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YOUR GUIDE TO CORROSION UNDER INSULATION

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WHAT IS CUI?

In the simplest terms, corrosion under insulation (CUI) is any type of corrosion that occurs due to a moisture build-up on the external surface of insulated equipment. The build-up can be caused by a multitude of factors, with corrosion most commonly found to be galvanic, chloride, acidic, or alkaline corrosion.



If undetected, the results of CUI can lead to the shutdown of a process unit or an entire facility, and in rare cases it may lead to a process safety incident.

A large-scale industry threat, CUI proves to be difficult to prevent. By and large, no matter the precautions taken, water invariably seeps into the insulation – sometimes unseen until process leakage occurs.

CUI can cost tens of millions of dollars in shut down expenses and repair costs.

Data has shown that about 60% of all insulation in service for more than 10 years will contain corrosion-inducing moisture, and that the highest incidence of leaks in the refining and chemical industries is due to CUI and not to process corrosion – with around 40-60% of piping maintenance costs, and 10% of overall maintenance costs, related to CUI.

As a common problem, it's very difficult to predict CUI and where and when it will occur. However, some of the conditions leading to higher CUI rates are:

- Offshore and coastal environments
- Hot or humid environments
- Climates with higher rainfall
- Steam tracing leaks
- Contaminants from the atmosphere or from the insulation (such as chlorides and sulphides) dissolving in water
- Intermittent wet-dry conditions
- Processes running at cyclic temperature conditions
- Systems operating below typical atmospheric dew point (sweating services)
- Insulating materials holding moisture
- Insulation systems not allowing moisture drainage

WHAT IS CUI?

As well as environmental considerations, thought should be given to the design, material and operations of hot CUI spots, and the types of corrosion caused by CUI.

- On carbon steels, CUI generally occurs in the form of general corrosion or localised corrosion – taking place when small local sites are attacked at a much higher rate than the rest of the original surface.
- In austenitic stainless steels, CUI is often seen as stress corrosion cracking (SCC) and pitting.
- On pipes and equipment, CUI typically occurs where water can collect by gravity, such as penetrations to insulation or where attachments may channel drainage.
- In carbon and low alloy steels, CUI results in large areas of wet scale. In austenitic stainless steels chloride (SCC) often occurs at welds and in non-stress relieved bends.



As one of the most significant integrity and cost threats that the hydrocarbon processing industry faces today, it is vital that inspection teams understand the factors that play into this, and are able to identify ways to protect against it.

Start applying more performance to your assets.

WHY DOES CUI OCCUR?

Several contributing factors create the conditions for corrosion under insulation (CUI). These can result in unique and challenging problems further down the line.

When moisture penetrates and accumulates between the installed insulation and the equipment it is protecting, corrosion can begin to occur. This creates the perfect conditions for other corrosive species to dissolve in the remaining moisture, causing further damage.

When CUI occurs, it can create a vicious cycle, which can be difficult to rectify. When moisture gets into insulation, it can become trapped and cause CUI to worsen and spread.

A main contributing factor is temperature. Both hot and cold temperatures can have an effect on corrosion if moisture is introduced, depending on the materials. The corrosion rate roughly doubles for every 15 – 20°C rise in temperature, with the most aggressive CUI occurring between the operating temperature of 60 and 120°C. However, experience from both the Norwegian continental shelf and cooling water pipes from industrial processing in China shows that CUI can readily occur outside of this temperature range.

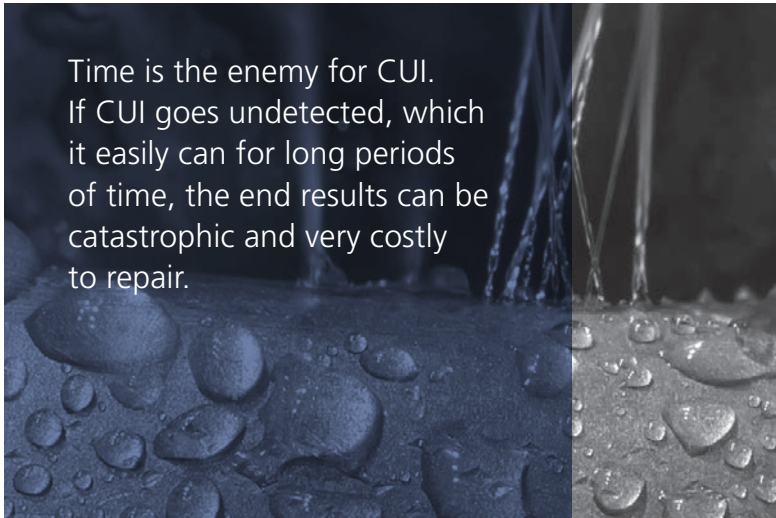
Time is the enemy for CUI. If CUI goes undetected, which it easily can for long periods of time, the end results can be catastrophic and very costly to repair.

