

On-Line Repair Solutions for Corrosion Under Insulation



NACE Jubail Technical Workshop
Corrosion under Insulation
10th December 2015

Presented By : Mr Rob Dawson

Belzona® Product Manager

Hajjan Trading & Industrial Services Co. Ltd. (HATCON)

Corrosion Under Insulation – Root Causes and Effects

Water Ingress

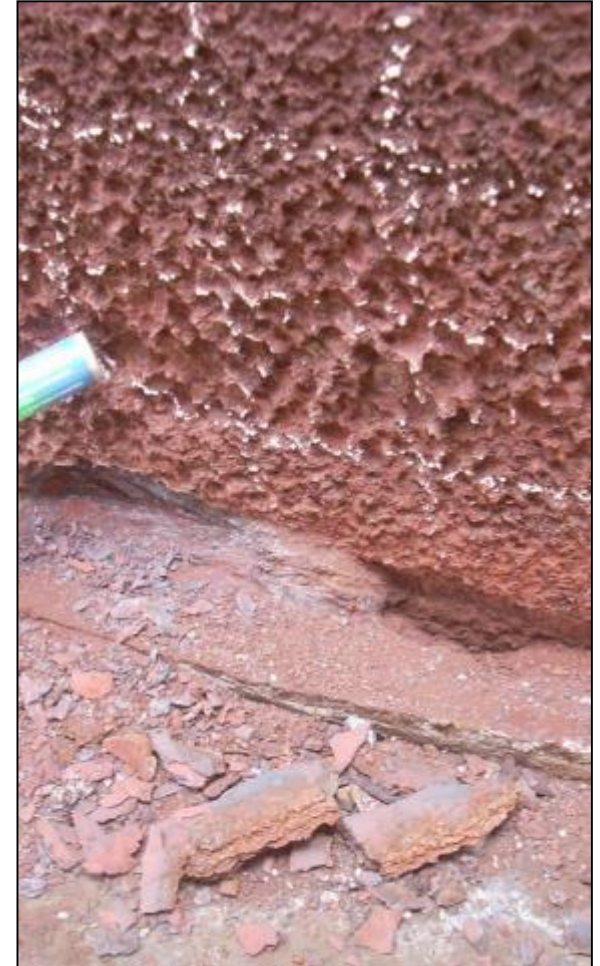
- Trapped during construction
- Leakage of weather-proofing
- Sprinkler Systems

Exacerbating Factors

- Contaminants in the insulation material
- Atmospheric pollutants
- Chemical Spillage

Temperature

- CUI most aggressive in the range of 15 – 150 C
- Cyclic wetting / drying accelerates corrosion



