connected to any analog input port used on a distributed control system (DCS) or programmable logic controller (PLC). Since it is HART enabled, critical data from CorrTran MV can be monitored with a standard hand-held communicator by field personnel at a plant, accessed directly by a "smart" analog input I/O card in the DCS/PLC, or sent directly to an asset management software (i.e., Emerson Process Management or Cornerstone Software) via a HART multiplexer (i.e., 2700 or KFD2-HMM from Pepperl+Fuchs).

Specifications

The standard probes used for corrosion detection on CorrTran MV consist of 3 electrodes: 2 for measurement and 1 for reference. In order to get an accurate measurement, the electrodes must be made of the same material as the pipe or tank being monitored. The sacrificial electrodes are induced with a small signal and are placed directly in the flow of corrosive media. These signals are monitored and analyzed by the transmitter over a period of 21 minutes in order to get an accurate representation of the general and localized corrosion rate as well as conductance. This can be reduced to 16 minutes if you only measure localized corrosion with conductance or 4.5 minutes if you only measure general corrosion and conductance. The following is a small sampling of electrode materials available for pipeline detection:

1018 carbon steel
304 stainless steel
316 stainless steel
Hastelloy
400 monel
1100 aluminum
2024 aluminum
GR2 titanium

Also available are various types of mechanical probes for direct or remote mounting in fixed or adjustable lengths. The basic probe comes with a standard 3/4" NPT fitting with pressure ratings up to 3000 psi (102 bar). The process media temperature can be as high as 500 ºF (260 ºC) while the transmitter can operate in an ambient temperature range of -40 ºF to +158 ºF (-40 ºC to +70 ºC). The intrinsically safe, Division 2, and general-purpose versions are suitable for ambient temperatures as low as -58 ºF (-50 ºC). The only requirement necessary to get an accurate corrosion reading is that the material inside the tank or pipe must maintain a small amount of conductance.

Given its rugged design and industrialized housing, CorrTran MV is ready to be installed in any industrial application from wastewater management to chemical processing to oil refining. If the area is considered nonhazardous (nonexplosive), this transmitter can simply be connected to an analog input on a DCS or PLC and installed according to local, state, and national regulations. For Division 2 applications, its low-power design allows it to be mounted directly within a Division 2 hazardous location regardless of the classification within the pipe. In this configuration, the control signal (4-20 mA circuit) must be connected in accordance with the National Electrical Code according to Division 2 wiring methods. For clarification, a Division 2 location is considered to be hazardous only under abnormal conditions (i.e., faulty valve, unexpected release, aging seal, etc). As a matter of fact, significant portions of a process facility can be designated Division 2; therefore, CorrTran MV can be easily installed in these areas. Division 1 applications require the use of our specially designed CorrTran MV. Our intrinsically safe (IS) unit requires the use of an isolation barrier mounted between the I/O card and the transmitter. This IS barrier (i.e., KFD2-STC4-Ex1 from P+F) limits the energy into the Division 1 area and works in concert with CorrTran MV to eliminate the potential of high energy causing ignition of the hazardous location. An explosion-proof version is available for Division 1 applications.

Configuration

For configuration purposes, CorrTran MV can be connected to any HART-enabled tool once the specific Device Driver (DD) has been loaded into the tool's library. This allows quick modification of a wide range of application-specific values such as range, alarm points, B-value, and damping. Large portions of today's HART transmitters are actually programmed with a hand-held communicator. If HART communication is impossible or unwarranted, our transmitter can also be configured using P+F's own PACTware tool. This configuration takes corrosion monitoring to a new level—one that makes corrosion data readily available to the process engineer so decisions can be made in real-time and according to current process conditions. CorrTran MV-Innovations in Corrosion Monitoring by Pepperl+Fuchs.

Advantages of CorrTran MV

- Takes corrosion out of the laboratory and into the control room
- Lowers the risk of equipment failures
- Minimizes unplanned downtime
- Reduces ownership cost
- Easy to integrate into existing system
- Optimize equipment utilization
- Simple to connect, install, and operate
- Suitable for new or existing installations
- CSA certified for the United States and Canada
- ATEX certified
- Suitable for aqueous solutions and vapor applications
- Available in standard, nonincendive (Div 2), explosion proof, and intrinsically safe versions
- Easily configured via HART or PACTware

Industries

CorrTran MV is suitable for a wide range of industries including:

- Gas & oil refining
- Oil exploration & transportation
- Chemical & petrochemical
- Pharmaceutical
- Water and wastewater
- Power generation
- Pulp & paper

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PROTECTING YOUR PROCESS

INNOVATIONS IN CORROSION MONITORING

Meant to take corrosion evaluation out of the laboratory and into everyday process control, CorrTran MV is a revolutionary approach to corrosion monitoring. With real-time monitoring of the corrosion behavior, customers will be able to react before significant damage has occurred.

