pH made easy, reliable

Mr Jonas Berge of Emerson Process Management tells us how

Water and wastewater treatment plants, as well as other industries, use several types of liquid analyzers to monitor quality in terms of many different properties. The pH meter is one of the most important. Analyzers communicate digitally using protocols such as HART®, Foundation® fieldbus, and WirelessHART. Maintaining this mix of analyzers can be a challenge. This is a result of analyzer probes being in direct contact with the process and subject to various different problems depending on the process conditions. However, modern pH analyzers diagnose themselves, the glass, and reference electrodes in the sensor, as well as the temperature sensor. This allows for more effective maintenance schemes that help keep the loop and plant running with minimum downtime.

Recent enhancements to the EDDL (Electronic Device Description Language) IEC 61804-3 standards have helped improve calibration and advanced diagnosis of high-end pH analyzers.

Calibration made easy

As a pH electrode glass membrane ages, the sensitivity drops. Regular recalibration against buffer solutions is required to correct for the loss of sensitivity and is usually done in two points. Auto calibration avoids common pitfalls, reduces errors as the analyzer calculates the actual pH of the buffer from the nominal value entered by the technician, and does not accept calibration data until readings are stable. In manual calibration, the technician enters buffer values and judges when readings are stable. The pH reading can also be standardized, which forces it to match the reading from a referee instrument.

A plant may have dozens of analyzers that can be a mix of different brands, different models, and even use different protocols. Mastering this mix of analyzers presents a challenge to technicians tasked with calibration. For the plant to perform at its best, the calibration must be done correctly for these different analyzers. Yet, the required calibration procedure may be slightly different depending on which analyzer is being calibrated. Therefore, technicians require proper guidance to do it right.

Some pH analyzers can be calibrated from a keypad and display, right on the analyzer faceplate. Explosion proof types have to use other means for local calibration. Either way, handheld field communicator or computer software provides a larger more powerful user interface that is easier to use.

Several early versions of configuration and calibration software did not support "wizards" to guide the technician's work. Calibration was difficult, particularly for early fieldbus devices that required mode and many other parameters to be set in order to calibrate the sensor, after which the parameters had to be returned to their original value for the pH analyzer to be operational. This required expert knowledge.

Another problem was that these software applications run on laptops with interfaces. Laptops are acceptable for workshop use but are not rugged enough for calibration in the field. Laptops contain moving parts such as hard disk and fan, have limited battery life are too heavy and difficult to operate with only one hand.

An EDDL file is a compressed text document loaded into device management software and other tools that communicate with intelligent devices. The EDDL files tell the software which commands to send, how to decode the device information, and how to display it. Wizards, officially known as "methods", have been part of EDDL technology since 1992 and are now seeing wider support in software. These wizards take the mystery out of pH analyzer calibration by enforcing the correct sequence. These wizards remind the technicians to inform operators to put the loop in manual and provide step-by-step instruction on when to put the sensor in the first buffer, wait for it to stabilize, put it into the second buffer, and wait for it to stabilize. They also remind the technician to inform operators to put the loop back into automatic when done. The wizards hide the complexity of fieldbus by taking care of mode switching, writing technician's input values to the correct parameters, and providing plausibility checks on these inputs.

Figure 1: pH analyzer supports EDDL for remote management.

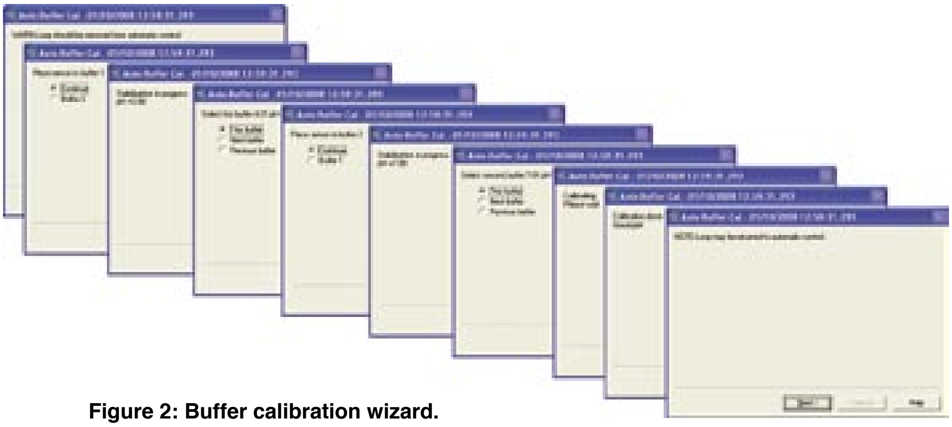

Figure 2: Buffer calibration wizard.

EDDL wizards work not only in software on Windows computers but also on handheld field communicators that can be brought to the field for in-situ calibration. These rugged yet light-weight tools are highly valued by technicians.