The leaking or dripping of moisture can cause both literal and financial damage to assets and the longevity of operations related to the affected area. The money that can be lost due to CUI because of internal leaks and concentrated and consistent issues within a pipe is considerable.

This can result in the end value of the product being less than anticipated because of the loss of volume due to the condition of the internal pipeline. This can cause a vast loss of money and risks asset operability in the long-term.

Specific challenges that can contribute to the CUI process include condensation building during shutdowns or temperature fluctuations. Moisture entrapment under any coverings or cyclic temperature increases the rate of corrosion and needs to be managed.

CUI is ultimately the result of a lack of initial foresight and delayed maintenance during the lifetime of an asset. Therefore, it is better to invest time into the planning and execution at the start of a project instead of dealing with the aftermath of CUI. However this is not to say it is not worth investing the time retrospectively in older facilities, as it will still have a positive impact.



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TIPS TO AVOID CUI

CUI often goes unnoticed until the insulation is finally stripped from the pipe. The stripping of insulation itself can be extremely costly. The uncertainty of actually discovering CUI also adds in an element of risk, meaning that significant resources and man-hours can be attributed to the discovery of CUI that is not present.

Due to the high costs and risks associated with CUI, the industry is investing time, money and efforts into preventative measures for this. Although there is no way to guarantee with 100% certainty that CUI can be prevented, there are some techniques than can help.

1 INSULATION SELECTION

Understanding and applying the correct insulation materials is one of the first tick boxes to check when avoiding CUI problems.

Insulations such as calcium silicate, glass fibre and, to some extent, cellular plastic foams absorb and retain CUI culprits, liquids and vapours, and thus prevent CUI from occurring. There is also the option of physical barriers for protection – meaning that no insulation is required.

The most suitable materials will depend on the operation so a discussion with your supplier is recommended.

2 EQUIPMENT DESIGN

Strategic and well thought out equipment design can significantly reduce the threat of CUI. By considering the support and connections of material for pressure vessels, tanks and piping, the collection of water and vapour between a metal surface and thermal insulation can be minimised and controlled to prevent the promotion of CUI.

Improvement in design can be accomplished by handling the insulation specifications early during the vessel design and by “simplifying” the surface to be insulated.

Care should be taken during modifications to consider consequences for CUI. If there needs to be a CUI risk, then allow for early inspection and removable insulation.



3. MOISTURE BARRIERS

A moisture barrier or weather/vapour jacket can in certain circumstances be an essential practice in preventative measures against CUI.

This type of protective covering is the only part of the system that can be inspected quickly and repaired economically.

However, in certain circumstances such as a cyclical service where condensation forms on a steel substrate, a moisture barrier can prevent any built-up moisture from escaping and can make any CUI issues worse. It is important to establish if a barrier would be a help or a hindrance.



4. PROTECTIVE PAINTS & COATINGS

Specialist paints and coating can offer preventative protection for pipelines and assets. Surface-tolerant and certain heat-resistant products can be applied directly onto hot surfaces with minimal preparation to stop and prevent corrosion, without the need for shutdown.

This type of protection will limit chloride contamination from the environment and, in many cases, will help prevent corrosion from happening.



5. MAINTENANCE PRACTICES

As with most industrial equipment, maintenance is needed to catch and prevent issues and problems that may arise due to deterioration or use over time.

Maintenance and asset integrity managers should plan and schedule maintenance investigations for CUI, with firm knowledge and understanding of what signs to look out for as part of any regular inspection programme.

HOW CUI CAN BE PREVENTED BY MAINTENANCE

The best way to prevent corrosion under insulation (CUI) is through forward planning, beginning with the insulation design and specification, through to the installation craftsmanship and maintenance, in both online and offline scenarios.

Online maintenance

The correct choice of coating system is vital to ensure that CUI does not get left to manifest and create problems for prolonged periods of time. This helps prevent loss of income and productivity that would occur if emergency maintenance had to be performed, which could be inconvenient whilst in operation.

Maintenance while in operation is cheaper than shutting down, which is why the correct precautions and planning should be undertaken. It is estimated that between 40 – 60% of piping maintenance costs are related to CUI .

Both our Jotatemp 250 and Jotatemp 1000 Ceramic products can be used whilst still in operation and are specially designed for preventing CUI. They offer proper corrosion protection at ambient conditions during both construction and shutdown periods and are suitable for insulated and non-insulated surfaces.

The perceived idea of on-going maintenance can often be one of high cost both financially and in time, however this is not as costly in the long-term as if CUI is ignored. Maintenance is key, as the cost hazard of CUI lies in the area of emergency repairs and shut-downs – which is why products that can allow maintenance whilst still in operation on live lines is so useful.

The result of poor maintenance includes lost production time, potential environmental costs from leaks, spills or other damage, and also overall health and safety impacts for personnel involved with the asset. This is why products such as Jotatemp 250 and Jotatemp 1000 Ceramic are so useful for operators as they can be incorporated into regular on-going maintenance planning.

