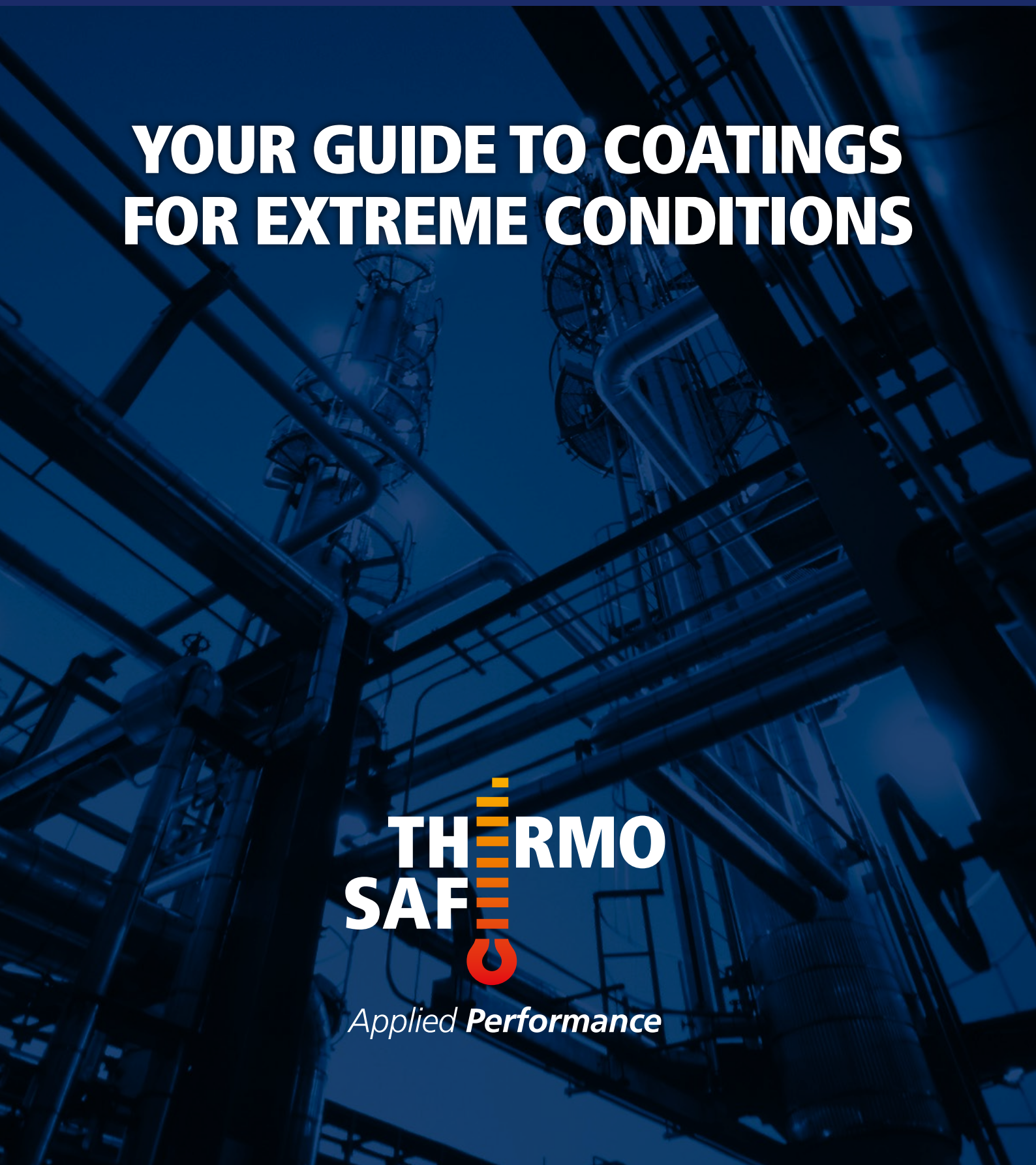
JOTUN

Jotun Protects Property

YOUR GUIDE TO COATINGS FOR EXTREME CONDITIONS



THERMOSAF

Applied ***Performance***

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A WORLD OF EXTREME CONDITIONS

The conditions in which oil, gas, and chemical companies now operate have become progressively complex in the quest to find and exploit reserves, as well as refine the outputs, placing increasing demands on pipes, valves, and hot structures within onshore oil, gas, and chemical facilities.

