A Paradigm Shift

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S many corrosion professionals in the oil and gas, chemicals, refining, and other industries can attest, a designated “plant” engineer often divides his or her time among multiple sites. Thanks to various “online” and “real-time” systems for monitoring corrosion, one can see and work with new data although the engineer may be thousands of miles away from the facility being analyzed. Applying long-established technologies such as electrical resistance (ER) and linear polarization resistance (LPR) probes can lower the frequency of travel to remote locations, saving both time and money. However, using these instruments and properly interpreting the data they collect can be burdensome given available resources. Moreover, the engineer may find the data to be of limited value—particularly in the case of identifying localized corrosion or understanding the actual relationship of corrosion with process variables—unless it is integrated properly with the existing online plant process control environment.

A Texas-based corrosion technology and consulting firm reports that its corrosion monitoring system offers the first such technology that provides reliable data about general and localized corrosion in real-time and online. The technology reportedly provides relevant, accurate information about the relationship between process conditions and the type and rate of corrosion, thereby enhancing the corrosion professional’s role in the operation and maintenance of a facility.

Predicting the Unpredictable

“The wide variety of materials used coupled with ever-changing process chemistries and operations mean that corrosion can be expected to be neither uniform—in rate or type—nor predictable,” says Dawn Eden, Corrosion Consultant with InterCorr International (Houston, Texas). “This really emphasizes the need for technology that can respond rapidly and report accurately in a changing environment and provide an early warning in advance of the point where substantial damage has occurred when process controllers can take preventative action.” Citing positive experiences from various clients, Eden and other InterCorr officials contend that the company’s Smart-CET™ corrosion monitoring system is such a technology.

Eden admits the terms “online” and “real-time” have been used for years to describe various types of corrosion monitoring systems. Indeed, industry has used ER and LPR probes for more than 3 decades to collect general corrosion data—usually for retrospective use. However, Eden says that these techniques have delivered on measuring a general corrosion rate or a uniform loss of wall thickness at the expense of offering an opportunity to evaluate localized corrosion. “Since industry reports that some 70 to 90% of corrosion failures are attributable to localized corrosion, this means that the greater proportion of market-ready technology addresses little of the real corrosion issues faced by industry,” she says.

Eden explains that analyzing the localized corrosion data produced by those systems tended to be labor-intensive because it required detailed and expert “off-line” interpretation. “The combination of early, cumbersome electronics devices and extensive...
support services meant that implementation of this type of monitoring could be quite expensive before the advent of modern distributed instrumentation and its remote computing capabilities,” she says. “Careful consideration was required with respect to the potential value it would bring to the user.”

InterCorr Vice President Russell D. Kane adds that the nature of localized corrosion—an “on-off process” that often occurs during upsets—has kept accurate measurements out of reach for many. “[As a result], the typical approach with corrosion engineers has been: accept that failures will happen and then take care of it after-the-fact,” says Kane. “Nobody’s been able to measure this type of thing [localized corrosion] in the field.”

Conventional ER and LPR probes also present challenges in terms of speed and accuracy, says Eden. “Many other available methods and technologies respond too slowly or provide data that is little more than a qualitative indication of the corrosion rate,” she explains. “Such approaches may provide a method of materials accounting, but they are not able to deliver data to assist in truly proactive corrosion assessment needed for process control or plant asset management.”

Eden maintains the new corrosion monitoring system differs from its precursors because it emphasizes user-friendliness and compatibility with existing plant process control systems, substantially lowering the cost of implementing corrosion monitoring and dramatically simplifying data interpretation. It also allows for both process control and corrosion specialists to view the same data, lending itself to today’s global decision-making environment. “The ultimate objective was to provide an online, real-time simplified evaluation of both general and localized corrosion, effectively elevating corrosion to the level of a ‘process parameter’ and enabling its use directly in the context of improving process control and equipment reliability,” she explains.

A direct effect of the new technology is that corrosion—and the corrosion engineer—achieve a more prominent place in the areas of plant operations, process control, and asset management, says Kane. He says this result has become evident at the BASF Corp. chemical processing facility in Freeport, Texas.

