



Combat the risk of  
Corrosion Under Insulation



Don't let water take  
hold of your pipes

**How to mitigate the risk  
of CUI?**

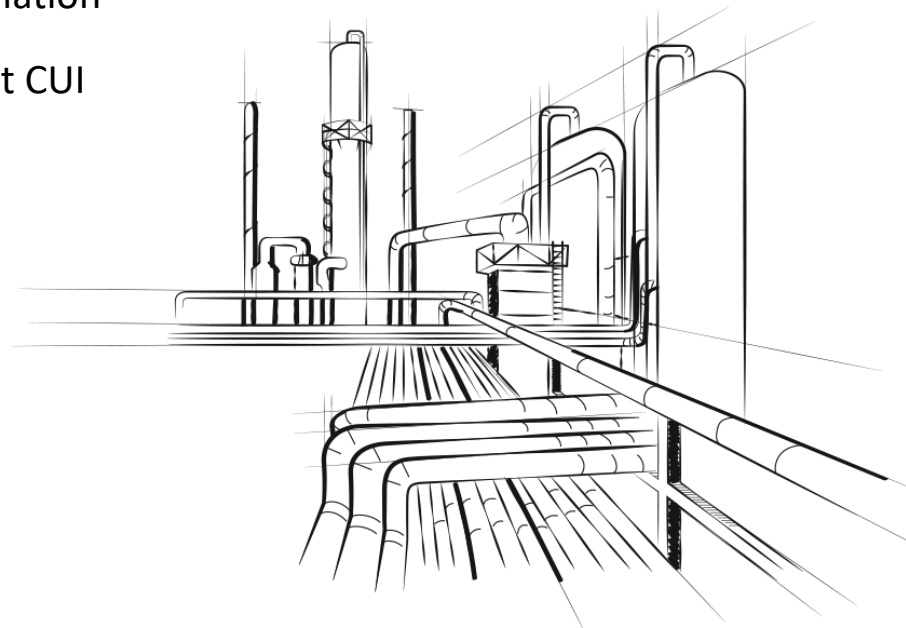
**ProRox PS 960/970 mandrel  
wound pipe sections with**

**WR-Tech**



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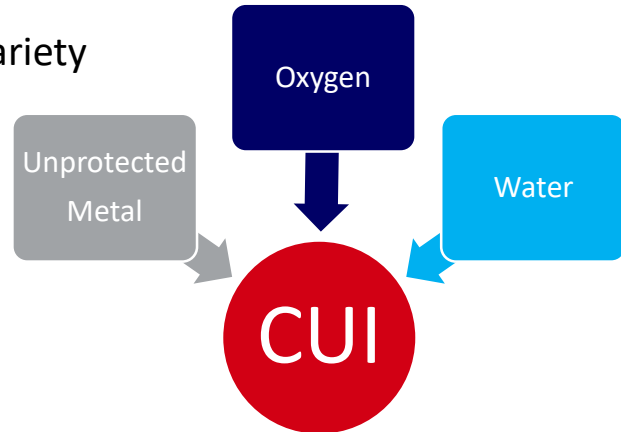
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# What is CUI and why is it a problem?

# What is CUI?

- Corrosion Under Insulation (CUI) is the result of an electro chemical reaction between an unprotected metal, water and oxygen, occurring under the insulation
- CUI is a product of wet metal exposure, from trapped moisture build-up under the insulation (unable to evaporate)
- Accelerated by temperature and the presence of chlorides and/or sulphates in the water
- Water/moisture (forming into an electrolyte) can come from a variety of sources, both external and internal:
  - Rain
  - Salt water mist
  - Condensation
  - Cycling of the system
  - Wash-down water
  - Leaks or spills in the process



# Temperature accelerate CUI

## Carbon/mild steel – risk of corrosion

Operating temperature	CUI risk
< -5 °C (25 °F)	Low
> 175 °C (347 °F)	Low
-5 to 49 °C (25 to 121 °F)	Medium
50 to 175 °C (122 to 347 °F)	High
Cycling temperatures between -20 and 320 °C (-4 and 608 °F)	Extreme

## Stainless steel – risk of ESCC

Operating temperature	ESCC risk
< 50 °C (122 °F)	Low
50 to 175 °C (122 to 347 °F)	High
>175 °C (347 °F)	Low

*Reference: Shell DEP 30.46.00.31-Gen. September 2011*

- **83% of CUI incidents occur on pipes** (Exxon study)
- CUI can be accelerated in an environment in high salt (seaside & coastal areas) & humid conditions and / or installations with intermittent and cycling temperature ranges.

