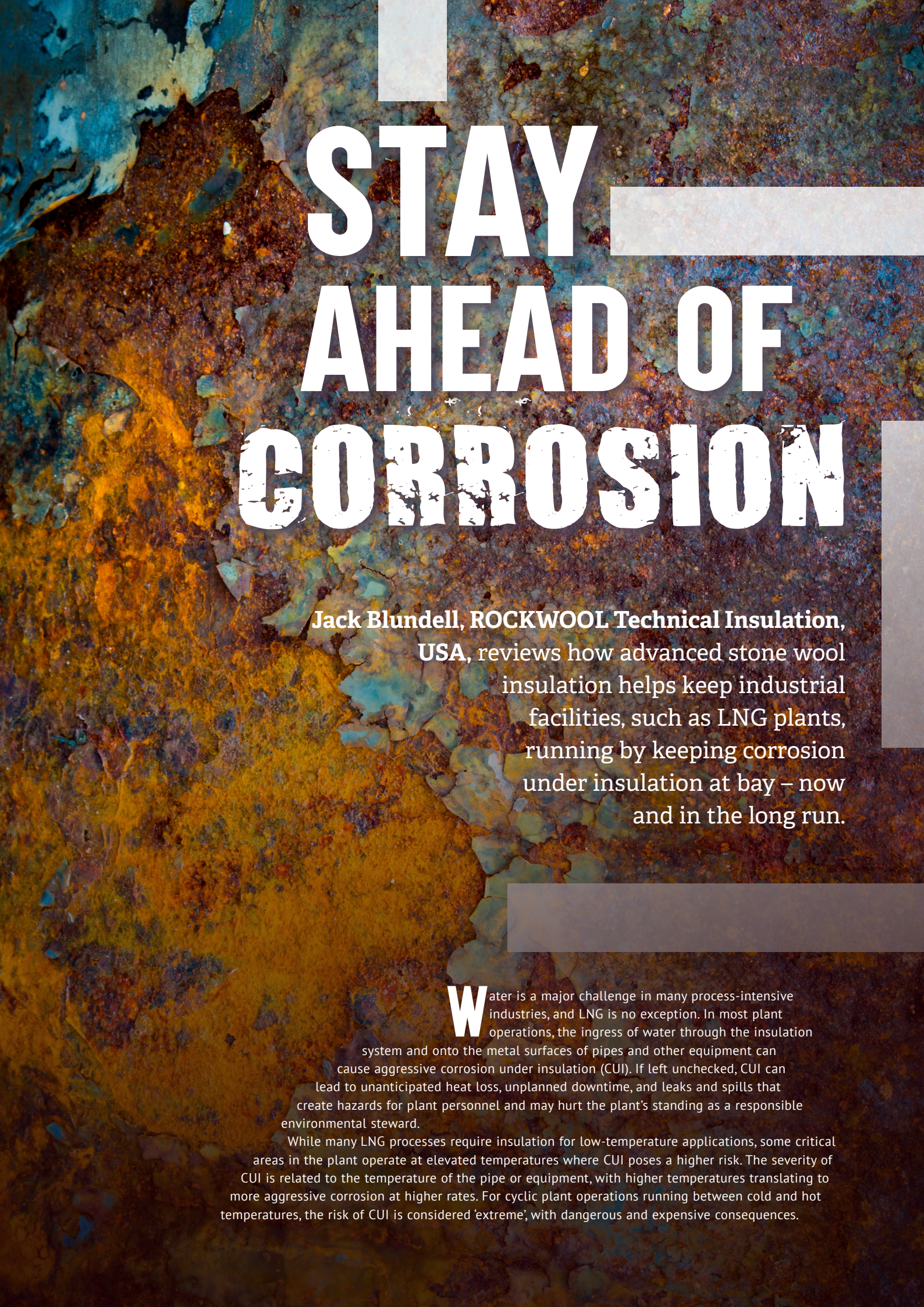




STAY AHEAD OF CORROSION

Jack Blundell, ROCKWOOL Technical Insulation, USA, reviews how advanced stone wool insulation helps keep industrial facilities, such as LNG plants, running by keeping corrosion under insulation at bay – now and in the long run.

Water is a major challenge in many process-intensive industries, and LNG is no exception. In most plant operations, the ingress of water through the insulation system and onto the metal surfaces of pipes and other equipment can cause aggressive corrosion under insulation (CUI). If left unchecked, CUI can lead to unanticipated heat loss, unplanned downtime, and leaks and spills that create hazards for plant personnel and may hurt the plant's standing as a responsible environmental steward.

While many LNG processes require insulation for low-temperature applications, some critical areas in the plant operate at elevated temperatures where CUI poses a higher risk. The severity of CUI is related to the temperature of the pipe or equipment, with higher temperatures translating to more aggressive corrosion at higher rates. For cyclic plant operations running between cold and hot temperatures, the risk of CUI is considered 'extreme', with dangerous and expensive consequences.

