RECLAMATION
Managing Water in the West

U.S. Department of the Interior
Bureau of Reclamation

Western Water and Power Solution Bulletin

Bulletin No. 42
September 2011

Research and Development Office — Denver, Colorado

Protecting Infrastructure by Predicting Coating Service Life Span

Using Electrochemical Impedance Spectroscopy (EIS) to select the most durable protective coatings

What Is The Problem?

Industrial coatings are the primary means of controlling metal corrosion in water conveyance and storage structures. Various types of protective coatings are used in new installations and for re-coating existing structures. Water managers rely on accurate predictions of coating service longevity to select those that will minimize maintenance costs, maintain structural integrity over time, and maximize water availability by avoiding downtime for coating removal and application. Many new coating products are entering the market place, some of which have little or no track record in field applications. Without a proven track record, new materials must be tested in an attempt to determine the expected service life. Without this testing, the coating could risk poor corrosion protection, and we might have to re-coat more frequently.

Traditional laboratory methods for evaluating coatings simulate field exposure and include: cathodic disbondment, water immersion (including sea water), high humidity, burial, prohesion, ultraviolet light (UV), alternating fog and UV, adhesion, abrasion, and impact resistance. The problem is that when most coatings surpass the testing period with little or no visual deterioration, the extent of future service life is still unknown.

What Is The Solution?

To test coatings for Reclamation use, Reclamation's Materials Engineering and Research Lab is using a highly sensitive test method that supplements traditional coating inspections and can rapidly (within 30 minutes) measure the effectiveness of coating resistance to corrosion by recording the impedance value over time. Electrochemical Impedance Spectroscopy (EIS), also known as impedance spectroscopy, measures coating impedance (resistance to alternating current [AC]) over a range of frequencies with corresponding responses that include varying energy storage and dissipation properties in the test circuit.

By observing the rate of impedance variance, it is possible to extrapolate to a point in time when the barrier properties fail, marking the expected service life. Although higher impedance levels generally correlate to better corrosion protection, it is the rate of impedance change that is the best predictor of coating service life. The EIS method allows for direct comparisons among different coating systems and degrees of changes over time. Although most coatings can be evaluated using the EIS method, the approach works best for such barrier coatings as epoxy, polyurethane, polyurea, moisture-cured urethanes, and coal tar epoxy.

Who Can Benefit?

Owners of infrastructure that include components requiring protective coatings can benefit when appropriate coatings are selected in order to maximize time in service and reduce costs. Testing and selecting cost-effective durable protective coatings is critical for protecting such water storage and conveyance structures as canals, gates and valves, and pipelines.

Electrochemical Impedance Spectroscopy test cell.

Where Have We Applied This Solution?

Coatings tested with EIS have been applied to a multitude of structures at various sites, including: Platoro Dam Outlet Works, Enders Dam Outlet Works, Flatiron Powerplant Penstocks, Carr Powerplant Penstocks, Grand Coulee Third Powerplant Mechanical Overhaul, Palisades Mechanical Overhaul, and many others.

Future Development Plans

Reclamation is using the EIS method to evaluate new Quagga and Zebra mussel antifouling, foul-release, and fluorinated powder coatings that are crucial for controlling rapid mussel spreading and destruction to water infrastructure.

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Collaborators

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