December 2022

The LEADING Edge

Cortec Laboratories, Inc.

BEHIND THE SCENES R&D: A NEW APPROACH TO CUI PREVENTION

A Costly Concern

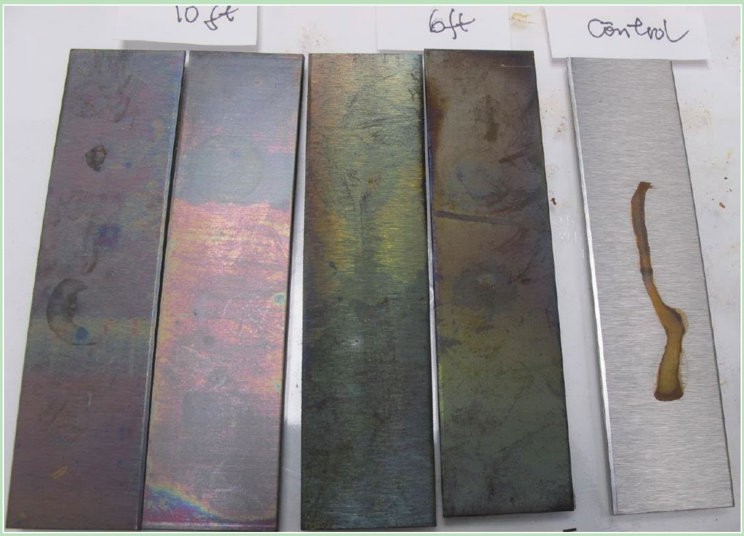
Corrosion under insulation (CUI) is a huge, costly concern for industries such as oil and gas where insulated piping is used. Over the years, Cortec® has developed CorroLogic® CUI High-Temp Inhibitor and CorroLogic® CUI Inhibitor to protect against CUI. The first product is thermally stable up to 1100 °F (600 °C) but must be applied directly to either the pipe or insulation material before the insulation is installed. The second is an injectable Vapor phase Corrosion Inhibitor liquid that allows greater flexibility for application but has a more limited range of temperatures (below 338 °F [170 °C]). This covers the range in which most CUI failures occur (between 120 and 350 °F [50 and 175 °C]). However, many insulated pipes experience temperature cycling above and below 347 °F (175 °C) during the full course of operation and idling. Cortec® R&D therefore set out to develop a CUI inhibitor that could be injected without disturbing existing insulation, would remain stable at high temps, and would protect against corrosion at low temperatures when piping is most vulnerable to CUI. The result was the development and recent introduction of CorroLogic® CUI Inhibitor Injection.

Panels exposed for 18 days were so hydrophobic that washers had to be used to keep chloride water droplets from rolling off. Control at right.

Behind the Scenes

Part of the R&D process was to find out (1) if the CorroLogic® CUI Inhibitor Injection formula could be applied to metal via vapor deposition and 2) if the vapor-deposited formula could provide corrosion protection. To test and evaluate these aspects, a special apparatus was made connecting two cans with a 1/4 inch (6.4 mm) diameter coil and placing the apparatus in an oven at 482 °F (250 °C). The cans were sealed, with one containing a clean carbon steel panel and the other containing CorroLogic® CUI Inhibitor Injection. Various migration distances of 6 and 10 feet (1.8 and 3.0 m) were tested. The test was also performed for different lengths of time to discover the relative time frame needed for vapor migration and deposition to create an effective protective film on the metal panel far away from the VpCI® chemistry source.

Continued on p. 2 . . .



Corrosion protection of 18-day-vapor-treated panels after 22 hours of exposure to saltwater droplets at 176 °F (80 °C). Control at right.

Lab News

Hydrophobicity – in the Extreme!
Testing found that eighteen-day exposure worked well to allow a good protective film to form on panels 10 feet (3.0 m) away from the VpCI® source. After this length of time, the treated panels showed so much hydrophobicity that saltwater droplets placed on the panels for corrosion testing simply beaded up and rolled off. The only way for Sr. Scientist Ming Shen to keep the chloride solution droplets from rolling off was to set metal washers on the panels to hold the droplets in place.

Corrosion Protection with High Renewable Content
In addition to extreme water repellency, the panels with 18-day vapor exposure to CorroLogic® CUI Inhibitor Injection (which is classified non-flammable according to ASTM D93) showed good corrosion protection against chloride after 22 hours in an oven at 176 °F (80 °C). This discovery opens the door to a new level of protecting high-temp insulated piping without the interruption and extended labor time required to remove and reinstall insulation. Another special feature of the product is that it was made from a high percentage of renewable feedstock, which adds an important sustainability feature to this product!

