CHAPTER 10: CORROSION UNDER INSULATION

Read Chapter 10: CORROSION UNDER INSULATION. Then answer the questions at the end of the chapter

Corrosion Under Insulation (CUI) "is the corrosion of piping, pressure vessels and structural components resulting from water trapped under insulation or fireproofing."

CUI appears as a rough surface, covered with a loose, flaky, non-protective scale attached. The corrosion will be localized to the wet surface under the insulation.

PICTURE 9. INSULATION WINDOWING IN A VERTICAL PIPE IN A PRESSURE VESSEL SHOWING CORROSION UNDER INSULATION IN THE LOWER PARTS OF THE LINE. MORE INSULATION SHOULD BE REMOVED.

There are two types of insulation: heat conservation, personnel protection, or cold medium conservation.

Many tanks are not insulated because the Owner wants to avoid CUI. There are several reasons, However, why insulation is used in plants, like Reduced fuel consumption, reduced capacity requirements for heating/cooling systems, and Process Reasons

Probability of failure in Corrosion Under Insulation is drove at least by 10 critical factors, making CUI one of the most complex types of damage mechanisms.

AFFECTED MATERIALS

Carbon steel, low-alloy steels, 300 series SS, 400 series SS, and duplex stainless steels.

TEMPERATURE

Any kind of corrosion is increased with temperature. CUI is the same. However, above the boiling point of water, there is no more CUI.

Refineries generally inspect for CUI on insulated carbon steel, low-alloy steel, and 400 series SS equipment operating between 10 °F (–12 °C) and 350 °F (175 °C).

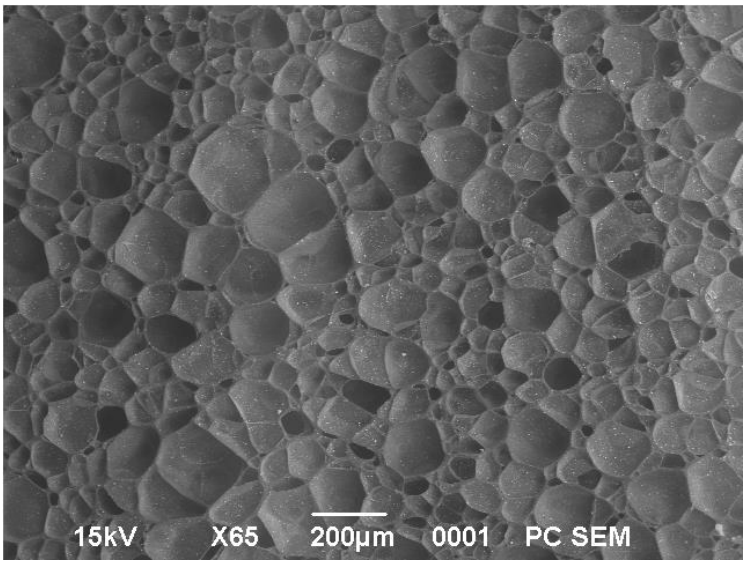
DESIGN

CUI is difficult to predict with certainty and difficult to find without 100% insulation removal. So the best idea is to have a good insulation from the start. You should make sure your tank and piping has the best insulation design, because maintenance of insulation is costly.

Some designs are bad for protection against CUI. Vessel external stiffening rings or insulation supports, may not allow for water egress or for proper coating maintenance. Insulated piping supported directly on beams is considered a bad design because it will pool water underneath the pipe, with no way out and no way for inspection (ALSO SEE FIGURE 64.)

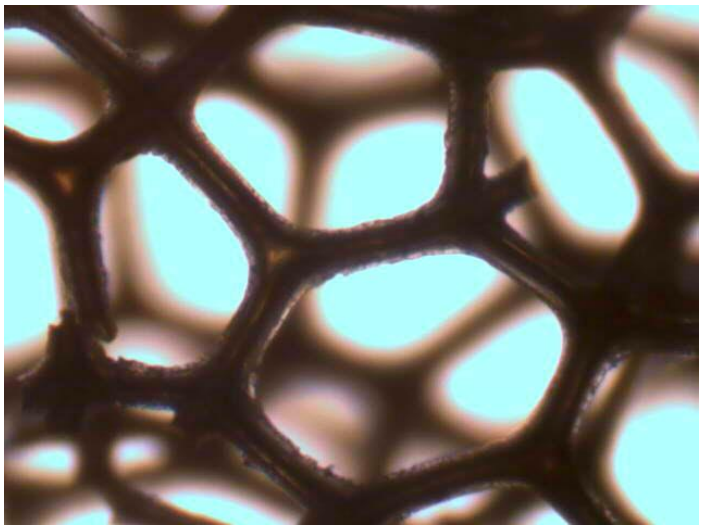
Some insulation materials are best than others. Ideally, you want the insulation material to not absorb water in the first place and also don´t retain it. Additionally, types of open cell insulation that limit and delay water ingress have been developed.

