ALUMINIZED STEEL TYPE 2

CORROSION/ABRASION TESTING

Technical Bulletin

CORROSION/ABRASION TESTING OF DRAINAGE PIPE MATERIALS
Long-Term Field Testing Versus Short-Term Laboratory Testing

Results of long-term field experience in the actual service environment in which a material will be applied are the final authority on material durability behavior. Corrosion and abrasion in actual service are influenced by several factors that cannot be reproduced realistically in the laboratory. Additionally, lab testing is normally accelerated to obtain early results, and it is usually not possible to accelerate corrosion without altering the basic corrosion/protection mechanisms. Thus lab test results are frequently misleading and are normally disregarded when they contradict field test results in any way.

EXAMPLES OF CONCERNS WITH LABORATORY TESTING

1. CORROSION TESTS IN SALT SPRAY OR STRONG SALT/ACID SOLUTIONS:

Passive film protection on the Aluminized Steel Type 2 coating plays a major role in Type 2 pipe superiority over pipes with other metallic coatings. In the strong salt/acid environments often used in lab tests, passive films are destroyed and the Type 2 coating corrodes actively, as do other metallic coatings. As a result, the Aluminized Type 2 coating is prevented from demonstrating its natural corrosion-retarding passivity.

2. ABRASION TESTS

- Severe abrasive conditions in circulation test loops utilizing heavy bedload in water of considerable velocity overwhelm and negate protection factors that are important under typical mild-to-moderate abrasive conditions. For example, overly severe conditions obscure the substantial abrasion/corrosion protection afforded by the Type 2 intermetallic coating layer, protection that is important under the less severe abrasion conditions common in actual pipe use. And the use of highly corrosive water, like seawater, in the test loop greatly compounds the problem by overwhelming coatings that are resistant to corrosion in their specified normal environments.
- Such severe abrasive/corrosive conditions mask important coating properties so that different metallic coatings tend to behave alike. Under such conditions, coating thickness easily becomes the only influential factor, the delay in penetrating successive thickness increments being the only impediment to the severe attack. Thus such tests may differentiate metallic coatings only on the basis of thickness, ignoring other, more important coating corrosion control factors.

3. TESTS IN TAPWATER

Typically, these tests are conducted by immersing a coated steel specimen in a small quantity of stagnant tapwater in a small covered beaker for several months. Extreme distortion of corrosion behavior results from these artificial conditions which bear no resemblance to real-world conditions. Under these artificial conditions, there is no water renewal and very little dissolved oxygen renewal. In normal corrugated steel pipe applications, water and dissolved oxygen are renewed through flow and convection currents. A few examples of distortion arising from artificial testing in tapwater are noted below.

- Stagnant water in small beakers containing galvanized specimens quickly saturates with soluble zinc due to zinc corrosion. Saturation artificially suppresses further zinc corrosion, and soluble zinc artificially suppresses steel corrosion at cut edges on galvanized. Thus the initial corrosion of zinc is actually responsible for a false impression of ongoing non-corrodibility in this unrealistic laboratory environment. In actual pipe waters all corrosion product concentration is negated, either by dissipation in flowing water or by diffusion and precipitation in quiescent water. Even in quiescent real-world pipe waters, precipitation is rapid in the presence of continual dissolved oxygen introduced by agitation from convection currents, and the galvanized corrosion tendency is not artificially suppressed.
- The Aluminized Type 2 coating does not corrode in tapwater. In the small quantity of unrenewed stagnant water, artificial chemistry changes occur. This causes uncharacteristic pitting of the coating. These artificial chemistry changes do not occur in real-world pipe environments with flowing or quiescent water.

ASPECTS OF PROPER FIELD TESTING

1. Field testing in severe environments well outside recommended environmental limits serves no purpose. Test results on Aluminized Steel Type 2 or other metallic coatings in environments like seawater or highly acidic minewater prove nothing about behavior in the recommended environments where the corrosion mechanism is very different.
2. Comprehensive long-term testing over the range of conditions in recommended pipe environments is mandatory to establish the range of environmental conditions over which good long-term durability is realized. This is crucial in comparing materials. Aluminized Steel Type 2 does not show advanced corrosion until threshold chloride/sulfate or threshold pH levels are exceeded. Corrosion of other metallic coatings, on the other hand, increases steadily with incremental resistivity/pH decreases.

In field testing of coupled tandem Aluminized Steel Type 2 and galvanized pipe sections, concern is sometimes expressed that Type 2 will benefit at the expense of galvanized due to galvanic interaction. Actually, the aluminum-zinc galvanic cell is very weak and can have no significant effect on large, bare, full-length culvert pipes. But if there were any significant interaction, Type 2 would be adversely affected rather than benefited in those more severe waterside environments where Type 2 shows its maximal superiority over galvanized. In these environments the zinc coating has a short life and galvanized is soon de-coated. For most of the 30 and 50 year exposure times involved in Cleveland-Cliffs field testing, the surface adjacent to Type 2 has been the steel substrate of de-coated galvanized, which can have only adverse galvanic effects on the aluminum coating. Despite the fact that any galvanic interaction would have on overall adverse effect on the aluminum coating, Aluminized Steel Type 2 pipe excelled in its performance.

The insignificance of Type 2/galvanized galvanic cell activity is easily seen by examining waterside surfaces at the junction of coupled pipe sections. In the dry-weather groundwater flow predominately experienced at most wet sites, the stream is thin and narrow, limiting galvanic throwing power to the immediate area around the junction and concentrating it there. This is especially true at sites with soft, high-resistivity groundwater flow where all galvanic action would be concentrated within several inches of the junction. Yet Type 2 and galvanized corrosion behavior at a junction is never any different from that in areas remote from the junctions, thus galvanic activity is clearly insignificant.

The insignificance is further verified by comparing Type 2 performance when isolated, with Type 2 pipes coupled with galvanized. Isolated Type 2 pipes have performed as well as coupled ones in field tests up to 50 years in duration.

ALUMINIZED STEEL TYPE 2 CORROSION/ABRASION TESTING

About Cleveland-Cliffs Inc.

Cleveland-Cliffs is the largest flat-rolled steel producer in North America. Founded in 1847 as a mine operator, Cliffs also is the largest manufacturer of iron ore pellets in North America. The Company is vertically integrated from mined raw materials, direct reduced iron, and ferrous scrap to primary steelmaking and downstream finishing, stamping, tooling, and tubing. The Company serves a diverse range of markets due to its comprehensive offering of flat-rolled steel products and is the largest supplier of steel to the automotive industry in North America. The Company is headquartered in Cleveland, Ohio with mining, steel and downstream manufacturing operations located across the United States and in Canada. For more information, visit www.clevelandcliffs.com.

CLEVELAND-CLIFFS INC.
200 Public Square
Suite 3300
Cleveland, OH 44114-2315
844.STEEL99 | 844.783.3599
clevelandcliffs.com

December 2023