Click here to see a video showing the extreme hydrophobicity of CorroLogic® CUI Injection: https://www.youtube.com/watch?v=ciyasehf6xk

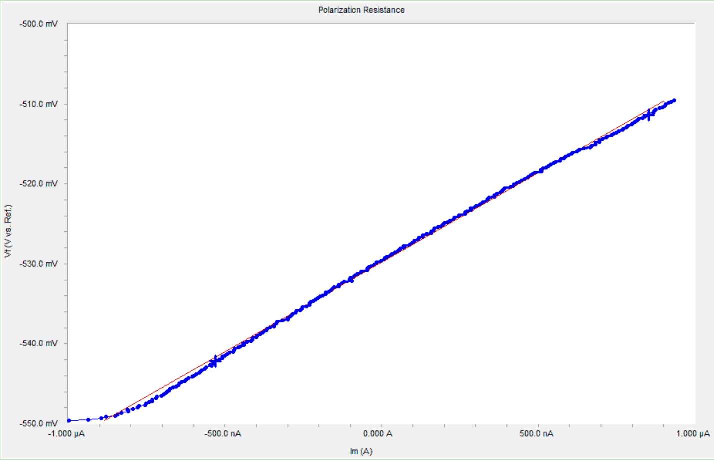
MCI® Lab Testing Developments

With our new Product Development Chemist, Colin Gardner, getting more established after nine months in our laboratory, we are excited to be branching out and diving deeper into new and resurrected areas of testing MCI® products for concrete.

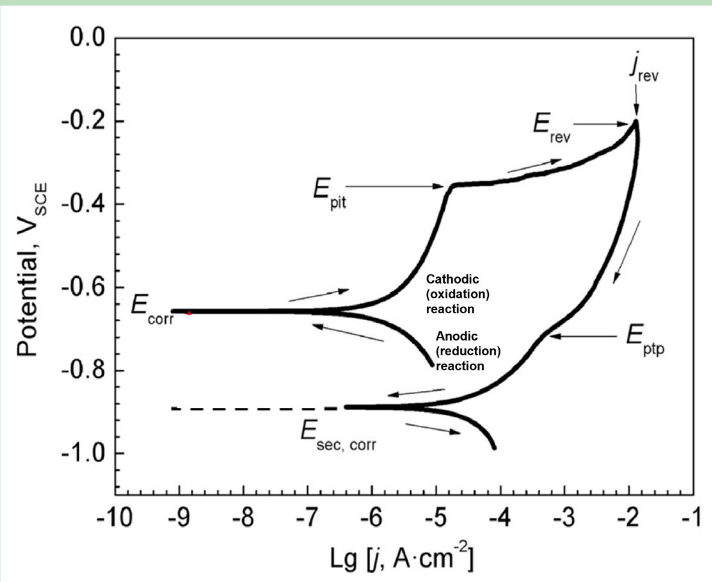
Resurrecting the GC-MS
Colin has gotten the Gas Chromatography-Mass Spectrometry (GC-MS) instrument back up and running after many years out of use. He is looking forward to employing this for more precise testing of things like MCI® SACI (surface applied corrosion inhibitor) migration. Up until now, he has been using the UV-Vis Spectrometer to detect MCI® penetration depth in customer concrete samples treated with MCI®-2018, MCI®-2019, MCI®-2020, etc. While the UV-Vis can detect the MCI® component in concrete, the challenge is that plasticizers and other elements may interfere with the results, requiring a control sample to be compared alongside to distinguish the difference MCI® makes. With the GC-MS, Colin says detection is much more specific. The GC-MS can individually identify MCI®, plasticizer, and many other components. Now that the GC-MS is up and running, Colin is eager to start using it for more precise testing of customer samples in the near future.

Continued on p. 3 . . .

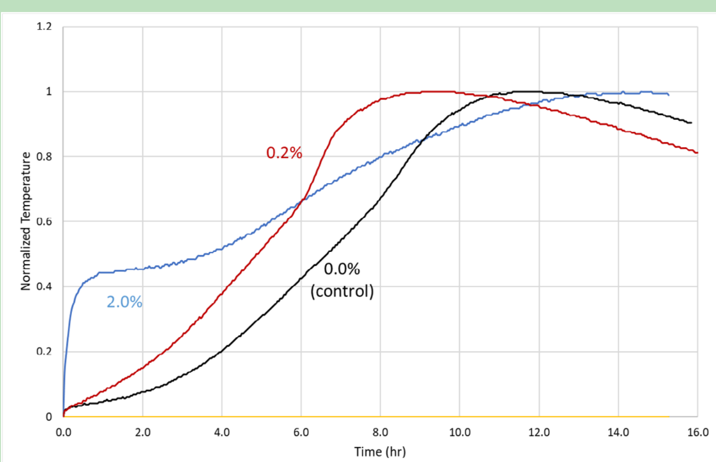
Colin with refurbished GC-MS. "I like big instruments," Colin admitted with a smile.



Example of linear polarization curve reflecting a uniform reaction rate.



Example of cyclic polarization showing very detailed reaction information.



Example of concrete set time measured by calorimeter.

Electrochemical Testing

ASTM G180 has long been the standard for admixture testing but has created much dissatisfaction among laboratories running the test. The problem is that ASTM G180 uses linear polarization, which does well at measuring uniform corrosion but does not do well at measuring pitting corrosion, the type of corrosion that poses a serious problem to reinforced concrete.

Pitting happens when chlorides get into the concrete and reach the level of the rebar, breaking down the natural passive layer that the highly alkaline environment has created on the steel surface. Colin explained that once a hole is created in the passive layer, the steel can corrode quite quickly. Pitting is very random and linear polarization is therefore not well-suited to study it.