The health and safety of workers and communities is of paramount importance, meaning the reliability and quality of pipe and valve products is critical. The more sensitive the environment, the more aggressive the chemicals being used and produced and the more complex the processing conditions in terms of pressure, temperature and corrosion, the more critical the performance of the structure.

This is set against a backdrop of oil, gas and chemical companies moving into some of the world's most extreme and often vulnerable environments to meet our growing demand for energy. Take the Middle East, an established and burgeoning industry where temperatures are extremely high all year round due to solar radiation and surface heat, plus there is the heavy abrasion resulting from sand storms. Conversely, the Arctic is faced with extreme cold, high winds, seasonal darkness, long periods of heavy fog and storms that almost reach hurricane strength. With temperatures as low as -50°C, material properties change, and uninhibited or unprotected fluids freeze. It is not just the location of facilities that dictates the conditions they endure. Technological improvements mean that processing and refining temperatures are on the rise, leading to an increased risk of corrosion and fire or conversely the risk of cryogenic spills.

Where do coatings come in? Given the need to cut capital costs and the need to conform to tighter environmental legislation, the long life of a coating system and effective protection of facility assets is increasing in importance. Designing a plant is a huge and complex task requiring a delicate balance between meeting production goals, maintain budgets, achieving design life and ensuring all HSE concerns have been taken into consideration. With such a complex project, less critical design choices such as coating selection for pipes and valves tends tend to be pushed down the list of priority. But protective coatings are more than a commodity purchase, they come with applied performance, meaning they're the best way to safeguard your assets and enhance your performance. Either by prefabrication and secondary installation or simply with products to use during operations, they enable improvements without halting production.

A WORLD OF EXTREME CONDITIONS

In a time when crude oil prices have changed the cash flow in the global market, companies are keeping a very close eye on their expenditure. Applying the correct coatings and coating systems can aid in reducing materials cost, or increasing earnings by bringing facilities more quickly back online after a shut down. For example, if coatings can be applied on hot steel substrates, some of the coating work, or touch-up of coating systems, can be carried out after the facility has started up. When we take into consideration that a facility can produce products worth anywhere from US$1-12 million per day, getting online faster represents massive monetary gains.

Jotun's Thermosafe's range of protective coatings have been designed to offer a simple and effective way to add measurable value to performance of your HPI assets. Our series of smart products are proven to perform in extreme temperatures, to provide protection from corrosion an against fire. Their ease of application, durability and superior specifications will reduce installation time, lower maintenance costs, increase safety and improve operational efficiency.

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THERMOSAFE

Applied ***Performance***

Start applying more performance to your assets.

TOP 10 TIPS FOR PROCESSING PLANTS TO SURVIVE EXTREME CONDITIONS

1

For refineries to **mitigate against risk of reducing runs** and halting operations due to power outages, ensure roads for tanker trucks with deliveries of petroleum product and propane are gritted, pipelines have protective coating against subzero temperatures.

2

Industrial fireproofing is an important facility safety measure that is recommended by external auditors. You will need to look at the different types of passive fire protection. Using mesh-free epoxy passive fire protection eliminates one risk element from the facility.

3

One of the challenges of process piping is that over time there can be buildup of contaminants inside the pipelines. This buildup reduces the internal pipe diameter, thereby limiting production capacity. **Regular steam outs to remove such buildup** ensures that production capacity is maintained. When selecting a coating, ensure that it can also withstand the higher temperatures of a steam out to avoid coating degradation and premature coating failure.

