Online Corrosion Monitoring
Pepperl+Fuchs Brings Evaluation Out of the Laboratory, into Process Control

Corrosion monitoring in the process industry has always been something left to the expert corrosion engineer who was a trained specialist, highly educated and largely experienced 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 analysed for metal loss and other imperfections. This was the basis for determining the general and localised 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 that can be easily implemented into a standard control room architecture is available.

CorrTran™ from Pepperl + Fuchs is the first, two wire; 4-20 mA transmitter that evaluates either general or localised (pitting) corrosion in the same industrialized, transmitter housing. Meant to take corrosion evaluation out of the laboratory and into everyday process control, CorrTran™ is a revolutionary approach to corrosion monitoring. Over the years, CorrTran™ customers have been able to monitor real-time corrosion behaviour and react to it before significant damage has occurred. CorrTran™ takes this success to a new level with a simple, easy-to-use two wire transmitter operating on the industry standard 4-20 mA control basis and easily integrated HART protocol.

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:

\[
\text{Fe} \rightarrow \text{Fe}^{2+} + 2e^- \\
2\text{H}^+ + 2e^- \rightarrow \text{H}_2
\]

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, called \(I_{corr}\). These excess electrons are then consumed by the oxidising agents in the corrosive solution. Anodic and cathodic points con-
Kalvin current is always the same. As the electrochemical noise (ECN) measurement, which in combination with the corrosion rate data, provides a measurement of pitting. At the completion of each measurement cycle, the respective corrosion rate or pitting value is calculated and made available to the plant personnel in the form of a 4-20 mA signal.

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 excitation with the measured corrosion current to produce a measurement of polarisation 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 the measurement current, the resistances of the corrosive solution can be calculated through a harmonic analysis of the resulting signals. With both the polarisation resistance and the solution resistance, a more accurate general corrosion rate can be determined. Lastly, the ECN method allows the localised 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 localised corrosion.

**Specifications**

The standard probes used for corrosion detection on CorrTran consist of three electrodes: two for measurement and one 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 analysed by the transmitter over a period of seven minutes in order to get an accurate representation of corrosion. The following is a small sampling of electrode materials available for pipeline detection: 1018 carbon steel; 304 stainless steel; Hastelloy; 400 Monel; 1100 aluminium; 2024 aluminium; and 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-inch NPT fitting with pressure ratings up to 100 bar. The process media temperature can be as high as 260 °C, while the transmitter can operate in an ambient temperature range of -40 °C to +70 °C. The only requirement necessary to get an accurate corrosion reading is that the material inside the tank or pipe must be at least 1 % water.

Given its rugged design and industrialised housing, CorrTran is ready to be installed in any industrial application from wastewater management to chemical processing to oil refining. If the area is considered non hazardous (non explosive), this transmitter can simply be connected to an analogue input on a DCS or PLC and installed according to local and national regulations. For hazardous applications, its low-power design allows it to be mounted the corrosive material inside the pipe is non-flammable.

In this configuration, the control signal (4-20 mA circuit) must be connected in accordance to ATEX wiring methods. Our intrinsically safe (IS) unit requires the use of an isolation barrier mounted between the I/O card and the transmitter. This IS barrier limits the energy into the hazardous area and works in conjunction with CorrTran™ to eliminate the potential of high energy causing ignition of the hazardous location.