**At Work in Process Conditions**

Established in 1958 as BASF’s first manufacturing site outside Germany, the Freeport facility produces acrylic monomers, caprolactam, polycaprolactam, and oxo alcohol/diols. Debottlenecking and other process modifications were performed at a particular plant at the site. Many of these improvements increased the plant’s capacity and efficiency, but the modifications also introduced various corrosion problems. Much of the plant equipment is constructed of carbon steel and types 304L (UNS S30403) and 316L (UNS S31603) stainless steels.
To-date the engineers have used their observations to make minor process adjustments, and they contend that these changes have reduced corrosion rates without sacrificing acceptable yields and product quality. Further investigations may lead to the opportunity for more process adjustments, as plant operations allow.

“I thought it would show that we’d have to reduce production rates to reduce corrosion,” says BASF Senior Materials Engineer Joseph Kintz. “To my surprise, we found that corrosion rates in this system don’t necessarily parallel production rates. Both high and low corrosion rates occur during periods of high and low production rates. This technology clearly shows how corrosion rates vary with process conditions. This makes it possible to find the optimal process conditions, which maximize process quality and yield, while minimizing corrosion.”

Kintz adds that he is pleased with the system’s accuracy. “We recently took a new set of ultrasonic thickness readings on 316L stainless steel piping in our plant,” he says. “There were approximately 80 ultrasonic thickness measurement locations. In the 479-day period preceding the latest set of thickness measurements, the average corrosion rate indicated by these measurements was 2.965 mpy [75.3 µm/y]. For the same period, the SmartCET indicated an average 2.9-mpy [73.7-µm/y] corrosion rate for the 316L probe in the same line.”

Kintz notes that the system runs reliably with minimal maintenance. “It clearly shows in real time how the corrosiveness of the various process streams changes with process conditions,” he says. “It continually supplies the real-time corrosion data to the plant process information management system so that corrosion rates can be trended alongside other process parameters.”

According to Kintz, the plant’s operations technicians and operations and materials engineers are able to work directly with InterCorr’s technology. “The learning curve for operations technicians and operations engineers is short and simple,” he says. “They are shown how to access the real-time corrosion data in their process information management system [PIMS] and given a basic explanation of how to interpret the data. Ideally, operations technicians and engineers monitor the real-time corrosion information, just like the usual process temperatures, flow rates, vessel fluid levels, and other process data in PIMS.” He adds that they can use the new data to adjust process conditions, balancing corrosion rates, production rate, process efficiency, and other metrics.

Although he or she has a “somewhat longer and steeper” learning curve, the materials engineer also can easily learn how to operate and maintain the technology and derive the most beneficial data from it, says Kintz. He adds that data from the system are made available throughout the process...
facility. Others who benefit from the information include maintenance engineers and maintenance coordinators, process engineers, project engineers, and operations management.

**Flexibility**

InterCorr officials say that the monitoring system readily adapts to different sites. Eden notes that the monitoring system conforms to standard “off-the-shelf” three-electrode LPR probes. “Among the probe suppliers, there are differences in internal wiring of these probes but we are able to provide the appropriate connectivity to enable use of existing probes,” she says.

Eden adds that the standard-configuration LPR probe, with its flush or protruding electrode, will not operate well under certain conditions. These conditions typically include temperatures greater than 500°F (260°C), extremely high pressures, vapor phase, stratified multiphase (oil/water), and condensing (dew point) environments, extremely low water cut, and situations where the process chemistry is incompatible with standard epoxy or glass sealing materials. She says that alternative probe designs are available in such cases. In fact, she cites the Freeport installation as an example of where the conventional probe designs and measurement methods are unsuitable and an alternative probe design was utilized.

**A New Approach**

Kane emphasizes that the technology can help facility operators accomplish three primary objectives: allow units to run uninterrupted for longer periods, perform shorter turnaround inspections, and prevent unplanned outages. Moreover, he stresses that the system enables process and corrosion engineers to collaborate more effectively. “For the first time, process engineers are inviting a corrosion engineer to participate in their periodic process optimization review meetings,” he says, adding that they can display accurate corrosion rate, pitting tendencies, and selected process data as key process indicators. “Also, with real-time, online capabilities interfaced with modern communications technology, we can now link specialists and process engineers on a real-time basis.”

According to Kane, the technology represents a new way for corrosion engineers to combat corrosion proactively and thus create greater value with their efforts. “This is a paradigm shift that can make major inroads into controlling the cost of corrosion through reduced corrosion damage and failures and increased unit run time and productivity,” he concludes. “It’s a real leap ahead of the curve for corrosion engineers.”

Editor’s note: Paper No. 04238, presented at CORROSION/2004, gives a more in-depth discussion of the BASF Freeport application of this technology.