4

Processing plant and facilities are often near sources of chlorides. While pipes and valves can often be made from stainless steel, the combination of high temperatures and mechanical strain can give rise to chloride induced stress corrosion cracking. **Choosing coatings that prevent chlorides from migrating to the steel surface can help mitigate this risk.**

5

On facilities where there are thousands of kilometers of pipes, hundreds of pressure vessels and a multitude of processing operations, doing inspection work is a challenge. **Doing a risk assessment to determine what are the most critical areas** means inspections are more focussed, ensuring that potential threats can quickly be identified and dealt with.

TOP 10 TIPS FOR PROCESSING PLANTS TO SURVIVE EXTREME CONDITIONS

6

During a shut-down, time is of the essence. **Having standard sections pre-painted with a temperature resistant zinc silicate** in the warehouse means that these can quickly be replaced should the need arise. Since the sections are coated with a zinc silicate they will not corrode prior to installation. Depending on the usage conditions the section can then be overcoated with a suitable coating system or left as it is.

7

Coloured top coats can be used for marking pipes. This can make installation faster and allow for quick identification of the pipe contents. These coatings are also UV-resistant, allowing for protection of epoxy coatings which suffer from UV degradation.

8

During the lifetime of a facility things change. The value and cost of feedstocks and finished products change. Parts of the facility might not go into operations and other parts might need to be more efficient. These types of changes can alter operational parameters such as pressure and temperature. While steel structures are generally engineered with ample safety margins to allow for this, this tends not to be the case for coatings. Why not **design some safety margin into the coating system as well, to futureproof your facility?** Remember, upgrading the coating system is a fraction of the cost compared to staging, preparation and going off-line.

9

In extreme conditions moisture gets into insulated areas and cannot readily escape, this creates hidden corrosion problems in the form of corrosion under insulation (CUI). **Using a suitable coating system that has been tested and approved by third parties for CUI conditions** means you can prevent the water from reaching the steel substrate, greatly reducing the risk for hidden corrosion problems under thick layers of insulation and cladding.

10

Generally, when a facility is being built, or if maintenance is being carried out in remote areas, coated structures need to be transported to the construction site. Often this creates transportation damages on the coated sections. **Applying coatings that minimize transportation damages, or a zinc silicate as the first coat, reduces or sometimes even removes the need for recoating.**

CORROSION

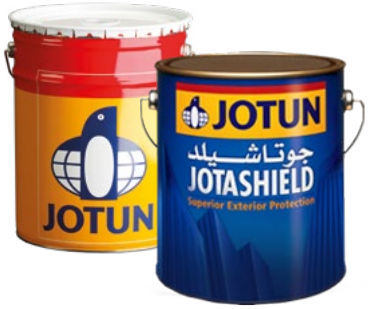
Any industry that uses or produces corrosive or hazardous chemicals – such as fertilizer plants, oil and gas facilities, chemical plants and tank farms – are tasked with ensuring their services are safe and reliable. From the mid-1900s, owners relied on acid brick linings to mitigate against severe thermal, chemical and mechanical conditions.

The global cost of corrosion in 2016 was US$2.5 trillion, equivalent to roughly 3.4 percent of the global Gross Domestic Product (GDP) [source https://inspectioneering.com/news/2016-03-08/5202/nace-study-estimates-global-cost-of-corrosion-at-25-trillion-ann] and the daily cost of shut down can be up to US$12 million. This is particularly pertinent in the oil, gas, and chemical industry, where significant amounts of carbon steel – from plants and industrial facilities to pipelines and processing equipment and refineries are exposed to extreme environments or harsh processes.

