedure so technicians know how much longer they need to wait.

The meter verification wizard makes this a simple pass or fail test. It does not present incomprehensible numerical

Figure 2: Meter verification detects leading indicators of drift by comparing present characteristics against stored baseline signature.

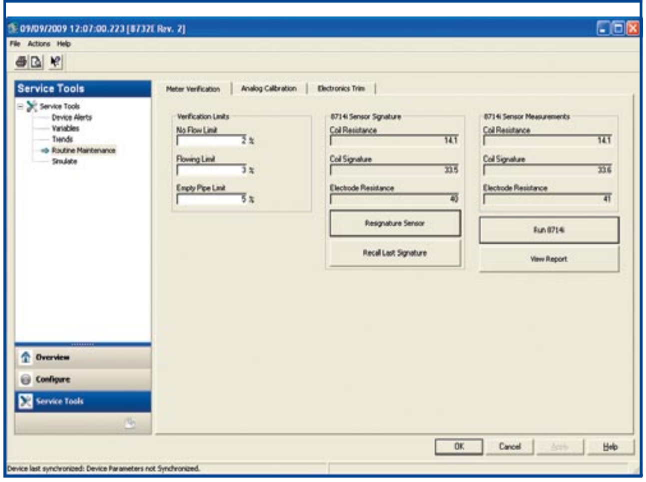
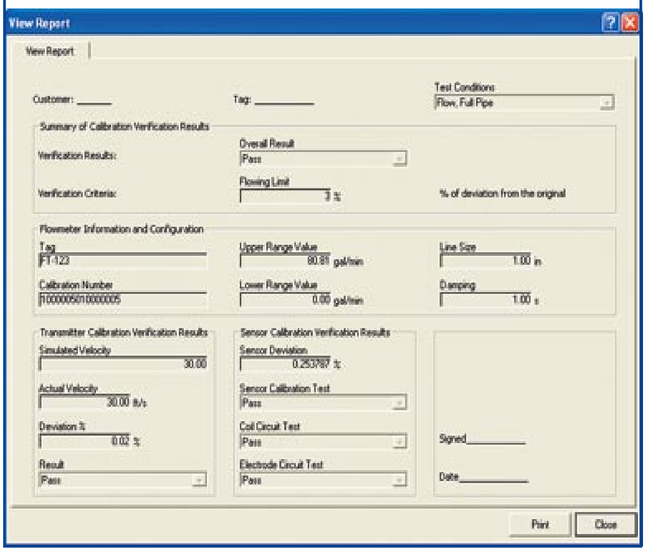


Figure 3: The meter verification report can be printed documenting the results.



values or charts that need interpretation, but rather offers clear, actionable information. If the result is "fail", the technician schedules calibration, or if damaged, replaces the flow sensor. If the result is "pass", calibration can wait.

Test results are automatically entered in a report, ready for print out from any EDDL-based system.

In-line meter verification is faster than calibration and non-disruptive to operations. Unnecessary calibrations can be eliminated, saving the plant thousands in operating costs each year by calibrating only those magnetic flowmeters that need it. Verification helps ensure regulatory compliance with fewer calibrations at lower cost. By knowing the magnetic flowmeter is unchanged, maintenance personnel may be able to extend the time between calibrations for some magmeters. Plant availability is increased as plant downtime for calibration is reduced. Verification enables magnetic flowmeter problems to be identified before they adversely affect the water quality.

Increasing performance

There are two main sources of noise for magnetic flowmeters: Electrical noise due to poor installation, and process noise from the application. Noise results in erratic flow measurement and poor ability to control, for example, the amount of treating chemicals entering a process. Personnel may have to operate loops in manual, resulting in poor water quality and waste of chemicals.

The most common installation issue with magnetic flowmeters is improper grounding where the magnetic flowmeter is not properly referenced to the process which allows noise to be picked up by the electrodes.

Some applications, such as slurries, entrained air, and active chemical reactions can also result in noise. Background noises such as pumps can affect the measurement signal.

On older magnetic flowmeters, the only hope to deal with a noisy process was to apply damping (first order lag filter) on the process variable (PV). However, damping negatively impacts the ability to control, resulting in fluctuations which in turn translate into lower water quality. Moreover, the over-damped PV misleads operators.

Some electromagnetic flowmeters have built-in diagnostics that measure the amplitude of the noise at 50/60 Hz. If the level exceeds the limit for best practices, indicating stray electrical noise, it is flagged as a fault. The installation can be verified at a glance in the diagnostics page. This diagnostic can also detect if grounding is lost over time due to corrosion, etc. Depending on the criticality of the flowmeters, operators or technicians can be alerted to this abnormal situation, prompting technicians to review the installation: Grounding wires, grounding rings, grounding electrode, cable shields, etc. There is no need to configure any parameters to make this diagnostics work. Thus, it is easy to benefit from.