The wizard comes from the pH analyzer manufacturer and is incorporated in the EDDL file provided with the pH analyzer from the factory. The manufacturer know-how is built-in to ensure proper steps unique to the pH analyzer are taken in the right order. EDDL wizards thus reduce mistakes, ensure correct setup of the pH analyzer, and make field work easier. Lastly, device management software part of asset management solutions logs into the audit trail that calibration as done, and by whom.

pH sensor diagnostics made easy

The pH sensor consists of a pH glass electrode, a reference electrode, and a temperature detector. A damaged pH sensor is an issue because the pH is not measured.

In the past, pH analyzers were not able to detect electrode failure. Most of the time a sensor failure would result in a false indication of neutral pH value of 7, which in most cases is the desired process value; therefore, no alarms were triggered, though the actual process was too acidic or alkaline. The problem could go unnoticed for long periods of time, during which products were out of specification or regulations inadvertently broken.

Even when diagnostics were available in the analyzer, they were often not displayed to the operators on their consoles, again preventing the operators from taking proper action upon failures. Diagnostics could not become part of daily work practices.

Today, some pH analyzers have sophisticated diagnostics that continuously measure the impedance of the pH glass electrode and the reference electrode to detect sensor failure or degradation online. Sensor diagnostics alert the technicians and operators to problems with the sensor.

Reference impedance

The major contributor to reference impedance is the resistance across the liquid junction plug. In a properly functioning electrode, the resistance of the liquid junction should be no more than several hundred kilo ohms. If the junction is plugged or if the filling solution or gel is depleted (dry), the resistance increases. High reference impedance may also mean the sensor is not immersed in the process stream.

Glass impedance

Glass impedance refers to the impedance of the pH-sensitive glass membrane, the sensing element in a pH electrode. The impedance of the glass membrane is a strong function of temperature. As temperature increases, the impedance decreases.

The impedance measurement must be correlated to a reference temperature. The impedance of a typical glass electrode at 25°C is several hundred mega ohm. A sharp impedance decrease implies that the glass is cracked.

A cracked glass electrode produces erroneous pH readings and should be replaced immediately. High glass impedance implies the sensor is aging and nearing the end of its life.

High impedance glass can also mean the pH electrode is not completely submerged in the process liquid. The high and low impedance limit can be set to the appropriate values for the specific sensor model to trigger the diagnostics alert.

Because the display is rendered by the device management software, based on content and layout from the EDDL file, it highlights the failures using the same indication for all kinds, protocols, and brands of devices.

For example, red for failure. There is no difference from one type to the other. This consistency in look and feel is inherent in EDDL technology and doesn't even require the device manufacturers to follow a style guide.

This unique consistency makes devices easy to use. Device manufacturer controls display content and structure while consistent look and feel comes from the system.

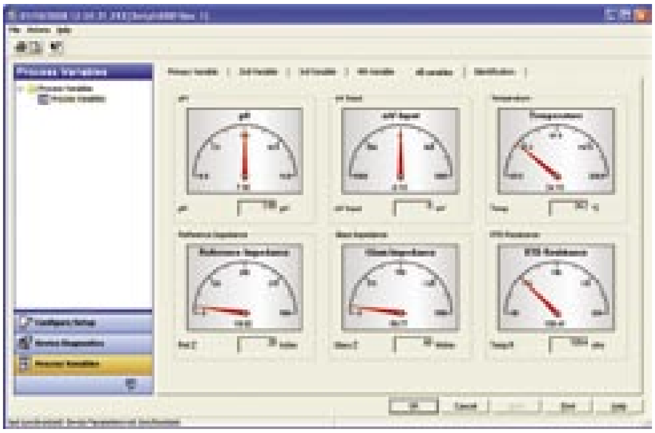

Figure 3: pH analyzer "dashboard".

Intuitive graphics

Graphics were not part of the original Device Description (DD) technology from 1992. Other device integration solutions based on software components provided rich *Windows* graphics but brought with them IT-world issues of long-term system version management problems. Plants challenged the industry to come up with a device integration technology including graphics to unleash the full functionality of all devices, yet retain all the ease of management benefits of the original DD.

Engineers from the Fieldbus Foundation, HART Communication Foundation, Profibus Nutzerorganisation e.V. (PNO), and OPC Foundation collaborated to solve this human interface problem. The result of their effort is the new IEC 61804-3 standard for EDDL which includes graphical enhancements, such as trend charts and gauges. EDDL is an integral part of HART, Foundation fieldbus, and WirelessHART standard so it benefits all analyzers around the plant.

The resulting graphics used to display setup information and diagnostics results are designed by the analyzer manufacturer in such a way as to make use of all the analyzer features as intuitive as possible.

For this purpose, EDDL provides an advantage of being the only device integration technology decoupled from *Windows*, thus avoiding version compatibility issues and obsolescence, yet still allowing the rendering of rich and familiar *Windows* graphics on a computer.

Figure 4: Diagnostics is clearly indicated the same way for all devices in the system.

