Global Risk Solutions

What Went Wrong?

Lessons Learnt from Recent Losses - Corrosion Under Insulation (CUI)

Series Introduction

Understanding and learning from past industry losses is essential. By critically analysing both major accidents and minor operational failures, we can gain valuable insights that can be used to help mitigate the risk of similar incidents occurring again.

In this article, we explore common themes that we have identified through our involvement in Downstream Energy losses.

Corrosion Under Insulation (CUI)

As Loss Adjusters with specialist industry knowledge and experience, we have witnessed the damaging consequences of Corrosion Under Insulation (CUI) on Downstream Energy facilities. Our recent experiences have highlighted that CUI remains a prevalent and persistent issue within the industry. Left unaddressed, CUI can lead to significant issues, including losses of containment, major equipment shutdowns and unforeseen maintenance expenses.

How Does it Occur?

CUI can occur when water or moisture enters the insulation systems. This is a common problem in open-air plants, especially in the Downstream Energy Sectors, where there can be many sources of water, including:

- Rainwater
- Deluge systems
- Spills from process operations
- Leaking steam tracing
- Condensation in humid environments

Breaks in the insulation jacketing can provide pathways for this water to ingress into the insulation systems. Such breaks are not uncommon and can be brought about through poor installation, damage during service, or general deterioration over time.

Once the water has penetrated the insulation, the cyclic nature of evaporation and condensation processes can result in a build-up of contaminants, concentrated at the steel surface. Over time, these contaminants can break down the steel's external coatings, contributing to the occurrence of CUI.

CUI not only affects Carbon Steel (CS). It can also have a damaging effect on austenitic and duplex Stainless Steel (SS).

CUI of Carbon Steel (CS) can occur on equipment with a skin temperature range of -4 – 150°C, where the metal is exposed to moisture over time under any kind of insulation. The rate of corrosion is heavily influenced by the specific contaminants in the moisture, as well as the temperature of the steel surface.

For austenitic and duplex SSs, within an operating temperature envelope of 50 – 150°C, failure can occur through a mechanism known as External Stress Corrosion Cracking (ESCC). For ESCC to develop, sufficient tensile stress must be present, along with the concentration of water-borne chlorides on the surface of the equipment, which can be present in estuarine and coastal environments.

What are the Challenges?

A major hurdle in managing CUI is that the insulation systems themselves severely limit the ability to inspect the underlying equipment. Consequently, detecting the initial stages of corrosion becomes difficult. In severe cases, the corrosion can develop unnoticed to a point where the mechanical integrity of the equipment has been compromised.

Whilst inspection ports are often provided within insulation systems, they typically provide less than 1% visibility of the underlying equipment and are likely not representative. Removal of insulation is usually a last resort, because of the prohibitive cost of doing so. This is typically only performed on a 15-to-20-year cycle. CUI can develop unnoticed, and coating systems can prematurely fail during this time.

Therefore, it is not unusual for Maintenance Engineers to unearth significant and unexpected corrosion issues whilst carrying out routine maintenance activities requiring insulation removal.

How can CUI be Detected?

Whilst the presence of heavy rust staining of the insulation can be treated as an indicator, it does not necessarily indicate the actual location of any underlying corrosion.

As we discussed above, the only 100% sure way of knowing that there is no underlying corrosion developing beneath the insulation is to remove the insulation system and carry out a full external visual inspection. However, this is not an approach that Inspectors would commonly wish to adopt, due to the prohibitive cost.

As a result, a robust CUI Inspection plan will typically involve a combination of Screening and Direct Assessment techniques.

Screening techniques are typically employed as initial assessment tools to identify areas that may be prone to, or exhibit signs, of CUI. These techniques aim to quickly evaluate a large surface area or many components, helping to prioritise further inspection or mitigation efforts. Common screening techniques include visual inspection (w/o insulation removal), thermal imaging, and specific NDT methods such as Guided Wave UT or Pulsed Eddy Current.

Direct assessment techniques involve more detailed and targeted inspection of specific areas or components suspected of having corrosion or at higher risk of CUI. These techniques provide more accurate and in-depth information about the severity and extent of corrosion. Typically, this would require insulation removal (either partial or complete) to inspect the underlying metal surface for signs of corrosion directly.

How can CUI be Prevented?

Below we briefly discuss some common strategies employed within the Downstream Energy industries to mitigate the risks of CUI.

- Insulation systems should be designed, installed, and maintained in a way to minimise, as far as possible, the potential for water penetration.
- CUI of carbon steel can occur under all types of insulation. However, an appropriately

selected insulation system can at least mitigate the CUI threat.

For example, an insulation system that holds the least amount of water and dries the most quickly *should* result in the least amount of corrosion damage to equipment. This may lead to the selection of cellular glass or pearlite based insulation, in place of commonly used mineral wool.

- Additionally, the use of insulation that is free of potentially harmful substances, such as chlorides in fibrous insulation, may be required.
- Because some water will eventually enter the system, a protective coating is necessary as part of a good design. The type of coating required largely depends on temperature (environmental and the underlying process).
- Ancillary materials used for weatherproofing should be appropriate for the application and properly applied.
- Maintenance should monitor for and immediately repair compromises in the protective jacketing system.
- Considering the requirement for insulation and removing, where appropriate (provided there is adequate consideration of process.

Summary

CUI poses a significant risk to the mechanical integrity of various Downstream Energy facilities that rely on extensive insulation of equipment and piping.

CUI has been found beneath all types of insulation systems, coatings, and external claddings. Equipment design and the use of newer insulation materials, coatings, and cladding can help to mitigate CUI, but this must be applied in conjunction with an effective Inspection and Maintenance strategy.

Why this Matters for (Re)Insurers

An analysis of common causes of major losses in the Onshore Oil, Gas and Petrochemical Industries found that 43% of the losses analysed (a sample of 100 major industry losses occurring over the past 20 years) were due to 'Mechanical Integrity Failure'.[1]

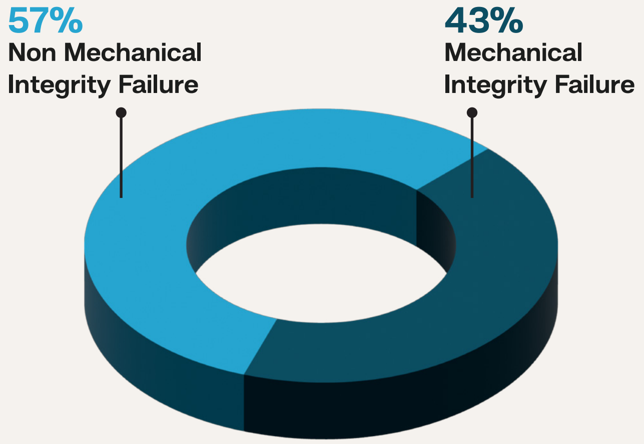

Figure 1 - Mechanical Integrity Failure Losses

Of this 43%, 16% has been attributed to external piping and equipment corrosion. The authors of this study went on to state that external piping corrosion was primarily due to Corrosion Under Insulation (CUI).

It is important for (Re)insurers to maintain a focus on the common causes of major losses. Of course, this is a critical part of dealing with claims effectively. But also, engagement with the expert Adjusters they are working with can help share knowledge; this can improve risk assessment, selection and mitigation strategies through robust Underwriting and Risk Engineering approaches. Ultimately, this benefits (Re)insurers and their customers, the insured parties – so it is a win-win for all.

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[1] *An Analysis of Common Causes of Major Losses in the Onshore Oil, Gas and Petrochemical Industries | Implications for Insurance Risk Engineering Surveys | September 2016 | LMA*