Leading magnetic flowmeters are capable of stable operation in noisy applications by increasing the drive frequency and use of a Digital Signal Processor (DSP) to condition the measurement. However, instrument technicians need to know when to select a higher drive frequency. Therefore, these magnetic flowmeters have built-in diagnostics that measures the amplitude of the noise around the drive frequency. The noise level is compared to the signal level. If the signal-to-noise ratio exceeds the limit for best practices, indicating excessive process noise, it is flagged as a fault. The severity of the process noise can be verified at a glance in the diagnostics page. The magnetic flowmeter manufacturer uses standard EDDL (IEC 61804-3) to structure the content in a hierarchical menu system, adding graphics, wizards and conditionals to automatically handle data dependencies,

Figure 4: Magnetic flowmeter diagnostics page with actionable help provided by manufacturer's expert.

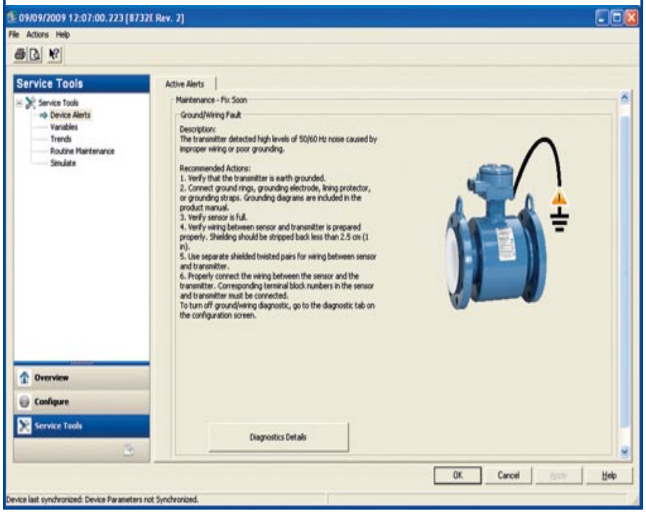
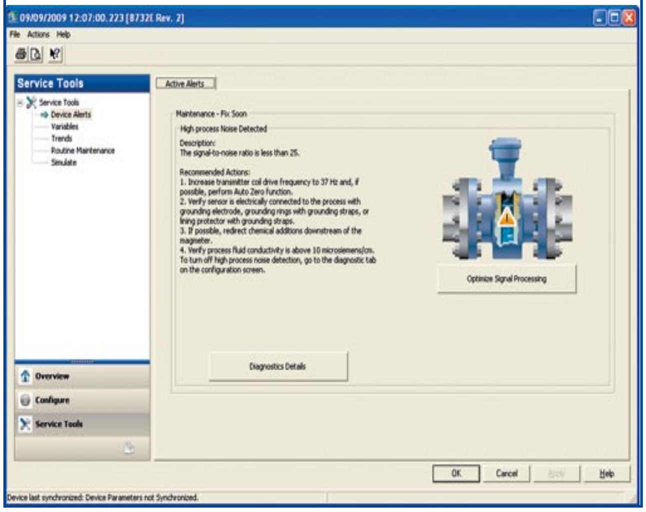


Figure 5: Magnetic flowmeter diagnostics page with know-how provided by manufacturer's expert as help text and illustrations.



making the flowmeter intuitive to use while providing full support for all its functionality.

Noise due to installation problems are identified at the time of installation and can be eliminated before the loop is started up.

Identifying process noise enables drive frequency to be set at ideal levels for the application. Less damping enables tighter control and loops that operate with the PID automatic mode, resulting in reduced fluctuations, and increasing water quality. It also enables setting ideal setpoints, thus achieving higher throughput, lower energy and chemicals cost.

Diagnostics you can trust

An empty pipe may result in false flow reading and totalization. This is particularly an issue in batch applications where the pipe often runs empty between batches.

Empty pipe detection is provided in most magnetic flowmeters with "cut-off" to force the flow reading to zero at no flow to eliminate false counts in the totalizer. But there is a great differentiation in how it is done. For instance, empty pipe detection based on an additional electrode has not always been reliable, and may cause false alarm and cut-off from gas pockets/bubbles. Diagnostics which triggers falsely are as bad as no diagnostics at all because both result in unnecessary service calls. Often times, the empty pipe detection was turned off due to such nuisance alarms resulting in noisy output when the pipe is empty. However, with microprocessors there is a better way.