Corrosion comes at a price. It increases production downtime, repair, and replacement, with companies looking for more proactive solutions. Corrosion is so prevalent and comes in so many forms that its occurrence and associated costs will never completely eliminated; yet all studies estimate that 25-to-30% of annual corrosion costs could be saved if optimum corrosion management practices were employed. [Source: Global Needs for Knowledge Dissemination, Research, and Development in Materials Deterioration and Corrosion Control by Günter Schmitt in cooperation with Michael Schütze, George F. Hays, Wayne Burns, En-Hou Han, Antoine Pourbaix, and Gretchen Jacobson.]

Today there is a range of corrosion resistant linings and materials available- including protective coatings – that offer more versatility. They can stop carbon steel corrosion, extend equipment life and minimise the cost and production downtime required to recoat, repair or replace equipment.

Corrosion is accelerated at high temperatures and in areas that are difficult to inspect and hidden under insulation. It shortens the design-serviced lifetime. Zinc coatings, for example, will degrade and break down faster when facilities operate at temperatures higher than the melting temperature of zinc.



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CORROSION

Ethylene plant in Egypt.

Jotatemp 250

Anti-corrosive protection against continuous temperatures up to 250°C.
If you only need 50 degrees or more, why pay for 450? Our unique composite coating will give you full service performance at temperatures all the way from cryogenic to 250°C without having to opt for more expensive materials.

Jotatemp 540 Zinc

Offering both barrier and galvanic protection for temperatures in excess of 120°C. Jotatemp 540 Zinc is the only zinc silicate on the market that has been specifically designed for use on high temperature areas, all the way up to 540°C.

Jotachar 1709 mesh free

Mesh-free epoxy PFP protecting against hydrocarbon fire, for up to four hours.
Jotachar 1709 mesh free, a next generation epoxy passive fire protection material, designed to protect against hydrocarbon pool fire scenarios for up to four hours as defined in the ANSI/UL1709 standard.

Jotatemp 1000 Ceramic

Based on ceramic binder technology, Jotatemp 1000 Ceramic provides protection to steel structures operating at temperatures from cryogenic up to 1000°C. It is a possible alternative to TSA or stainless steel options and offers greater flexibility in its ease of application.

Jotatemp 1000 Ceramic provides predictable long-term protection for your pipework, significantly reducing your operating costs and delivering measurable performance advantage.

HIGH TEMPERATURES

As their name suggests, high-temperature coatings are those that can offer corrosion protection under temperatures as high as 1000°C. Industrial heat resistant corrosion protections are widely used in process-based facilities such as refineries and petrochemical plants and on the increase due to the increase in refining and processing temperatures.

Extensive networks of pipe, valves and panels in these establishments are typically insulated and covered by cladding and therefore are commonly hidden from the naked eye. Force Technology carried out a study showing that 60% of insulated pipes aged 10 years or older contained corrosion inducing moisture, giving rise to hidden corrosion under insulation, (CUI). High temperature coatings can protect the steel from this moisture, limiting CUI conditions. That's why it is important for facility managers to have confidence and belief in the effectiveness of high temperature coatings.

High-temperature coatings have built-in unique properties that enable them to withstand extreme temperatures. They are designed for challenging environments where either the temperatures are very high or low, or they fluctuate between one extreme and another.

Processing and refining temperatures are increasing and can be as high as 250°C, which can damage most coatings, subsequently leading to premature maintenance and the associated costs.

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HIGH TEMPERATURES

Many coatings cannot be applied on structures operating at high temperatures necessitating bringing a plant to off-line to do any maintenance. Using the correct coating when the paint job is being carried out is therefore critical in eliminating future coating failures. Should the coating failure already have happened, identifying risk areas to determine where maintenance should first be carried out and using coatings that can be applied on hot substrates, can help minimise the need for disruption.

Coatings that are applied on hot substrates can also mean that a facility can return to operations more quickly, reducing the amount of days a facility is off-line or operating at reduced capacity. When it comes to a shut-down, the saying 'time is money' holds true.

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Based on ceramic binder technology, Jotatemp 1000 Ceramic provides temperature-resistant corrosion at cryogenic temperatures for extreme HT process pipework. It is the smart alternative to Thermal Spray Aluminium or stainless steel options and offers greater flexibility in its ease of application.