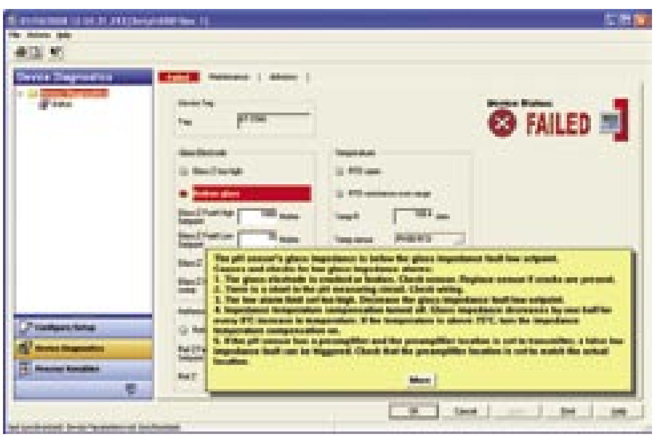

Figure 5: Manufacturer expert know-how built into EDDL.

Smart diagnostics

Intelligent device management software is permanently networked to continuously monitor self-diagnostics in pH analyzers and other field devices, all managed from the same single tool. EDDL-based device management software can be integrated with modern control systems so that when a sensor fails, the diagnostics – displayed at a central location – pin-point the problem. This data is available to plant operators at their workstations without them having to manually check the device or another computer.

EDDL is the only technology that integrates with the control system to display diagnostic detail directly on the operator consoles, showing failures that affect process operation. Predictive diagnostics, not yet affecting the process, are usually not routed to operators and only go to maintenance technicians.

Usually nobody watches over the maintenance station because technicians are out in the field, so if diagnostics are only displayed in the maintenance console, the device management software will fall into disuse.

Diagnostics must go to those that see it. Critical diagnostics must go to operator consoles because they are the only places continuously watched. Instead of flooding the operator console with alarms with all of the diagnostics, field diagnostics alerts from the devices are prioritized so only critical alerts from critical devices such as genuine failures that will impact the process are brought to the operators, not predictive alerts that have not yet materialized. This is smart diagnostics. Operators cannot repair devices, but after a failure occurs, they have minutes or hours to take evasive action, such as putting loop in manual, before process is affected.

It is a form of early warning of impending process problems. Operators can radio the technicians in the field that can replace the sensor or fix the device. Such practices are possible with an integrated system as per NAMUR NE 91.

Because problem areas are quickly and clearly highlighted on operator consoles, repairs can be completed rapidly, reducing measurement downtime.

EDDL is the only non-intrusive device integration technology that can be loaded in the DCS itself, so there are no other means to achieve comparable results. Likewise, only EDDL files are independent of Windows versions, leaving no comparable solution for system investment protection.

Analytical expert know-how

With many different kinds of analyzers and other instruments for the technicians to master, expert help is needed.

In the past, instructions were only available in hardcopy manuals in which finding the information could take a very long time. Softcopy manuals are an improvement, yet they have hundreds of pages of contiguous text to wade through, and searching can result in hundreds of hits.

A better solution is device management software based on EDDL, which not only gives access to softcopy manuals but also context-sensitive help provided by the analyzer manufacturer's pH expert for parameters, wizards, and diagnostics. Rather than searching through the entire manual, the technician clicks the help icon followed by the function in question, and the know-how from the analyzer manufacturer's expert is immediately displayed, dramatically improving the productivity of technicians.

Thanks to context-sensitive help, the technicians can quickly get an explanation of the functions they are viewing without extensive page flipping or screen scrolling. The analyzer manufacturer's help is available in any system, including handheld field communicators and laptop software.

Architecture

As analyzers grow increasingly sophisticated, they improve plant performance by providing more accurate measurements, greater plant availability, and lower maintenance costs. EDDL is an integral part of the digital plant architecture that uses the power of field intelligence to improve plant performance by integrating not just analyzers but all devices around the plant.

Large client-server systems with multiple clients can be built, where operators and technicians can work simultaneously. The same single tool supports devices of all kinds, including those from different manufacturers or using different protocols. A key advantage is that new device types and versions can be supported without having to install software.

These key advantages can be realised at your facility by incorporating pH analyzers with communication protocols that make diagnostics easily available. EDDL capabilities then make the information easily interpreted by the operators. Now the operators will know what is going on in the plant and will be more pro-active and effective in their maintenance schemes. **WWA**

Reference

1. *"Fieldbuses for process control: Engineering, Operation and Maintenance", Jonas Berge, ISA, ISBN 1-55617-760-7.*

2. *IEC 61804-3 Ed. 1.0 English, Function blocks (FB) for process control - Part 3: Electronic Device Description Language (EDDL).*

3. *IEC/TR 61804-4 Ed. 1.0 English, Function blocks (FB) for process control - Part 4: EDD interoperability guideline.*