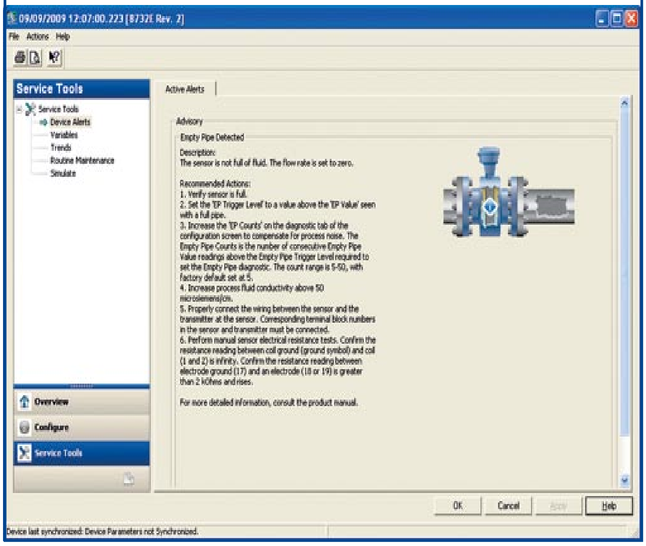
Process diagnostics are more challenging than device diagnostics. Devices fail in well-known ways that are easy to detect. However, across different industries there are many diverse processes and applications, with constantly changing conditions that make process diagnostics like empty pipe detection challenging.

Firmware embedded in the magnetic flowmeter has greater flexibility to handle process diagnostics. The principle for handling the diversity of process diagnostics is for the flowmeter to first "learn" the characteristics of the condition to be detected, and next to set a trigger level baseline at which a process problem shall be flagged. The key to trustworthy process diagnostics is to set a baseline threshold which has sufficient margin from "normal" condition in order to not result in a false alarm, yet not too conservative to not trigger on an actual problem. The first generation empty pipe detection firmware used a learn function to take a reading when the pipe had been emptied. However, if process conditions changed this could result in false alarms and technicians ended up having to "relearn" the empty reading.

Some electromagnetic flowmeters have tunable empty pipe diagnostics that can be adjusted to the specific application to prevent false triggering. The magmeter empty pipe diagnostics function continuously measures an "empty pipe value", a number dependent on fluid properties and other application characteristics, providing the most flexibility and insight into empty pipe detection. For challenging applications, the technician can at the time of magmeter commissioning, capture the empty pipe value for both a full and empty pipe, and set the threshold in between these two values providing robustness in the face of process changes. Once in operation, an empty pipe value exceeding the threshold triggers the empty pipe alert. A delay can be set to reduce sensitivity in applications where slug flow is expected in order to not trigger on intermittent air bubbles.

It is easy to suppress empty pipe diagnostics to not cause nuisance alarms during commissioning when pipes are not yet flowing.

Figure 6: Magnetic flowmeter diagnostics page with actionable help made available through EDDL.



Since diagnostics are more reliable, and time wasted on false empty pipe alarms is reduced. Reporting errors or poor control which would result from turning off empty pipe detection is avoided.

Incorporating diagnostics in maintenance

Most treatment plants have hundreds of field devices, many of which are not easily accessible. Most device failures will, if they go unnoticed, have a negative impact on the water treatment in terms of inferior water quality, reduced capacity, or even a complete shutdown. Although operators walk around the plant on a regular basis, they cannot check on all of these devices.

In the past, magnetic flowmeters and other devices were not inspected unless the operators suspected some type of problem. They had self-diagnostics, but a technician had to be sent to the field to check the indicator or hook up a handheld field communicator to know if the sensor or transmitter had a problem. This maintenance approach was reactive rather than predictive and therefore not very effective. By relying on the local display, plant personnel were not utilising the full power of the intelligence built into magnetic flowmeters.

Today, digital plant architecture with a network infrastructure, such as HART, Foundation fieldbus or WirelessHART, establishes a permanent digital connection with magnetic flowmeters and other instrumentation. Intelligent asset management software uses this infrastructure to continuously monitor every networked device in the plant. There is no need to send a technician into the field to look at the local display to determine if there is grounding or other problem; the diagnostics are available on operator or maintenance station in only two clicks. In addition, problems are reported immediately when detected by the device's self-diagnostics,

enabling corrective action to be taken sooner. EDDL is used by the magnetic flowmeter manufacturer's expert to share know-how in the form of text and illustrations which guide the technician toward a resolution for the problem.

Because EDDL is a compressed text file, not a driver program, it does not interfere with other software in the system. The non-intrusive characteristics of EDDL permit it to be integrated on the DCS operator consoles as per NAMUR NE 91 recommendations. Empty pipe is a process problem that needs to be brought to the attention of operators, but even an installation issue like a grounding fault may be of interest to them. That is, when a problem like noise due to ground fault occurs, operators have minutes or hours to respond to prevent the problem from escalating. Diagnostics are used as an early warning. Once operators have taken care of their

Figure 7: Wireless adapter unleashes the power of field intelligence trapped in advanced flowmeters connected to control systems without HART support.