Because of this, Colin is exploring the possibilities of using cyclic polarization to study pitting corrosion better and potentially come up with an improvement on ASTM G180 testing. He explained, “[C]yclic polarization is something that can look at pitting a little more directly, which we’re excited about because that is the kind of corrosion we are seeing [in construction applications] . . . as opposed to the general surface corrosion, which is what G180 tests for.” Ultimately, the goal is to use this testing to help develop the next generation of MCI® admixtures, as well!

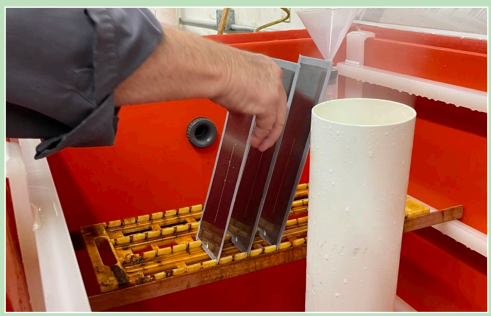
Studying Admixture Set Times

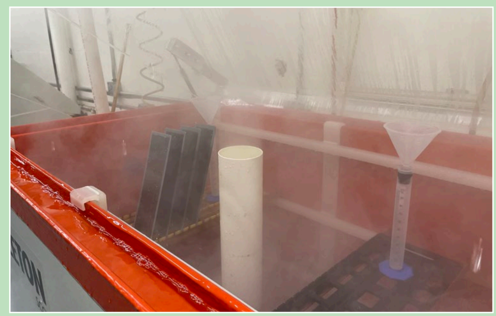
Another long-term project Colin is working on is studying MCI® admixture set times. To do so, Colin has made four calorimeters. He explained that hydration reactions which take place as the concrete sets also release heat. This heat can be measured by the calorimeter equipped with a thermal couple probe that notes temperature changes and graphs a curve that Colin can review to see initial and final set time. Knowing this data can be helpful when preparing admixtures to send out for third party testing and recertification, or experimenting with possible reformulations. Colin can mix and test four new concrete/admixture samples per day with these calorimeters.

Colin has created four calorimeters to measure set time. He can test up to four samples per day.

New Salt Spray Chamber

After a long service life of a decade or more, the familiar salt spray testing chamber at Cortec® Laboratories was ready to retire. Cortec® has replaced it with a brand-new salt spray chamber that will help the lab continue to do many of its core tests (e.g., ASTM B117) to evaluate corrosion inhibitor performance of coatings, packaging, and rust preventatives in a harsh environment. The test chamber is maintained at 95°F +/-3% (35 °C +/-2%) and fogs 1-2 mL/hour of 5% sodium chloride DI water to create the salt spray environment required for ASTM B117 testing.

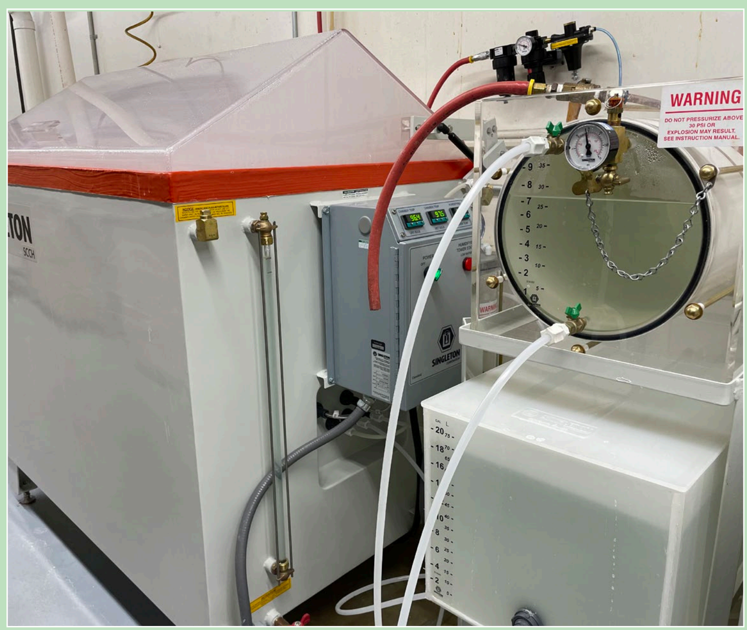




Top: New salt spray chamber open with salt fog rolling out.

Center: Coated panels placed inside the new salt spray chamber for testing.

Bottom Right: Saline water chamber that feeds into salt spray chamber.



Keywords: Cortec, Cortec Laboratories, MCI, corrosion, corrosion under insulation, CUI, pitting corrosion, ASTM B117, salt spray testing, ASTM G180

CORTEC CORPORATION
Environmentally Safe VpCI®/MCI® Technologies

ISO/IEC-17025 ISO 14001 ISO 9001

4119 White Bear Parkway, St. Paul, MN 55110 USA
Phone: (651) 429-1100, Fax: (651) 429-1122
Toll Free: (800) 4-CORTEC, E-mail: productinfo@cortecvci.com

www.corteclaboratories.com

Created: 12/2022