# Why is CUI a problem?

- CUI is a **SYSTEM** challenge!

- Surrounding environment
- Plant operation
- Equipment/system design
- Choice and installation of:
  - Coating
  - Insulation
  - Jacketing/cladding



Undetected  
corrosion

Leaks

Shut downs

Repairs

\$\$\$

- Inspection and maintenance
- CUI is a significant part (up to 40%) of the maintenance cost on pipes
- Costly problem – due to more frequent repairs, shutdowns, overhauls, and overall reduction of plant service life
- Even worse, CUI increases the risk of spills, leaks, and disastrous accidents

# Corrosion statistics and importance of insulation



# Corrosion statistics and importance of insulation

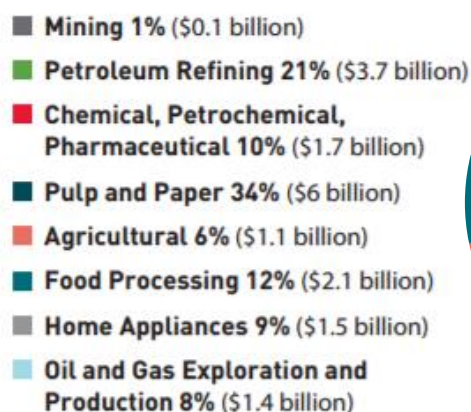
- Damaged insulation jacketing/cladding often allows water to penetrate into the insulation, which can cause corrosion
- Costs due to corrosion, downtime, and additional unanticipated energy losses are substantial

	Mid-Size Chemical plant	Refinery (150.000 barrels per day)
Insulation damage	19.2%	21.3%
Corrosion	182,000 euro annually	365,000 euro annually
Additional energy loss (0.012euro/kWh)	1,335,036 euro annually	7,783,942 euro annually

Source: US steam digest, insulation management and its value to industry

- Heat losses from damaged insulation can be up to 8x greater

## Annual Cost of Corrosion





# Common preventative measures to combat CUI

# Common preventative measures to combat CUI

- There are several (different) practices that can be employed to reduce or possibly eliminate the potential for CUI problems
- Basic material rules to help reduce CUI:
  - Properly designed and installed jacketing/cladding system
  - Use of a suitable coating system for pipe surface protection
  - Choosing an **insulation** material with important “corrosion reduction” characteristics



# Insulation selection

## NACE SP0198-2016 (2.1.2):

CUI of carbon steel is possible under **all types of insulation**. The insulation type may only be a contributing factor. The insulation characteristics with the most influence on CUI are:

- Water-leachable salt content in insulation, such as chloride, sulphate and acidic materials that may contribute to corrosion;
- Water retention, permeability, and wettability of the insulation; and
- Foams containing residual compounds that react with water to form hydrochloric or other acids.

Because CUI is a product of wet metal exposure duration, the insulation system **that holds the least amount of water and dries most quickly** should result in the least amount of corrosion damage to equipment.

Corrosion can be reduced by careful selection of insulation materials.

# The challenge and solution

# The challenge

## Keeping water out is not that simple!

- Water ingress cannot be avoided and will occur under every type of insulation
- Choose an insulation to counter the harmful effects of CUI with:
  - ✓ ○ The **lowest** water absorption
  - ✓ ○ The **fastest** moisture dissipation
  - ✓ ○ **Durable** performance over the entire CUI temp. range
  - ✓ ○ **Low** amount of leachable chlorides

# The solution

ROCKWOOL Technical Insulation has developed the next generation of stone wool pipe sections with a unique binder technology to mitigate the risk of CUI:

## ROCKWOOL ProRox PS 960 / 970 mandrel wound pipe sections with **WR-Tech** ("WR-Tech" — Water Repellency Technology)



# The solution

## *What is WR-Tech?*

WR-Tech® incorporates a revolutionary coating-friendly binder technology (inorganic hydrophobic resin) that coats the fibers of our stone wool pipe sections during the production process.