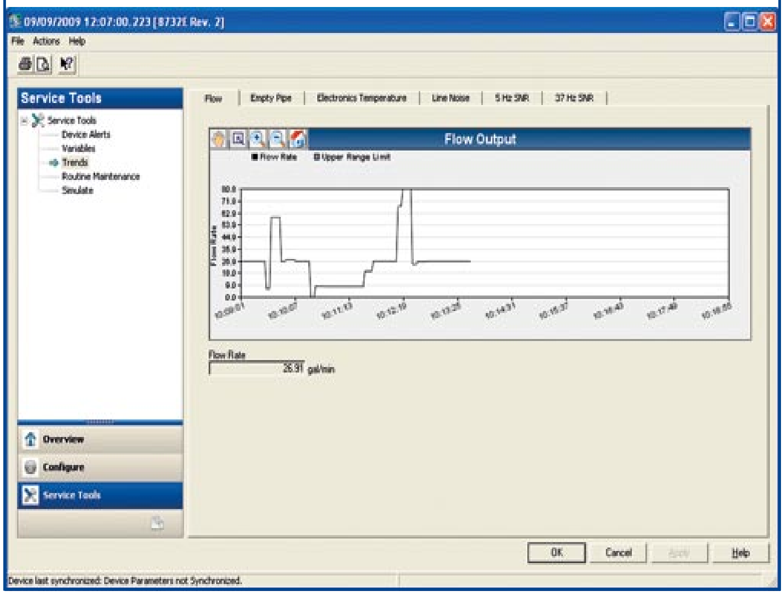
process, they can call on technicians to fix the installation. Had the diagnostics only been displayed on a dedicated maintenance station, they would not have been seen and acted upon as the maintenance station is typically unmanned. Device diagnostics are prioritised to prevent operators from being flooded in non-critical alarms.

High-end control systems use FOUNDATION fieldbus or HART which provides access to advanced flowmeter functionality. However, even if the water treatment plant's existing system such as a PLC does not support communication with smart devices, it is still possible to benefit from Smart Meter Verification and noise diagnostics by fitting a WirelessHART adapter on the magnetic flowmeter. A wireless gateway and intelligent device management software enable meter verification to be run and diagnostics to be monitored from a dedicated computer.

Once this simple wireless infrastructure is in place, it can be used for many other functions. It is now possible to deploy wireless transmitters for pH, temperature, level, conductivity, pressure, pump vibration and valve position monitoring in various applications for improvement in "mini projects" impractical in the past.

Unnecessary trips to the field can be reduced by checking flowmeter health remotely. As a result, technicians can focus on the devices that really need their attention, thus reducing failures and plant downtime.

Figure 8: EDDL enhancements include multi-pen trend chart that assists in identifying intermittent problems.



Standardising maintenance software

Instrument technicians often face the challenging task of managing a mix of device types including many kinds of flow measurement technologies from different manufacturers.

EDDL has made it possible to configure, calibrate and diagnose magnetic flowmeters from the same universal device management software used for the other devices in the plant. Technicians apply what they have already learned from working with the other types of devices to the magnetic flowmeter. For instance, they are already familiar with the buttons to apply an edited value, to print, to get help and to pan/zoom on the graphs and charts, etc. The technicians already have the clicks and key strokes at their finger tips and are less likely to make errors, as usage is second nature. It is possible to use the magnetic flowmeter without having to stop and think and pay attention to peculiarities of stand-alone software. Even multiple versions of devices are easy to handle.

The same degree of consistency and ease of use cannot be achieved with other device integration technologies because the user interfaces for various devices are invariably programmed differently.

Information chain

Smart Meter Verification functionality built into advanced electromagnetic flowmeters reduces maintenance cost and saves time by letting technicians determine if the magmeter needs to be removed for calibration or if it can wait. *Smart Meter Verification* is a sensible investment, reducing operations and maintenance costs by making calibration necessary only when really needed. Wizards developed by the device manufacturer's experts guide instrument technicians through the verification procedure step by step. Ground and process noise diagnostics uncover problems previously undetected, without sending a technician to the field. These advanced new functions are user-friendly because EDDL hides any underlying complexity embedded deep inside the device, and guidance is provided by the flowmeter manufacturer. It is not necessary to switch device management technology to benefit from new innovative devices. Instead, upgrade from traditional DD to enhanced EDDL.

A digital plant architecture that uses the power of field intelligence to improve plant performance utilises an unbroken chain of intelligent flowmeters and other devices, digital networking, and universal device management software to deliver accurate, actionable information to the right person in time to make a difference. **WWA**

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