During cycling, water vapour gets into the system at cold temperatures and the system is susceptible to higher CUI risks as it cycles through the water dew point. During each temperature cycle, the chloride salts in the water concentrate on the surface of the metal (and possibly in the insulation) when the water evaporates during the higher temperatures. By some estimates, CUI accounts for 10% of a plant's overall maintenance costs and up to 60% of pipeline maintenance costs.^{1,2}

In addition, a growing number of LNG facilities are being built along the US Gulf Coast and in India and Pakistan – high-humidity regions prone to increased rainfall and seasonal weather events such as hurricanes and monsoons. The warm, moisture-laden climate of these regions makes corrosion resistance a critical need for the vast network of pipelines and other equipment in an LNG facility.



Figure 1. ProRox insulation with WR-Tech improves plant safety by reducing noise and mitigating the effects of corrosion under insulation.



Figure 2. ProRox PS 960 with WR-Tech installed easily and quickly, even on tight clearance areas of the test pipe.

Traditional materials like coatings are considered the best line of defence against CUI, but are not always a singular corrosion mitigation solution in these regions. These coatings often need to be reapplied every few years, which adds maintenance costs and may require non-productive downtime in some parts of the LNG plant. With the rapid and common onset of flash rusting in some high-humidity environments, this means that the coatings cannot always be effectively applied.

Mitigating CUI with water-repellency technology

ROCKWOOL Technical Insulation is a global leader in stone wool insulation solutions, with more than 85 years of history in providing innovative products that help meet required design criteria and help solve the most critical industry challenges – including enhanced water repellency and proven corrosion mitigation. Leveraging the natural power of stone, the company's ProRox insulation materials provide proven, effective thermal and sound resistance in industrial applications. These materials are manufactured by melting natural rock, spinning it into long fibre strands, and then weaving the strands into high-density mats or sectional forms that easily conform to the outside of piping systems and other LNG equipment.

ROCKWOOL has built on the proven thermal and acoustics insulation performance of its ProRox stone wool solutions, to now mitigate against CUI with a water-repellent additive called WR-Tech ('Water Repellency Technology'). This binder technology coats each individual fibre of the stone wool insulation with an inorganic, hydrophobic additive during the manufacturing process. This imparts the stone wool with superior water repellency, even at elevated operating temperatures, while preserving the insulation's thermal and acoustics performance.

WR-Tech substantially lowers CUI and extends the piping network's operating life in several ways.

Water repellency for long-lasting corrosion protection

In third-party tests conducted to the EN 13472 standard (the European standard for determining short-term water absorption in pipe insulation), insulation treated with WR-Tech has a water absorption five times lower than the next-closest insulation material. The treated insulation also very importantly maintains this water repellency even after being subjected to pre-heat stress tests of 250°C (482°F) for 24 hours.

The insulation also contains less than 10 ppm water-soluble chloride content, making it compliant with industry standards such as ASTM C795 and EN 13468, ensuring its safe application over steel. Additionally, in testing per the ASTM C1763 standard (test method for water absorption by full immersion in liquid water), the insulation's fibrous, vapour-open structure shortens drying times, even over long periods of time in applications with cycles of heating and cooling.

Wide performance versatility beyond corrosion mitigation

ProRox insulation with WR-Tech maintains a stable and durable thermal performance to minimise heat losses

in hot pipes, save on energy consumption, and reduce greenhouse gas emissions for the plant. On average, stone wool insulation saves 20 000 times more carbon dioxide over its operating life than what is emitted during its manufacturing process.³

In addition to its thermal insulation performance, ProRox with WR-Tech delivers effective acoustics insulation for inherently noisy LNG plant equipment (including air-cooled heat exchangers, piping systems, compressors, and pumps). This equipment typically generates noise levels of 100 dB or more, which exceeds the recommended exposure limit (REL) of 85 dB (as an eight-hour time-weighted average) set by the US National Institute for Occupational Safety and Health.

ROCKWOOL tested its stone wool insulation materials to the ISO 15665 standard, a widely accepted standard developed by the International Organization for Standardization (ISO), to guide the selection and design of acoustic insulation for pipes, valves, and flanges.

ISO 15665 has been adopted by major oil and gas operators, refineries, and LNG plants and defines different classes of sound control (Classes A, B, C, and D). The Class D specification requirement has become the predominant sound control class for LNG plants around the world.

The standard sets requirements for minimum insertion loss, which is a measure of the minimum noise reduction in decibel for each class when acoustic insulation is applied to a pipe system. Insertion loss testing is conducted in a sound room with a single steel pipe running the length of the room.

ProRox stone wool insulation effectively meets the ISO 15665 standards for recommended insertion loss levels for all classes A, B, C, and D materials in this testing – at less than half the thickness of other insulation materials.

Easy installation with less downtime and maintenance

ProRox insulation with WR-Tech is available as lightweight pipe sections or mat (wrap) that installs with fewer application layers than conventional insulation options. The mat (wrap) insulation applies easily to vessels, columns, complete pipeline systems, and other applications requiring design flexibility – and without the need for sealants, offsite cutting, or specialised personal protective equipment.