## *What is the advantage of WR-Tech?*

ProRox mandrel wound pipe sections with WR-Tech has a 5 X lower water absorption than the standard available EN classified stone wool. This reduced water absorption contributes to a mitigation of the risk of CUI.

## *How do ProRox mandrel wound pipe sections with WR-Tech mitigate the risk of CUI?*

The 5 X lower water absorption increases water repellency of the stone wool, making it difficult for water to penetrate the wool. At the same time, the wool remains open for water vapour diffusion, allowing any water inside the system to egress.



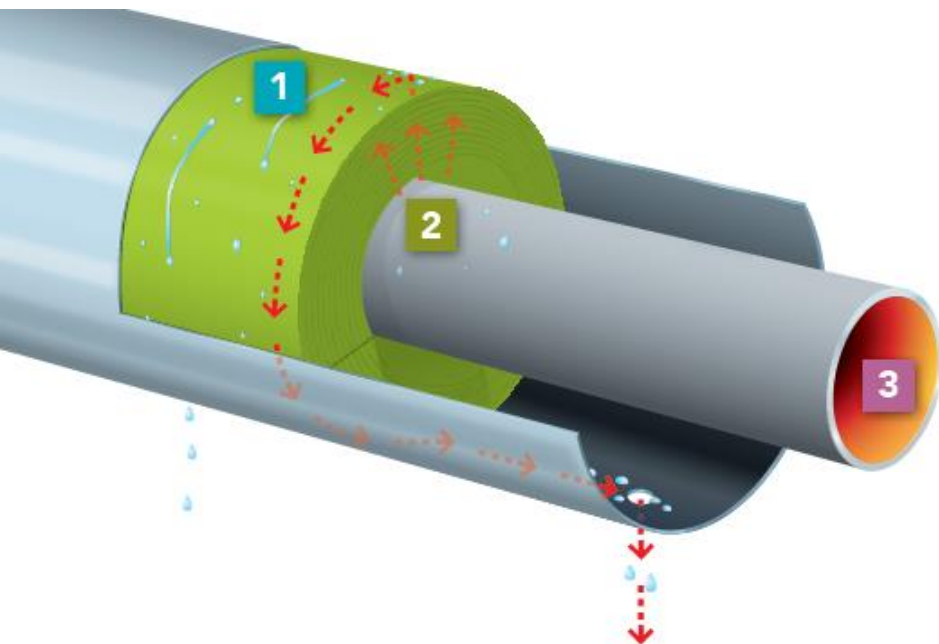
Lower amount of water at the pipe surface = Reduced risk of CUI








# The solution

## Product features:



**1**  
  
**LOWEST WATER ABSORPTION**  
**HIGHEST WATER REPELLENCY**  
5x lower absorption than best available standard EN 13472, minimizing water absorption and maximizing water flow away from insulation material.

**2**  
  
**QUICK RELEASE**  
**FASTEST WATER DISSIPATION**  
The vapor open structure ensures that water can evaporate freely if it might reach the pipe surface. The low water absorption ensures the fastest dry-out time.

**3**  
  
**DURABLE PERFORMANCE UP TO 250°C**  
**NO REDUCTION OF REPELLENCY**  
Fully durable water repellency performance up to 250°C over the whole CUI range.



