Corrosion

Significant metallic corrosion can develop in systems using absorptive insulations resulting in major economic and safety concerns. This is particularly true when these systems are at temperatures that allow water to exist in the liquid state. With carbon steel, acidity can accelerate corrosion, while with stainless steel, chlorides can promote stress cracking.

Corrosion costs in the U.S. alone currently exceed $300 billion a year. What might not be fully appreciated is that approximately one-third of these losses can be avoided by the correct use of existing products and technology. Serious corrosion is generally associated with an absorptive insulation. Corrosion is most severe in the temperature range where liquid water can be present. It is not as much of a concern in cold or hot applications where water would freeze or turn to a gaseous state.

Slightly alkaline, inert and impermeable cellular glass insulation, however, reduces the likelihood of corrosion and the resultant system failure.

PROBLEMS

- *Economics & Safety*

  The corrosion rate under wet insulation can be up to 20 times greater than by the ambient atmosphere. This high rate of corrosion, coupled with the fact that the metal surfaces are "hidden" under insulation, make this one of the biggest problems in insulated systems.

  When corrosion creates the need for system replacement, costs can run in the millions of dollars annually for a single plant—not including lost production and the possibility of total facility shutdown.

  Hidden from view, corrosion under insulation can result in sudden, hazardous leaks with potentially catastrophic consequences—especially when combustible fluids, very high temperatures or pressure vessels are involved.

- *Conditions*

  Three factors are necessary for corrosion under insulation to occur:

  - *Water*

    Water can be introduced during insulation storage or installation, by internal system leaks, through ineffective waterproofing, improper maintenance or service lapses.

  - *Chemical Content of Water*

    As the pH drops below 4, corrosion climbs dramatically. Such acidic corrosion is especially common with carbon steel. Consequently, quality assurance requirements often limit the pH of an insulation to the neutral/alkaline range of 7.0 to 11.7.

    With austenitic stainless steel, the primary concerns are free chloride content and mechanical stress. In fact, quality assurance procedures for insulations to be used in contact with stainless steel require the lowest possible levels of soluble chloride and fluoride. In the United States and several other countries, these levels are balanced against an insulation's leachable sodium and silicate ions. Leachable chloride ions also may be introduced by rain water, plant and cooling tower atmospheres, or even portable water often used for fire fighting, deluge testing or wash downs.

  - *Temperature*

    Service temperatures between 32°F and 212°F (0°C and 100°C) allow water to exist as a liquid. Within this temperature range, the corrosion rate doubles for every 27°F to 36°F

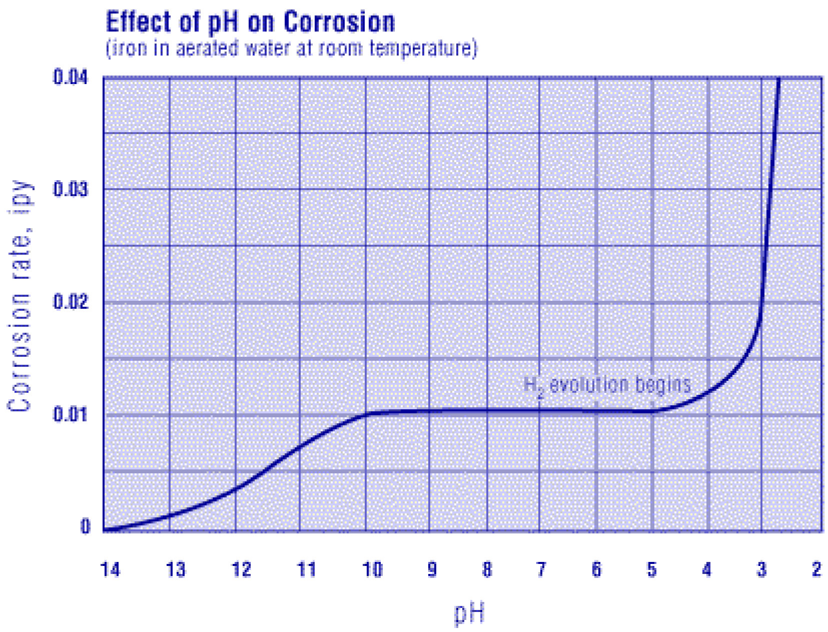
(15°C to 20°C) temperature increase. The maximum corrosion potential generally lies between these two extremes.