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CRYOGENIC OPERATIONS

Gas processing has increased in importance in recent years, and gas has become an important part of the energy and chemicals industry. However gas processing also means a new set of engineering challenges has cropped up, due to the low temperatures used.

In order to efficiently transport and process gas, high pressures and low temperatures are used to liquefy the gas. With the introduction of natural gas, the temperature range of processing is moving into the cryogenic temperature area and the frequency of cryogenic conditions has increased. Low temperatures in chemical processes introduces a brand new set of engineering challenges, where specialized materials and processing steps are introduced. In addition, the rapid change in temperatures that occurs with the introduction of liquid gasses also presents its own set of challenges.

The challenges to materials from exposure to these low temperatures also extends to coating systems. In order to protect steel substrates from the frigid temperatures of liquid gas, Jotun uses a variety of technologies to reinforce and engineer coating systems to be resistant down to cryogenic temperatures.

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Jotatemp TB550

Thermal insulation for cryogenic spill protection and heat reduction. Combined with our Jotachar 1709 PFP coating, it provides protection from flare radiation, cryogenic spill and long-term corrosion.

FIRE

Every step of the production process is wrought with fire hazards, from extraction and transportation to refining and storage in downstream operations. For many facilities managers, fireproofing is mandatory to validate insurance policies.

This is a tough requirement, as a range of flammable liquids and by-products flow through pipe networks and used more generally in the refinement process. This exposes all sorts of structures, pipe racks, refinement vessels and steel structures to fire.

Facility managers will no doubt have broader fire protection measures in places such as foaming or sprinkler systems, but the particulars around fire proofing for the pipe networks, valves and vessels often go amiss. Equally, the flammable liquids that form the 'engine' of the facility can suddenly become the fuel to help burn it down.

Passive fire protection can be the difference between a structure on fire and a structure melting to the ground. It can buy valuable time, allowing for the evacuation of workers and avoiding loss of lives. When applied to steel structures, it can protect them against hydrocarbon fire scenarios, until the fire can be extinguished. When a fire is in full blaze, temperatures can reach the dizzy heights of 2000ºF plus, enough to melt most steel structures.

Protective coatings are measured according to how long they can withstand fire. Independent safety science laboratories such as Underwriters Laboratories (UL) offer independent accreditation.

Jotachar 1709 mesh free

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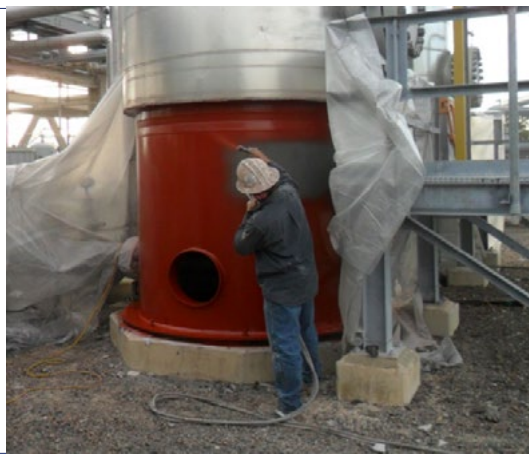


MYTHBUSTING

Corrosion is small business in the oil and gas industry

Corrosion Under Insulation (CUI) is one of the principal causes of accidents in the oil and gas sector. If we take the EU, there have been 137 major oil and gas accidents since 1984, 20% of which were associated with corrosion. These have devastating consequences that impact safety and affect the local environment and can cause so much damage to plant equipment it can lead to complete failure and in worse case scenarios, total plant shutdown. The economic impact of this is immense.

Higher quality coatings don't make a difference to material life expectancy

By selecting high-quality products, the time between major maintenance can be extended, increasing plant operation time. When a plant off-line costs somewhere between 1-12 million USD per day, it becomes evident that decreasing days off-line significantly impacts profitability. While premium coatings come at a cost, compared to the loss of profit generated by shutting down production, this is minimal.

