1. **What is Corrosion under Insulation?**

Corrosion under insulation (CUI) is, as the name indicates, the corrosion or corrosion-related cracking that occurs under insulation and/or fireproofing. It is a major problem in all parts of the chemical processing industry, and constitutes a major portion of many plants’ maintenance budgets. The corrosion can take the form of general corrosion, pitting, or stress corrosion cracking. In carbon and low alloy steels, CUI is almost always general or localized corrosion in which there is a significant amount of metal loss. In stainless steels, general corrosion is unusual. Pitting can occur, but the most common problem is stress corrosion cracking in and around welds and cold worked areas without any significant loss of metal.

2. **Why does it occur?**

CUI occurs because of the combined action of three factors:

- Moisture penetrates and accumulates between the insulation and the equipment
- Other corrosive components dissolve in the moisture that remains behind
- The mixture of corrosive components and water are held in place by the insulation allowing the corrosion to continuously progress.

A fourth factor that occurs in most cases is the elevated temperature of the insulated equipment that increases the rate of corrosion. However, elevated temperature is not always a factor: Cold carbon and alloy steel equipment whose temperature cycles above and below 32°F (0°C) often suffers CUI although the metal temperature never rises above ambient. In all cases, the corrosion is hidden under the insulation and progresses unnoticed for long periods of time.

3. **How is it prevented?**

There is really no way to guarantee with 100% certainty that CUI can be prevented. However, two techniques can be employed to minimize and/or delay CUI (1) Stop the water and moisture from penetrating and accumulating in the insulation and (2) Use a coating or other protective barrier to stop the corrosive fluids from contacting the bare metal surface.

**Prevent moisture from penetrating the insulation –**

- Design insulation sheathing so that water runs off the insulation
- Improve insulation system designs, especially on horizontal sections or at changes in direction where openings in the insulation often occur.
- Maintain caulking on joints.
- Use insulation that does not retain moisture, e.g. cellular glass or perlite in place of fiberglass
- Use insulation that is free of potentially harmful substances, e.g. chlorides in fibrous insulation or halogenated expanding agents
- In lower temperature applications, operate the equipment run without insulation. (Consider heat losses and personnel protection before adopting this method.)

**Use a barrier coating to protect the equipment –**

- Use a conventional paint on steel subject to CUI. Typically epoxies or epoxy-phenolic coatings are used. The upper temperature limit of the coating should be at least 250°F, but 300°F or 350°F is preferred.
- Use aluminum foil wrap around piping or equipment. This provides both galvanic protection and a barrier protection for the metallic substrate. It is particularly good for protecting stainless steel against chloride stress corrosion cracking.
- Use thermally sprayed aluminum on piping or vessels as a barrier coating. The coating
is highly reliable and has only minimal porosity. It can have high initial costs, but is actually less expensive than conventional paints and coatings for equipment with an extended design life.

- Use galvanizing or other coating for structural steel under fireproofing. Avoid using galvanized steel in areas where the environment can be alkaline. Zinc and zinc-based coatings will corrode in alkaline environments.

4. **How is it detected?**

Plant personnel may consider two categories of inspection techniques, visual and the more sophisticated NDT techniques, usually performed with the insulation system still in place.

- **Visual Inspection** – This is the simplest technique and most commonly used. It can be done rapidly and inexpensively, but areas of CUI can be overlooked. The inspector needs to look for staining and evidence of rusting as shown in the photo below. He or she must also look more closely at water ingress locations such as attachments, nozzles, and structural supports which often penetrate the insulation weather barrier. In severe cases, corrosion of the aluminum weather barrier, as evidenced by pitting and white deposits, are indicative of CUI.

- The more sophisticated techniques involve the use of radiography, ultrasonic testing, infrared thermography, and eddy current testing. These techniques have been used with varying degrees of success. The capability of these techniques and the associated costs are rapidly changing.

- **Insulation removal is usually required for definitive confirmation of CUI.**

5. **References:**


- European Federation of Corrosion – Information is available on their Website under the topic, “Corrosion in the Refining Industry” and Working Party (WP) 15 [http://www.efcweb.org/WP_on_Corrosion_in_the_Refinery_Industry.html](http://www.efcweb.org/WP_on_Corrosion_in_the_Refinery_Industry.html)