**<10PPM Cl**  
**LOW LEACHABLE SUBSTANCES**

Complies with EN 13468 & ASTM C795, the most strict standards



**COATING FRIENDLY**  
**SILICONE OIL FREE**

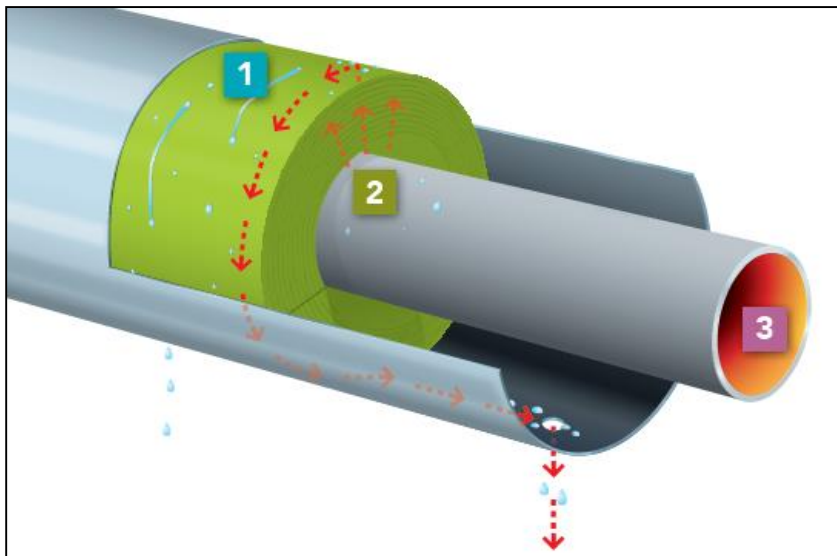
Complies with VW test 3.10.7, does not result in fish-eyes, usable in paint shops



**PRODUCT TOUGHNESS**  
**FLEXIBLE & STRONG**

No cracks when exposed to external impact

# The solution



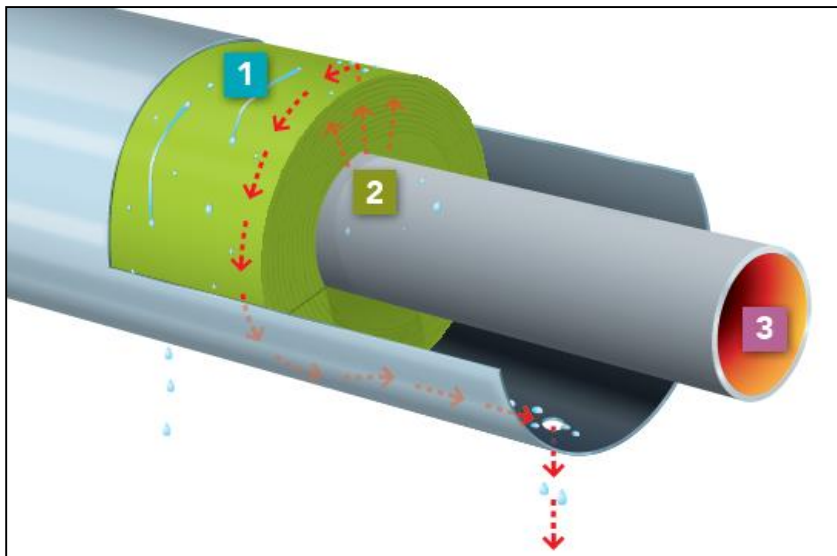
## Water ingress

Metal jacketing/cladding is sensitive to mechanical damage and improper installation. As a result, water ingress can occur into the system.

### 1 - Highest water repellency

ProRox Pipe sections with WR-Tech are 5X more water repellent than the best available stone wool products.

# The solution



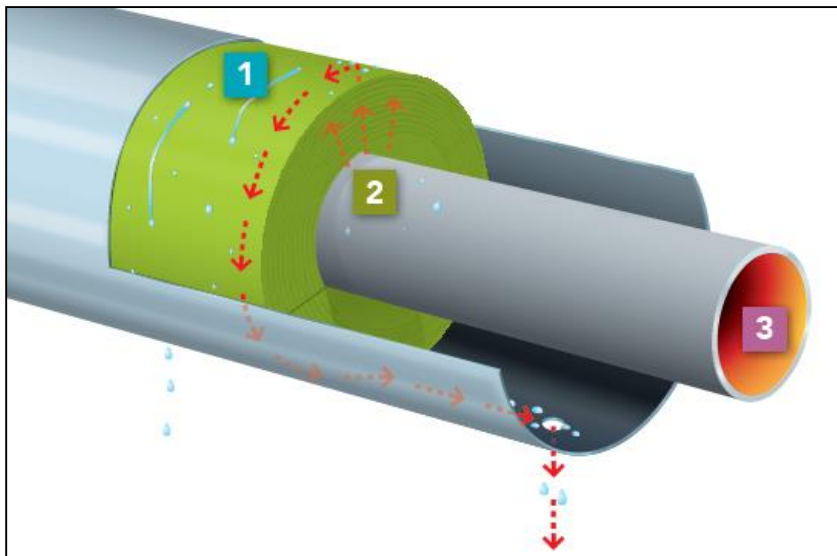
## Water removal from surface

CUI can happen under all types of insulation. It is paramount to remove water when it does get to the pipe surface.