Coatings cannot be applied to structures when in operation

Utilizing coatings that can be implemented on substrates operating at higher temperatures means that maintenance work can be carried out on live lines.

Coatings are all the same

When it comes to coatings, there is no one size fits all model. Much like designing a plant, engineering coatings require consideration of a variety of factors. Any adjustments in the coating design will impact on the overall properties of the coating. Increasing the chemical resistance can lead to increased brittleness, allowing for application in colder climates to decrease the heat resistance of the product. Reducing the coating cost can make it less suited to cyclic services.

It can be done on the cheap

You get what you pay for as the saying goes, but many managers choose contractors based on price. The experience of application contractors and their employees directly links to the successful coating of a structure.

Exotic materials resist everything

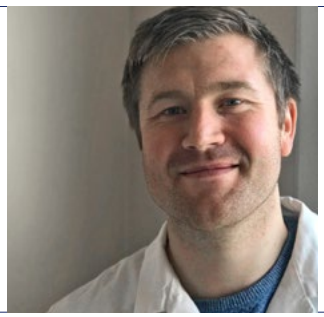
It is often expected that a material chosen for the media in the process will also be resistant to external stresses, such as water, chemicals and chlorides. This need not be the case. Stainless steels, for instance, are prone to chloride induced stress corrosion cracking. High temperatures and high chloride contents combined with the mechanical stresses that are found in cyclic processes make the perfect storm for these type of damages to occur.

I use vapor barriers and sealants, so my insulation is free from moisture and my pipes are dry

Proper design and installation, such as using vapour barriers can keep moisture and water in the environment from getting under the metal sheathing of pipes and structures and entering the insulation material, at least for a time. However, moisture can also come from the condensation caused by temperature fluctuations. Think about your bathroom mirror after you've taken a shower, it is full of condensation. Or a water bottle straight from the fridge, which becomes wet with condensation once placed at room temperature. Even small temperature gradients can cause condensation to occur. This condensation will occur on the pipe surface, underneath the insulation, and the moisture barrier and sealants that are so effective at keeping water out, will now keep water in the insulation, preventing evaporation.

This is further underlined by a study carried out by Force Technology where it was discovered that 60% of pipes aged 10 years or older contained corrosion inducing moisture. Despite our best efforts, wet insulation and the risk of corrosion underneath insulation is not simply a possibility, it is an inevitability.

SEEKING PERFECTION BY DEGREES: HOW OUR THERMOSAFE RANGE WAS BORN



Svein Jacob Kaspersen Ph.D. Senior Chemist, R&D

The evolution of Jotun's Thermosafe range of protective coatings is a story that spans several years of research and development and represents a perfect synergy between our clients' requirements and our on going drive to improve the technical quality of our products.

A common industry benchmark for many companies to operate their assets continuously on a day-to-day basis is around the 200°C range, although we know from experience that there can be occasions when operational temperatures can reach 230°C or 240°C, such as steam outs.

And while such events may occur only a few times a year, we knew that we had to create an epoxy technology that would enable our customers to successfully continue operations beyond the 200°C perimeter, without being limited by the integrity of their pipe coatings.

To get that extra increase in coating performance, companies had previously had to jump to more expensive products with maximum temperature limits of 650 or 1000°C. But it was clear that they only needed an extra 50°C for their operations, so why pay the extra?

We therefore decided to create an anti-corrosive protection that would operate successfully at a continuous temperature of 250°C and would drastically reduce costs, compared to alternative, higher temperature resistant solutions. We were told many times that it couldn't be done, and while we knew it was an ambitious target, our years of experience in technical innovation gave us the confidence and commitment to prove the doubters wrong.

We therefore decided to create an anti-corrosive protection that would operate successfully at a continuous temperature of 250°C and would drastically reduce costs, compared to alternative, higher temperature resistant solutions.