Closed cell foam insulation materials will hold less water and, therefore, might be less prone to originating CUI. Closed cell foams don´t have pores which connect. Because they are more compact, they weigh more and cost more.



PICTURE 10. CLOSED CELL FOAM. SOURCE: PUBLIC DOMAIN

Open-cell foams contain pores that are interconnected to each other and form a network that is soft. Some studies favor an open cell structure, because they provide a path for water to escape, drying the insulation faster. Faster drying time, helps mitigate CUI.



PICTURE 11. OPEN CELL FOAM BY TOMARENAS UNDER CREATIVE COMMONS ATTRIBUTION-SHARE ALIKE 3.0 UNPORTED

INSULATION TYPE

The probability of failure for an insulated tank increases if the material of the insulation is unknown.

Foamglass is at the top of the insulator materials list because it is impervious to moisture, inert, non-combustible and resistant to insects. API 581, Table 16.3

INSULATION CONDITION

CUI can be found on equipment with damaged insulation, insulation jacketing, vapor barriers, weatherproofing or mastic, or where caulking has hardened, separated, or is missing.

PICTURE 12. INSULATION DAMAGE IN PIPE SERVICING A TANK, BECAUSE OF PEOPLE STEPPING IN THE JACKETING

COMPLEXITY AND INTERFASE

The design of the insulation should not trap water.

One of the things that set you up for CUI problems is that the insulation requirements are considered only after the pipework and equipment have been designed, manufactured and, even installed. Designers of insulation systems must consider the effects of the complexity of external forces. Pipes and equipment must be designed to allow for the required insulation thickness

PICTURE 13. TREATER INSTALLED IN ONE OF THE AUTHOR´S PROJECTS, WITH DAMAGE TO THE INSULATION

INSPECTION AND MONITORING

The inspector should not tackle the inspection of an insulated tank or pipe without a written inspection plan. The API 571 standard emphasizes how CUI inspection should have a "structured, systematic approach" starting with prediction and analysis. The risk manager is mostly a librarian. He considers history, standards, materials, locations and conditions to prepare an inspection plan.

Additionally, when the inspector arrives he/she should look for evidence of insulation system damage, mastic and/or sealant damage, signs of water penetration, rust in gravity drain areas on equipment and piping, etc.

The owner is the one that determines the extent of CUI inspection. A robust RBI program and/or software can help you take the guesswork out of CUI inspection and will allow for less decision making from the inspector.

The most effective way of inspection is to remove the entire insulation. The you can use using VT, UT, and/or a pit gage, as applicable, for determining remaining thickness.

PICTURE 14. INSULATION POSSIBLY SHOWING MOISTURE PATHS ABOVE THE CLEANOUT DOOR

PICTURE 15. A HOLE IN A TANK´S ROOF, CAUSED BY CUI CLOSE TO THE SCAFFOLD CABLE SUPPORT

Of course, to remove the entire insulation is costly. In some instances, insulation "windowing" can be used to remove insulation in selected areas thought to be more susceptible to CUI damage than others and inspecting for damage using VT, UT, and/or a pit gage, as applicable, for determining remaining thickness.

In pipes, guided wave testing can be used to detect the profile of the surface. Also PEC neutron backscatter (a fairly fast and relatively cheap inspection technique) and infrared thermography imaging can be used for identifying wet insulation. Special probes can be inserted in the insulation from the start, which will detect moisture in the insulation.

Conditions that increase humidity also increase CUI. For example, high-moisture areas near cooling towers, steam vents, deluge systems, exposed to acid vapors, or near supplemental cooling with water spray.

The best defense against CUI is using appropriate coatings under well maintained insulation barriers.

PICTURE 16. GATE VALVE SHOWING SEVERE CORROSION UNDER INSULATION IN A PETROCHEMICAL COMPLEX

QUESTIONS FOR CHAPTER 10: CORROSION UNDER INSULATION

1. What are the signals of a bad insulator?

2. What is a problem with insulation during the design stage?

3. What is a problem during insulation installation?

4. What are some objectives of insulation?