## 2 - Fastest water dissipation

The open structure ensures that water can evaporate freely from the pipe surface through the insulation material. The lowest water absorption within the mineral wool category ensures the fastest dry-out time.

# The solution



## Thermal exposure

The CUI range covers temperatures up to 250°C. Ideally, insulation material performance in relation to CUI related properties should not be affected over this whole range.

## 3 – No reduction of repellency

Maintains water repellency performance over the whole CUI temperature range. Thus, making it the most durable, water repellent stone wool product.

# The solution



**<10PPM Cl**  
LOW LEACHABLE  
SUBSTANCES



**COATING  
FRIENDLY**  
SILICONE OIL FREE



**PRODUCT  
TOUGHNESS**  
FLEXIBLE & STRONG

## Speed of corrosion process

Specific leachable substances in the insulation material can accelerate the CUI process.

### Low leachable substances

- < 10 ppm chloride
- Complies with strict industry standards ASTM C795 and EN 13468

## Pipe surface protection

Coatings are an important line of defense to prevent CUI. Proper coating protection over the whole surface is critical.

### Coating friendly

- Silicone oil free: no fish-eyes or negative influence on adhesion
- Complies with VW test 3.10.7
- Does not mechanically and/or chemically damage coatings

## Thermal/mechanical exposure

Mechanical loads + thermal cycles can increase the brittleness of insulation materials and cause cracking; enabling water to easily reach the pipe surface

### Durable product toughness

- ProRox PS with WR-Tech does not become brittle over time or after exposure to high temperatures
- No cracking – reduce potential water ingress to the pipe surface

# Competitive material comparison

# Competitive material comparison

## Water absorption

ROCKWOOL conducted water absorption testing using 2 different standards:

Standard	Title	Description	Details
EN 13472	“Thermal insulating products for building equipment and industrial installations - Determination of short term water absorption by partial immersion of preformed pipe insulation”	Simulates the water absorption caused by exposure to rain during product installation	<ul style="list-style-type: none"><li>• 24 hr test</li><li>• Measures water absorbed (kg/m<sup>2</sup>)</li></ul>
ASTM C1763	“Standard Test Method for Water Absorption by Immersion of Thermal Insulation Materials”	Measuring the water absorption of flat specimens* under isothermal conditions, as a result of direct immersion in liquid water	<ul style="list-style-type: none"><li>• 2 hr &amp; 48 hr immersion under 1” head of water</li><li>• Measures water retained (% vol.) and “recovered” (% vol.)</li><li>• Heat treated and non-heat treated</li></ul>

*\* ASTM C1763 is typically for flat specimens, but ROCKWOOL adopted the test for **pipe sections***



# Competitive material comparison

## Water absorption

Summary of EN 13472 test:

EN 13472

“Rain” (one side immersion) – 24 hrs

ROCKWOOL PS 960/970 with WR-Tech	Pipe section A	Pipe section B	Pipe section C
Water absorbed (kg/m <sup>2</sup> ): Non-heat treated			
0.1 (declared < 0.2)	0.1 (declared < 1)	0.5 (declared < 1)	1.4 (declared < 1)
Water absorbed (kg/m <sup>2</sup> ): Heat aged @ 250°C for 24 hours			
0.1 (declared < 0.2)	62.5 (no declaration)	30.1 (no declaration)	43.8 (no declaration)

Pipe sections A, B and C are commercially available mineral wool based pipe sections in Europe, with Ws declarations of < 1 kg/m<sup>2</sup>

# Competitive material comparison

## Water absorption

Summary of ASTM C1763 test:

**ASTM C1763**

**“Forced full immersion” – 48 hrs,  
no heat aging**

Standard	ProRox PS 960 with WR-Tech	Pipe section X	Pipe section Y	Pipe section Z
ASTM C1763 “ full immersion”	Water absorbed (volume %)			
	6.1	30.0	96.8	67.4
	Recovery Water absorbed (volume %) - 48hrs recovery (drying)			
	0.0	16.8	74.2	31.1