SEEKING PERFECTION BY DEGREES: HOW OUR THERMOSAFE RANGE WAS BORN

Extensive and rigorous corrosion, curing and temperature tests were first undertaken on sample panels at our research and development facility in Norway – incorporating the largest privately owned coatings laboratory in Northern Europe – and elsewhere in the world by third parties. The temperature tests progressed to 230°C, but breaking beyond that barrier proved a challenge – until we introduced additional raw materials to create a new composite, which delivered additional properties and helped increase the flexibility of the coating.

Tests on an aluminium recycling facility in Oman proved successful and conclusive. We had created a coating technology that could withstand a continuous temperature of 250°C. And it was able to provide cost savings of more than 70 percent on existing products. Jotatemp 250 was born.

The commercial success of Jotatemp 250 led us on to an examination of the other critical challenges in enhancing operational efficiency and on-site safety in the extreme environments faced by onshore oil and gas facilities. The highly sophisticated testing regimes and processes established in the development of Jotatemp 250 served as a template for the creation of the other products in the Thermosafe range, while a culture of continuous improvement, aligned with a desire to produce technologies with a clear commercial benefit to the industry, provided the impetus for our research and development.

But, rather than the establishment of a range of successful industry-leading technologies being the end of the Thermosafe story, it's just the latest chapter. We're now supporting our clients through providing combinations of Thermosafe technologies to suit their specific needs, whatever they may be. We're also exploring the science behind why combinations of materials work together and continually looking at ways to improve our products.

And while some may say that it can't be done, at Jotun we've learned that it can.

GLOSSARY OF TERMS

Abrasion damage
Surface deterioration caused by rubbing and friction against the surface.

Basecoat
Term used by contractors in relation to the Intumescent.

Carbonation
The conversion of calcium ions in hardened cementitious materials to calcium carbonate by reaction with atmospheric carbon dioxide.

Cohesion
The state in which the constituents of a mass of material are held together by chemical and physical forces.

Crack Cracking
a complete or incomplete separation of concrete into two or more parts produced by breaking or fracturing.

Dampproofing
Treatment of a material to retard the passage or absorption of water or water vapour either by application of a suitable coating to exposed surfaces or by use of a suitable admixture.

Degradation
A detrimental change in the physical and/or chemical properties of a material.

Epoxy resins
A class of organic chemical bonding systems used in the preparation of special coatings for concrete, adhesives for injection of cracked concrete, or as binders in epoxy-resin mortars and concretes.

Erosion
Progressive disintegration of a solid by the abrasive or cavitation action of gases, fluids, or solids in motion. (See also abrasion damage and cavitation damage.)

Feedstocks
Crude oil and other hydrocarbons used as basic materials in a refining or manufacturing process.

Fire rating
Relates to fire protection requirement of building.

Hydrocarbons
Oil, gas and other chemical components carrying hydrogen and carbon atoms.

Loading
Term often used by applicators – relates to film thickness.

Moisture content
The ratio, expressed as a percentage, of the mass of absorbed or adsorbed water in a given material to the total mass.

Passive
The state of a metal surface characterized by low corrosion rates in a potential region that is strongly oxidizing for the metal.

Partial Exposure
Where a steel section has perimeter reduced e.g., section flush to wall, block work into webs (usually columns).

Primer
The first coat of a material applied following surface preparation; serves to improve the bond of subsequent coats and may have corrosion inhibitive properties for use on metals.

Surface repair
Repair of a concrete surface, e.g., application of an overlay, or repair of near-surface concrete that constitutes only a small portion of the depth of a member or element.

Working life
The period of time during which an adhesive, after mixing with catalyst, solvent, or other compounding ingredients, remains sufficiently workable to permit application and spreading.

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.

kevin@jotun.com
www.jotun.com/thermosafe

JOTUN
Jotun Protects Property

THERMOSAFE
Applied **Performance**