Write-up in Materials Performance magazine...

Cathodic protection controller powered by galvanic anode current

A new concept developed by engineers at Farwest Corrosion Control Co. (Gardena, California), designed particularly for steel water tank applications, uses a small percentage of the energy generated by magnesium anodes to power an electronic controller that automatically regulates the tank-to-water voltage potential in a galvanic cathodic protection (CP) system.

In a galvanic anode system for a water storage tank, magnesium anodes are installed in contact with the water and are also connected to the tank. These anodes have a more active voltage—a more negative electrochemical potential—than the steel tank (the cathode). The difference in electrochemical potential between the anode and the cathode causes a galvanic current to flow from the magnesium anode to the cathode (steel tank). Through this process, the magnesium anodes corrode preferentially and provide corrosion protection to the tank. No electricity from an external power supply is used. Typically, the internal surface of a modern steel potable-water storage reservoir can be protected from corrosion with a galvanic (sacrificial) CP system, says John Bollinger, professional corrosion engineer with Farwest Corrosion Control Co., because the effectiveness and durability of today's internal tank coatings make it possible to provide CP using relatively little current (i.e., less than 100 mA for a 3 million gal [11 million L] storage tank). However, Bollinger notes, one drawback to this type of corrosion protection is that the galvanic current is difficult to regulate.

A new galvanic CP technology developed for water storage tanks like the one shown here uses power generated by magnesium anodes to operate a controller that automatically regulates tank-to-water voltage potential. Photo courtesy of Farwest Corrosion Control Co.

Because the water level in the tanks can vary unpredictably, the tank-to-water voltage potential in a tank may change as the water level in the tank changes. Often times, Bollinger explains, the anode current is higher than required and overprotection is possible on the tank's interior.

NACE International recommended practices call for tank-to-water potentials to be maintained between −0.850 and −1.100 V. But in some instances, Bollinger notes, exceeding the −1.200 V potential limit can produce excessive hydrogen and may cause the tank's protective coating to disbond or blister.

John Bollinger works on the controller system powered by a magnesium sacrificial anode-cathode cell. Photo courtesy of Farwest Corrosion Control Co.

CP designers are also specifying that all tank-to-water voltage potential measurements be "IR free"; that is, the measurements are corrected for voltage drops (gradients) that can result in measurement errors. Because most magnesium anode systems are "on" continuously, it is very difficult or impractical to capture a true IR free potential measurement.

Impressed current CP (ICCP) systems utilize electronic equipment to automatically measure and regulate tank-to-water potentials. An ICCP also can easily facilitate an IR free measurement. However, providing alternating current (AC) power to a water tank to operate the circuitry of an automatic potential control CP system can be difficult in many cases. For example, Bollinger says, water storage tanks are often located in remote areas where an AC power source is simply unavailable. Another way to provide power to an automatic control system is needed, he adds.

Drawing inspiration from the latest low-power digital communication systems, Bollinger developed a patent-pending technology, PowerMag†, that taps into the power generated by a sacrificial anode-cathode cell to operate a controller that automatically adjusts anode current to maintain a constant IR free tank-to-water potential. The controller requires no external power or internal batteries. "The digital technology available now for electronics has resulted in components

†Trade name.

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that have very low power requirements," Bollinger says. "We can operate the control circuit on as little as a 3 mA drain from the anode system."

The controller uses a state-of-the-art microprocessor that includes a pulse width modulation current regulator and a sophisticated potential measuring system to monitor and control various functions. The system, which can also be retrofitted into existing magnesium systems, is designed to control up to 2 A of anode current and can accommodate two reference electrode inputs. "This technology provides the ability to regulate the potential of a sacrificial CP system and avoid 'over-voltage' issues; something that is very unique," comments Bollinger. "By regulating this CP system, the anodes can run at a lower current output, which would result in longer anode life as well."

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