The insulation provides effective thermal, acoustic, and corrosion protection at a noticeably lower installation thickness vs conventional insulation materials, making it easier to apply around tight pipe bends or in areas with limited clearance space. A thinner insulation layer translates to lower installation costs, more effective use of installation crews, less storage space required for inventory, and lower transportation costs. Stone wool insulation is also removable and reusable, allowing for easy inspection without having to purchase replacement materials.

Proven CUI protection in demanding plant conditions

Since its introduction to the global market in 2017, ProRox insulation with WR-Tech has received industry accolades. The technology won the prestigious AMPP 2019 Corrosion Innovation of the Year Award, one

of 10 technologies out of more than 50 nominees to receive the honour. Winners were selected by a panel of corrosion-control experts, spanning a diverse range of subject matter expertise from across the industry.

The product is recognised by industry experts in the corrosion field as a proven technology for water repellency and CUI mitigation potential. The technology has also successfully kept critical plant systems safer from CUI risks in a growing number of facilities – many of which operated under more severe conditions than a typical LNG plant.

Case study

One such facility was a large chemical plant in northern Europe that had been in continuous operation for nearly 60 years. The plant includes a large cracker unit that converts naphtha into benzene, ethylene, and propylene, which are used as feedstocks in several industries. This facility, one of the largest in the country and in the company's production portfolio, includes more than 50 production installations interconnected via 1200 km of insulated pipes.

Temperatures in the pipe network range from -180 – 1100°C (-292 – 2012°F). About 70% of the piping operates between 50 – 600°C (122 – 1112°F) and is covered with stone wool insulation to minimise heat losses and ensure greater process reliability, safety, energy control and cost reductions, and plant integrity.

For the plant's full-time maintenance crew and a support staff of approximately 1000 contractors, maintenance of pipes and systems is an integral part of their daily work. In recent years, CUI has become the main focus point for the team, with much of the team's time and costs going to CUI inspection and prevention. Inspection work schedules are planned years in advance, particularly for critical processes like the cracker, which must function reliably, safely, and properly to avoid a major shutdown that would impact the performance and profitability of the plant as a whole.

As part of its ongoing commitment to improving process safety and keeping CUI under control, the plant's



Figure 3. After three years at 120 – 140 °C (248 – 284 °F), the ProRox PS 960 with WR-Tech maintained its structural integrity and showed minimal ingress of water.

maintenance team performs practical tests on new coatings in the plant. The team worked with ROCKWOOL to conduct such a test on ProRox insulation with WR-Tech.

To analyse the WR-Tech's effectiveness at preventing CUI, the maintenance crew and ROCKWOOL set up a three-year test on an operating pipeline with process temperatures ranging from 120 – 140°C (248 – 284°F). ROCKWOOL supplied its ProRox PS 960 pipe sections with WR-Tech for the test.

A 60-mm thick test section of the PS 960 insulation was installed on 5 m of operating pipeline. Beginning in February 2018, the test section was initially exposed to all weather conditions over a four-month period. The crew then installed aluminium-zinc jacketing over the insulation, according to plant specifications, for the remaining 32-month test period.

At the end of the test period, disassembly and visual inspection revealed that the ProRox PS 960 with WR-Tech showed some slight flaking and fluffiness at its surface due to exposure to natural elements such as wind and rain. However, a closer inspection of the rest of the insulation showed no evidence of further moisture penetration. In addition, no CUI was visible on the surface of the pipe.

Further moisture analysis by ROCKWOOL showed that the test section measured 0.1 kg/m² water absorption, well under the EN 13472 standard's limit of 1 kg/m². This value was also under the standard of 0.2 kg/m², which ROCKWOOL imposes on its own products.

The plant operator stated that they will continue to evaluate and implement other inspection methods to

improve its CUI prevention efforts, including developing in-field pipe insulation moisture detection systems. But the operator's focus remains the prevention of moisture ingress in the first place. And given ROCKWOOL's performance in this first field test, the operator has the confidence to evaluate ProRox insulation with WR-Tech on other piping systems in the plant.

Conclusion

As existing LNG facilities expand and new LNG projects are built to meet the growing global demand for gas, LNG operators will need proven, cost-effective CUI solutions to ensure the safety and long-term productivity of their facilities. Material advances, such as ProRox stone wool insulation with WR-Tech, offer the promise of effective noise suppression and superior water repellency to keep personnel safer and plant equipment running longer. [LNG](#)

References

1. 'NACE Impact Study: Appendix D', *NACE International*, (2016), p.D-10.
2. FITZGERALD, B. J., DROZ, C., and WINNIK, S., 'Piping System CUI: Old problem, different approaches', *European Federation of Corrosion (EFC)*, Minutes of meeting, presentation by ExxonMobil Chemical Company, (2003).
3. 'Greenhouse Gas Equivalencies Calculator', *United States Environmental Protection Agency*, www.epa.gov/energy/greenhouse-gas-equivalencies-calculator