

## Chloride Contamination and its effect on Coatings

Of great concern in application of Epoxy Coatings on steel substrates are the presence of water-soluble salts such as chlorides, sulfates and nitrates, which are deposited on the steel surface by acid rain, marine spray, chemical processes, splash, spillage and immersion. They are all a salt or ester derived from an acid and are differentiated by their origin. Chlorides originate from hydrochloric acid, sulfates from sulfuric acid and nitrates from nitric acid.

Soluble salts cause an osmotic action, which draws water through the coating. Lead pigments incorporated into primers have mitigated corrosion by insolubilizing sulfates and chlorides, the predominant contaminating ions, thus reducing the osmotic forces and limiting, somewhat, the harmful corrosive activity of these anions. The solubilities of lead chloride and lead sulfate are much lower than the solubilities of ferrous or ferric salts of chloride or sulfate. In terms of osmosis, ferrous chloride will draw 200 times as much water through a coating as lead chloride will; ferric sulfate will draw 150,000 times as much water through a coating as lead sulfate will. Thus lead sulfate will usually not produce osmotic blistering.

However, lead compounds, which were in widespread use until their health hazards became generally recognized, are severely restricted. Without the incorporation of lead pigments in primers, chlorides and sulfates must now be minimized by other means such as neutralizing agents or soluble salt removers.

It has been well documented that soluble salts, particularly chlorides and sulfates, initiate and accelerate corrosion of steel, and become deeply embedded within the iron corrosion products.<sup>2</sup> They are capable of causing breakdown of the coating by the mechanism of osmotic blistering and disbondment if deposited between coats. The salts stimulate corrosion through osmotic action by drawing moisture through the coating. They keep on drawing, forming blisters that actually build up internal pressure. Plus the fact that moisture, when combined with chlorides, actually often forms a mild hydrochloric acid. This causes corrosion, undercutting of the coating and, finally, a coating failure. Often, a film of chlorides left upon the surface has been the cause of major disbondment. They also set up a cell potential and lower the pH. The most harmful actions of salt are the lowering of pH resulting in a regeneration cycle that consumes oxygen and the absorption of water through osmosis or lowering of vapor pressure.

The damaging effect of salts on steel surfaces have the following consequences.

- They absorb and hold moisture from the air.
- Salts draw moisture through a coating by means of osmosis.
- They reduce corrosion cell resistance (i.e. increase the conductivity of the electrolyte in the corrosion cell.)
- They establish concentration cell potentials. The difference in salt concentration between highly contaminated areas and adjacent, less contaminated areas creates a voltage which causes corrosion current to flow.
- Salts lower the pH. By introducing oxygen through the paint film, the iron salts can ultimately become oxidized releasing hydrochloric acid with a pH as low as 1.5 which attacks the steel.

Any of the above, alone or in conjunction, are detrimental to the protection provided by coatings. Hence, these corrosive actions are destructive forces beneath the coating film.

The **ARCOR®** Specification for Coating provides appropriate methods for testing for and remediating Chlorides on steel surface.