*MiWo products X, Y and Z are commercially available mineral wool based insulation for piping (industrial) in North America*

# Competitive material comparison

## Water absorption– heat aged samples

Summary of ASTM C1763 test:

ASTM C1763

“Forced full immersion” – 48 hrs after  
heat aging, 24 hrs @ 250°C

Standard	ProRox PS 960 with WR-Tech	Pipe insulation X	Pipe insulation Y	Pipe insulation Z
ASTM C1763 “ full immersion”	Water absorbed (volume %)			
	24.6	77.5	95.3	104.8
	Recovery Water absorbed (volume %) - 48hrs recovery (drying)			
	4.1	62.6	78.4	84.0

*MiWo products X, Y and Z are commercially available mineral wool based insulation for piping (industrial) in North America*

# Competitive material comparison

## Water absorption – conclusions from tests

### EN 13472 – “Rain Test”

- Without heat aging, there was up to 14 times difference in the amount of water absorbed in “CE-marked” pipe sections from Europe, with the new ProRox PS (WR-Tech) being best in class.
- Even after heat aging at 250°C for 24 hrs, the new ProRox PS with WR-Tech still had superior water repellency at < 0.2 kg/m<sup>2</sup>
- Competitive mineral wool based pipe sections from Europe absorbed from 30 to 60 kg/m<sup>2</sup> after heat treatment

### ASTM C1763 – “Immersion Tests”

- The new ProRox PS with WR-Tech had superior performance
  - Competitor mineral wool products absorbed substantially more water than ProRox PS with WR-Tech.After all materials were preheated:
  - The water absorption for other, competitor mineral wool products went up by over **10X**, where as ProRox PS with WR-Tech only went up only about **4X**.
  - Even after preheating, the WR-Tech material still had lower water absorption values than even the unheated samples of other, competitor mineral wool products
- Dryout performance after water immersion was superior for ProRox (WR-Tech), both with and without heat aging.

# Competitive material comparison

## Water absorption – Conclusions from tests

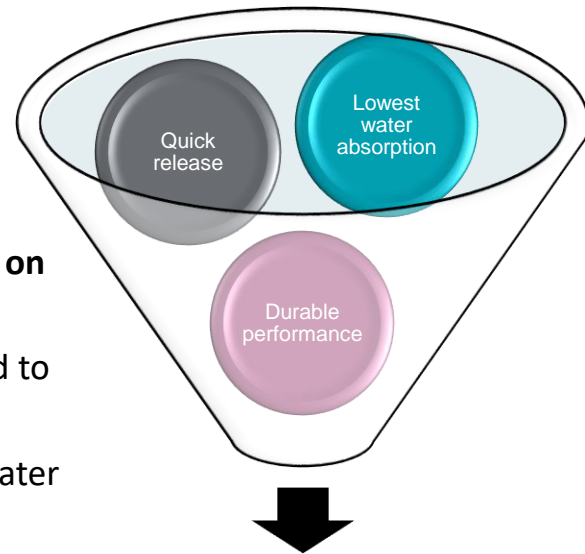
- ROCKWOOL's ProRox PS mandrel wound pipe sections with WR-Tech:
  - **Excellent water absorption performance** vs. all other materials ★
- ProRox PS with WR-Tech is the “best-in-class” because of:
  - Superior water repellency
  - Fastest water dissipation



# Conclusions

# Conclusions

- CUI is a system challenge and occurs under all types of insulation
  - Water ingress cannot be avoided!
- Water retention at the pipe surface has a large influence on the rate of CUI
- Products with higher concentrations of leached chlorides increases CUI rates
- Choose an insulation material with important characteristics that counter the harmful effects of CUI
- ProRox PS with **WR-Tech** is by far the superior hydrophobic, open-cell insulation on the market
  - 5X better water repellency than leading mineral wool materials when tested to the stringent EN 13472 standard (on declarations)
- Laboratory test results have proven that ProRox PS with **WR-Tech** has superior water absorption performance compared to competitive materials.