Offline maintenance

To help alleviate any further costs and time spent on maintenance, our unique products, Jotatemp 250, Jotatemp 540 Zinc and Jotatemp 1000 Ceramic can be used for maintenance while on shutdown – using this time effectively.

When used together, with Jotatemp 540 Zinc as a primer and used in a system with Jotatemp 250 or Jotatemp 1000 Ceramic, the Jotatemp 540 Zinc can be used under insulation to protect against CUI. As up to 60% of piping maintenance cost is related to CUI, this is hugely beneficial as shutdowns cost both time and money for an operator.

A common misconception is that insulation can help against corrosion. This could not be further from the truth, as insulation can in fact increase the need for maintenance, due to corrosion under insulation. Many industry leaders are moving away from using insulation in their projects, and simply installing physical barriers to prevent people from touching hot steel structures or any other material requiring a protective area. This solution eliminates the hidden aspects of corrosion, and eradicates the insulation all together that would trap moisture in the first place. After all, when insulation comes in contact with moisture, it loses its ability to deliver on three key areas: optimisation of chemical processes; less energy being exerted; and the safety of people in its surroundings.

Having a plan in place from the start of an asset's lifecycle for maintenance ensures there is consideration for, not only emergency response, but limiting faults due to CUI. Our Jotatemp 1000 Ceramic, Jotatemp 250 and Jotatemp 540 Zinc products are all unique in their offering, providing protection and resilience towards the potential corrosion that can occur in both online and offline situations. With such a vital element of care and long-term consideration often being overlooked, it is critical that maintenance is a major part of both budget and personnel consideration when planning and executing.

CUI IN NEW CONSTRUCTIONS – HOW TO GET OFF TO THE BEST START

Corrosion under insulation (CUI) is a potential maintenance issue for all facilities or structures, new or old. Understanding and applying the correct insulation materials at the beginning of the construction process is one of the most important elements to consider – and could potentially save you time and money in the future.

Insulations such as calcium silicate, glass fibre and, to some extent, cellular plastic foams absorb and retain CUI culprits, liquids and vapours, and thus help prevent CUI from occurring. There is also the option of physical barriers for protection – meaning that no insulation is required – which can provide an aesthetically pleasing option for design in a new structure.

The most suitable insulation option will depend on operation and specification so a discussion with your supplier is recommended. This conversation is important to have to understand the best option for your build so to avoid potential costs and unscheduled additional maintenance in the long run.

This is because, during the maintenance process, the uncertainty of actually discovering CUI adds

in an element of risk. Significant resources and man-hours can be spent looking for CUI, as it is not easily accessed, and it may or may not be present. Prevention of CUI can also be helped by using products such as Jotatemp 1000 Ceramic, Jotatemp 540 Zinc or Jotatemp 250.

It is better to invest time into the planning and execution at the start of a project instead of dealing with the aftermath of CUI. If undetected, the results of CUI can lead to the shutdown of a process unit or an entire facility. By and large, no matter the precautions taken, water invariably seeps into the insulation – sometimes unseen until process leakage occurs. This is why it is vital for the correct planning and long-term maintenance scheduling to be considered when in the initial planning phases of a structure.

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CASE STUDY

WHAT: CUI discovered on hot steam pipe

WHERE: China

PRODUCT(S): Jotatemp 250

OUTCOME: Pipe restored to good condition while site remained operational and without unscheduled downtime

CUI was found at a factory in China when a hot steam pipe running along the site was undergoing maintenance.

The pipe had a steel surface temperature of 115 degree Celsius, and could not be brought to an ambient temperature for the coating work to occur. While the pipe was not in terrible condition, there was some surface rust and the need for paint work was present.

In order to deal with these issues, which could have escalated to a larger problem for the site, Jotun recommended its protective Jotatemp 250 for the coating.

While the operating temperature of the pipe was not very high, because Jotatemp 250 can be applied on a hot steel pipe where manual surface preparation had been carried out, it meant the pipes could be restored to a good condition without unscheduled downtime on site.

Being able to use Jotun's products while still in operation is a major benefit for operators for this reason.

The pipes were prepared with a disk grinder, and a satisfactory level of surface roughness was obtained to achieve good adhesion between the paint and the substrate. Two coats of Jotatemp 250 were then applied with a brush and allowed to cure, before the insulation was re-attached to the pipe.

The chosen course of action meant that there was minimum disruption to activity and that the pipe was treated with ease in order to rectify the underlying case of CUI.

CUI is a universal issue that should be monitored closely across the globe. In order to treat cases of CUI in a timely and effective way, the correct products and practices should be used in order to resolve, maintain and attempt to ward off the symptoms of corrosion under insulation for as long as possible.



To find out more about Jotun's Thermosafe range of coatings, designed for the extreme environments of onshore oil and gas facilities, visit the website or contact Kevin.

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