PEPPERL+FUCHS
PROTECTING YOUR PROCESS

CorrTran MV: Innovations In Corrosion Monitoring

Corrosion History

Corrosion monitoring in the process industry has always been something left to the expert corrosion engineer—that highly educated specialist with a great deal of experience in metal alloys and chemical reactions. The corrosion evaluation methods used by these individuals often involved the analysis of sacrificial samples (coupons) placed in the pipeline. These samples were precisely weighed prior to their exposure to the process media then analyzed for metal loss and other imperfections. This was the basis for determining the general and localized corrosion rate for the entire process. More coupons located at more locations resulted in larger amounts of data for evaluation thus a more accurate corrosion picture for the facility. Over the years, corrosion evaluation tools have been developed to help the corrosion engineer do his or her job more efficiently. In the end, these tools gave the corrosion expert a high level of data for determination of corrosion but the data was only useful to the specialist, not the facility operator or control systems engineer—until now. Finally, a corrosion monitoring system is available that can be easily implemented into a standard control room architecture.

Corrosion Future

CorrTran® MV from Pepperl+Fuchs is the first 2-wire, 4-20 mA transmitter that evaluates both general and localized corrosion, as well as conductance, in the same industrialized, transmitter housing. Meant to take corrosion evaluation out of the laboratory and into everyday process control, CorrTran MV is a revolutionary approach to corrosion monitoring. With real-time monitoring of the corrosion behavior, customers will be able to react before significant damage has occurred. Evaluation of the multiple variables is done by setting a primary variable for the control loop and extracting the secondary and tertiary variables through HART protocol.

Figure1

Corrosion Technology

The corrosion process is based on the fact that when a metal/alloy is immersed in an electrically conducting liquid it will corrode through an electrochemical process. The following example shows a simple reaction of a metal (iron) dissolving in an acidic solution:

$$Fe \rightarrow Fe^{2+} + 2e^-$$
$$2H^+ + 2e^- \rightarrow H_2$$

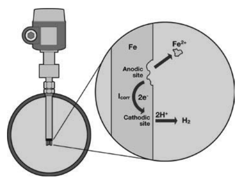

Figure 2

An anodic site is formed when metal from the surface of the corroding pipe or tank passes into the adjacent solution (the liquid causing the corrosion) by way of an ion (Fe^{2+}). This process results in an excess of electrons at the metal surface. The excess electrons flow to a nearby cathodic point which results in the corrosion current I_{corr}. These excess electrons are then consumed by the oxidizing agents in the corrosive solution. Anodic and cathodic points continuously shift position and exist within the entire conductive surface (metal). This random configuration makes direct measurement of I_{corr} impossible. To overcome this limitation, an electrical probe consisting of three measurement electrodes of the same metal is placed into the corrosive solution. Using this probe, it is possible to apply small potentials between the electrodes and measure the resulting current. The same corrosion process responsible for I_{corr} influences this current. If the electrodes are corroding at a high rate, metal ions (Fe^{2+} in this example) are passing easily into the solution and a small potential applied to the electrodes will produce a high current proportional to I_{corr}. Similarly, if the electrodes are corroding at a low rate with ions passing slowly into the solution, a small potential applied to the electrodes will produce a small current. Using complex algorithms and data analysis, CorrTran MV interprets this corrosion information and makes it available for plant engineers in the form of a 4-20 mA signal.

CorrTran MV Operation

At the heart of CorrTran MV are state-of-the-art, patented algorithms and data analysis techniques that accurately measure corrosion rate and localized corrosion. Harmonic distortion analysis (HDA) is applied to improve the performance of the industry accepted linear polarization resistance (LPR) technique used to measure corrosion rate. One of the most useful equations behind most electrochemical techniques in corrosion studies is without doubt the Stern Geary equation. To further enhance CorrTran MV's performance, the application-specific Stern Geary value (B-value) is calculated with every measurement cycle. The B-value changes along with your process parameters. During a measurement cycle, CorrTran MV performs a unique electrochemical noise (ECN) measurement, which in combination with the corrosion rate data, provides a measurement of localized corrosion. At the completion of each measurement cycle, the respective general and localized corrosion rate are calculated and made available to the plant personnel in the form of a 4-20 mA signal with HART.

The LPR technique has long been the industry standard for general corrosion monitoring and it is based on the Stern-Geary relationship. This B-value relationship correlates the potential excitations with the measured corrosion current to produce a measurement of polarization resistance. This resistance is then used to determine the general corrosion rate. Since it is critical to use the correct B-value in this method, it is generally considered unreliable by itself as a measurement technique for general corrosion rate. The HDA analysis is based on an evolution of the LPR technique. By applying a low frequency sine wave to determine the polarization resistance, a harmonic analysis can be performed. The result of this analysis helps in determining the B-value. With both the polarization resistance and the solution resistance, a more accurate general corrosion rate can be determined. Lastly, the ECN method allows the localized corrosion rate to be calculated. ECN is the measurement of spontaneous fluctuations generated at the corroding metal-solution interface. This measurement is only possible in a 3-electrode probe configuration and is used to determine the existence of localized corrosion.