ROCKWOOL ProRox PS  
with **WR-Tech**®



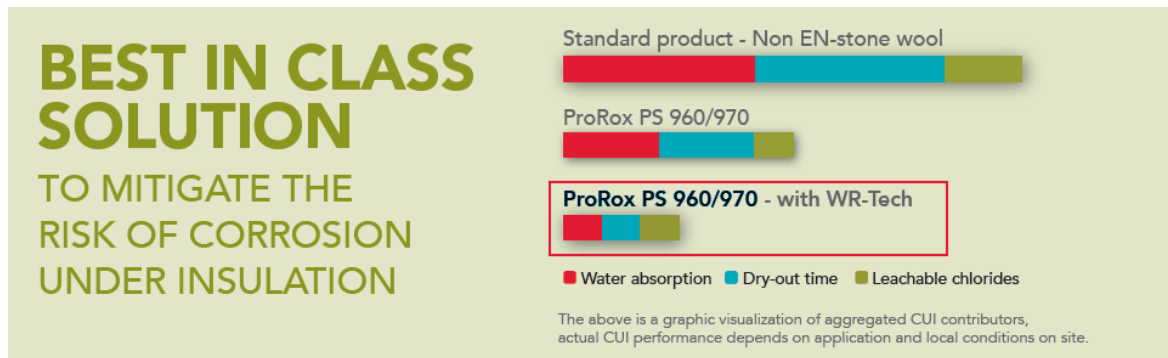
# Conclusions

ProRox PS  
960/970 mandrel  
wound pipe  
sections with  
**WR-Tech®**

NACE – National Association of Corrosion Engineers – NACE SP0198-2010(2.1.2)

*“Because CUI is a product of wet metal exposure duration, the insulation system **that holds the least amount of water and dries most quickly should** result in the least amount of corrosion damage to equipment.*

*“Corrosion can be reduced by careful selection of insulation materials”*



# FAQ

# Frequently Asked Questions (FAQs)



## ***Have you changed the name of the ProRox pipe sections with WR-Tech?***

- We will continue to sell ProRox pipe sections under the global nomenclature - ProRox PS 960 and ProRox PS 970.

## ***Is there an impact on thermal performance of ProRox pipe sections with WR-Tech?***

- No, the thermal performance of the products is not impacted by the new Water Repellency Technology.

## ***Have other technical or performance properties been changed?***

- No other technical properties (e.g. leachable chlorides) of the stone wool have been changed or are being influenced by the new WR-Tech binder technology. The product appearance and physical properties will be the same and will continue to be produced to the highest quality that you expect from ROCKWOOL.

## ***When will ProRox pipe sections with WR-Tech® be available?***

- Effective 1<sup>st</sup> October, our factories in Roermond and Bohumin will commence production of ProRox pipe sections with WR-Tech. We will also maintain the same item number and pieces per box/pallets. More information about Dahej will follow soon.
- To indicate which product have the new WR-Tech innovation, the WR-Tech logo will be placed on the label.

## ***Is WR-Tech a surface treatment of the finished products?***

- WR-Tech is not a surface treatment. This new technology coats the individual stone wool fibres in the insulation product and provides improved water repellency.

## ***Can ProRox pipe sections with WR-Tech be used in paint shops?***

- Yes. ProRox with WR-Tech is silicone oil free and the technology will not affect coating applications. There is no risk of fish eyes, pinholes, or other paint defects in paint shops. Also not when the pipes are recoated for maintenance.

# ROCKWOOL Technical Support

# ROCKWOOL Technical Support

## Calculations

- Insulation thickness using **ROCKASSIST**
  - No installation required
  - Certified VDI 2055 calculation
  - EN ISO 12241 calculation
  - Extensive calculation options
  - Wide range of products
  - Dynamic product proposals
  - Plausibility checks
  - Tablet & smartphone friendly

## Design

- Engineering input and technical guidelines (extensive product literature available)
- Specification reviews
- Interpretation of codes and standards

## Support

- Seminars on CUI, insulation science, product comparisons, etc.
- Documentation of product compliance

***ROCKWOOL Technical Insulation takes the lead in providing cost effective and energy efficient insulation solutions, protecting both the environment and your investment.***

# Where to find more information?

# Where to find more information?

Check the website in order to find more information about WR-Tech or ask you sales representative

<http://www.rockwool-rti.com/>