Chloride-induced stress corrosion cracking in carbon steel generally occurs in the range of ambient (or even below) to 248°F (120°C).

Two temperature-corrosion conditions are of special note:

(1) Cyclical temperatures which accelerate corrosion

(2) The lack of temperature extremes during extended plant shutdowns, where water accumulates without freezing or evaporating (in this case insulation removal is recommended).



- *Lines of Defense*

  Three approaches can help prevent the problem of corrosion under insulation:

  - *Vapor Retarders*

    This is the most obvious defense, but suitable water vapor retarders are not reliable.

  - *Other Barriers*

    Other barriers such as paints or mastics (e.g. silicones, epoxy phenolics, coal tar epoxies and bitumens) can be used to physically prevent water from coming in contact with critical equipment. With these materials, surface preparation is critical, and a defect-free coating is essential. Aluminum foil can also be used as a physical barricade as well as a cathodic protection layer.

  - *Proper Insulation*

    A third alternative is the use of an insulation that minimizes water intrusion, will not retain water and, thus, will not accelerate metal corrosion.

- *Insulation Types*

  Insulations generally fall into two categories: those for low and high temperatures.

Low-temperature insulations include polyurethane and polyisocyanurate cellular plastics, as well as phenolics. All of these, however, can form acidic solutions (pH 2-3) in the presence of water.

On an Exxon polyurethane-insulated hot tank, severe corrosion was found when the insulation was removed. Water had combined with halogens in the insulation to produce conditions to pH 1 and accelerated metal corrosion. The source of the halogens was the fire retardant applied to the polyurethane. As a result, Exxon has reduced its use of this insulation type.

The potential for the creation of acidic environments within polyurethane cellular plastics is further enhanced because a chloride-containing phosgene compound is used in their production. Consequently, manufacturers state that metallic surfaces must be protected with a corrosion-inhibiting coating.

Other examples of corrosion failure with polyurethane insulations include an ARCO oil/gas pipeline, where 85% of the pipe wall was rusted away after less than 10 years of service; the complete penetration of a hot oil tank roof in the Netherlands; deep pitting and general corrosion of cold storage gas tanks in England and Saudi Arabia; and stress corrosion cracking in stainless steel brewery vessels.

Phenolics, on the other hand, are acidic due to the acids used in their manufacture, and can develop environments to pH 1.8.

The other general category of insulations includes those for high-temperature applications. Among these are calcium silicate, perlite, mineral wool and fiberous glass. While each is inherently porous, calcium silicate and fiberous glass generally cause the most problems.

Exxon systems have experienced much calcium silicate-related corrosion due to water-leached chlorides. At Monsanto, calcium silicate has given the most trouble. Even at a European meeting on corrosion under lagging, the consensus was that calcium silicate has unfavorable wicking properties. This behavior has also prompted England's Institution of Chemical Engineers to warn that calcium silicate can enhance the risk of stress corrosion by allowing the wetting of hot metal surfaces. While some of these insulations contain stress crack inhibitors, over the life of a system, inhibitor levels will fall below those necessary for crack prevention.

ARCO and Esso in the Netherlands, DuPont, Exxon and Gulf have all experienced similar problems with absorbent fibrous glass insulators.

The FOAMGLAS® Cellular Glass Insulation Solution

FOAMGLAS® insulation resists the development of corrosion in three ways, by: (1) minimizing water intrusion and retention, (2) not accelerating the corrosion of carbon or stainless steels and (3) being a component of corrosion resistant barriers.

The primary gas within FOAMGLAS® insulation cells is carbon dioxide—from 70% to 100%—and the reaction between cellular glass and water actually produces a weak, alkaline environment (pH 8-10).

FOAMGLAS® insulation, with minimal water-soluble chlorides, has been tested and certified in the United States, Belgium and Germany as acceptable for use with austenitic stainless steel.