Real-Time Corrosion Monitoring

Real-time information using a 4-20 mA control signal allows the facilities operator to interpret the corrosion status. The operator can evaluate historical corrosion rates to current rates and quickly determine changes in water quality, chemical changes, and inhibitor performance. As expected, all these situations can affect pipeline corrosion and each can be more efficiently monitored and controlled with the help of CorrTran MV. Furthermore, the plant operator using CorrTran MV and its real-time data can plan for replacement of suspect equipment as part of a predictive maintenance schedule. The superior performance of this instrument allows the user to monitor general corrosion and localized corrosion. It is localized corrosion that can be especially dangerous if not detected at an early stage. Corrosion of this type can perforate a pipe very quickly but with early intervention it can be neutralized. For the first time, both general and localized corrosion can be monitored on-line and in real-time rather than in a historical "after-the-fact" method that misses the possibility of a process-corrosion correlation. Rather than determining corrosion occurrence over a period of time using an outdated technique, corrosion can now be monitored like any other process variable (i.e., pressure, flow, level, temperature, pH) by the plant operator or control systems engineer using the existing human-machine interface (HMI). Because CorrTran MV is capable of detecting both types of corrosion, it operates more effectively than any other monitoring device. This is critical since in some situations the general corrosion rate may be low but localized corrosion may result in high rates of attack and unexpected perforation in a pipe. This real-time data allows a rapid and clear understanding of corrosion.

Why is real-time corrosion data important? Plant assets are working harder and longer than ever before so the reliability of the process (up-time) is critical to bottom-line profitability and employee safety. Corrosion has a clear and direct relationship to system reliability. Never before has an on-line tool like CorrTran MV been available. It is difficult to understand why any plant operator would be satisfied with off-line measurements of temperature, level, or pressure. The same is now true for corrosion. A real-time corrosion measurement can be used as an evaluation tool of system integrity and asset damage just like temperature, level, and pressure are used for some of the very same reasons. The process data accumulated by the DCS and PLC systems are typically displayed "real-time" on monitors in a control room. What would a process engineer do if the data were delayed by an hour or a month?

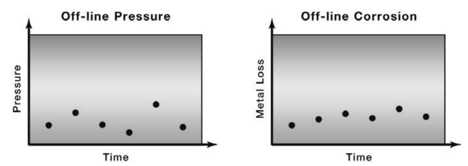

Figure 3

The actual conditions of the process could be drastically different than the off-line information displayed in Figure 3. It is clear from these illustrations (Figures 3 & 4) that on-line

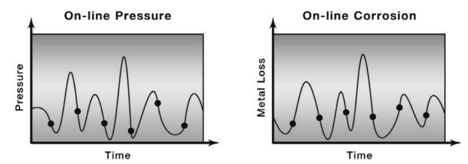

Figure 4

variables are extremely important to any process. It is impossible to imagine a facility operating in an off-line methodology for the basic process variables of pressure, level, and temperature; therefore, it is only reasonable to imagine the need for on-line corrosion information in this manner as well. Dangers related to run-away reaction, over-flow conditions, or corroded pipes are too valuable to allow them to be evaluated in an off-line method. The need for CorrTran MV is clear.

New Developments

Corrosion is an enormous and costly problem on which industries spend billions of dollars annually. Pepperl+Fuchs knew the process industry required a product that would give plant operators the ability to monitor corrosion rates within their existing control system and to distinguish between general and localized corrosion. The industry needed a product that would enable the use of existing asset management tools rather than sophisticated software programs operating with non-standard communication protocols. Pepperl+Fuchs was determined to address the growing concern for on-line corrosion monitoring in the process industry and was able to apply its expertise in setting global standards for process instrumentation. This resulted in CorrTran MV, the first 2-wire, 4-20 mA transmitter that evaluates both general and localized corrosion, as well as conductance, in the same industrialized transmitter housing. Based in Twinsburg OH, Pepperl+Fuchs is part of a larger, internationally recognized firm headquartered in Mannheim, Germany. This 2600-employee-strong company serves both the factory automation and process automation markets with a wide range of intrinsic safety barriers, purge/pressurization equipment, level monitoring instruments, proximity sensors, and fieldbus equipment. P+F services the world's automation markets through three main facilities in the United States, Germany, and Singapore. With offices in more than 70 countries, P+F is focused on offering a wide range of solutions to a wide range of industries. Corrosion monitoring is a natural evolution of P+F's core competency and blends easily into its existing product range.

The Goal

The goal in the development of CorrTran MV was to create a product that would easily integrate into a standard 4-20 mA control system, easily communicate with the industry standard HART protocol, and would be easily installed in either hazardous or nonhazardous atmospheres. With this goal in mind, Pepperl+Fuchs chose one of their proven, Type 4X, 7, 8, and 9 transmitter housings used on its Vibracon (vibration fork point level monitoring) and Barcon (hydrostatic pressure level measurement) line of products as the basis of the CorrTran MV hardware platform. First and foremost, power consumption needed to be greatly reduced. Unlike other multi-conductor corrosion monitoring instruments, the new instrument needed to operate on as little as 4 mA, so the entire electronic insert had to be redesigned and optimized. Additionally, the overall size of the electronic insert was reduced to fit into the relatively small space of the transmitter housing.

After nearly 18 months of development, the end result was a 2-wire, loop-powered instrument that can be mounted in a safe area or Division 1/2 hazardous location. The transmitter can be

Continues

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