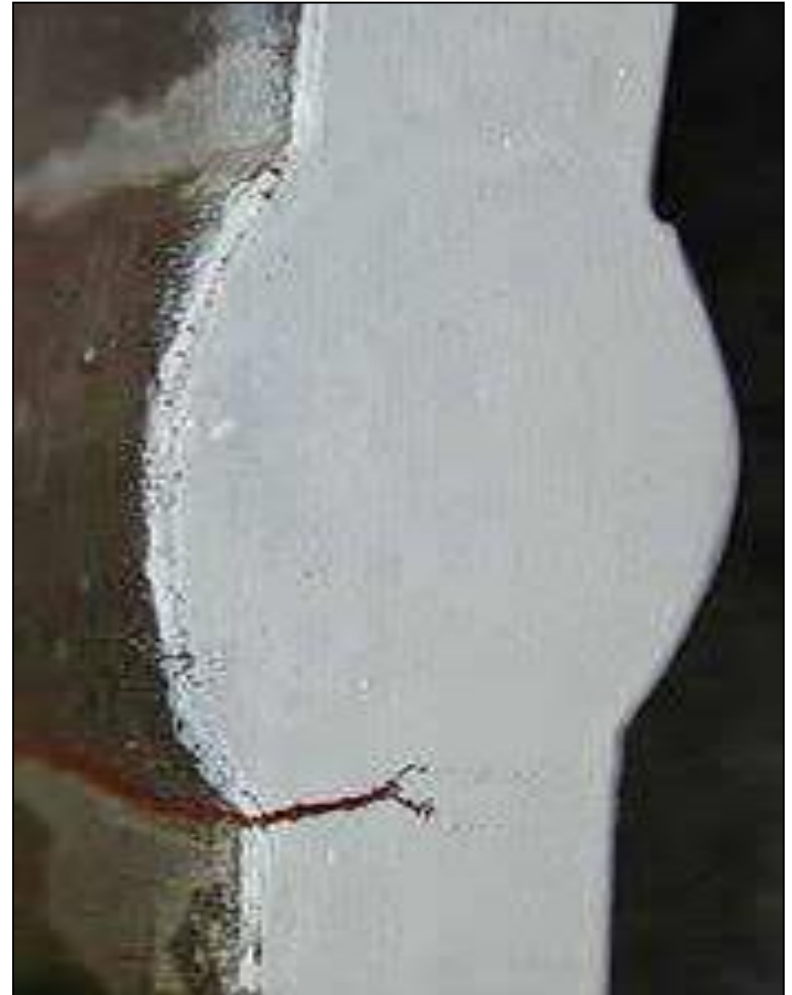
Corrosion Under Insulation – Effects

Carbon Steels

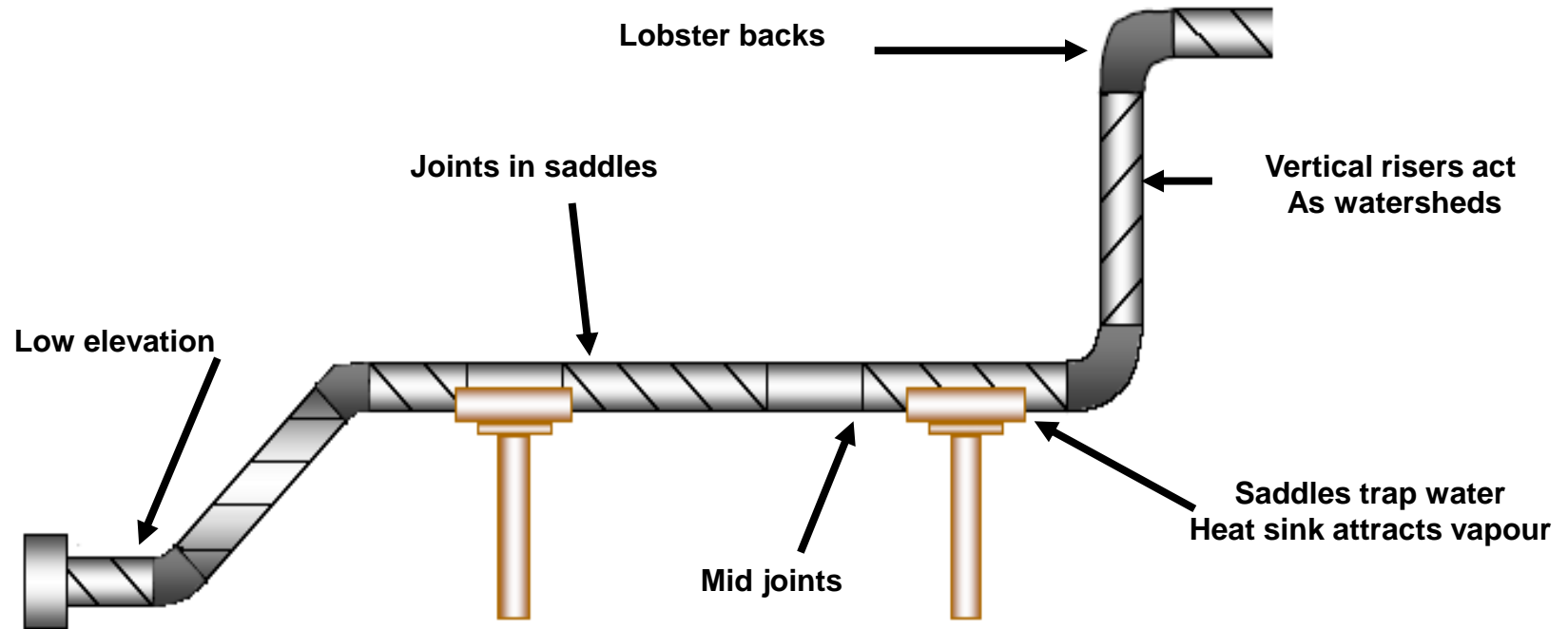
- Accelerated Corrosion
- Pitting

Stainless Steels

- Crevice Corrosion
- Pitting corrosion
- SCC (high risk: chloride + $T > 60\text{ C}$)



Corrosion Under Insulation – Problem Areas



Water penetration into Insulation is the primary cause of CUI

If the water can be prevented from entering the Insulation – CUI can be negated.

Corrosion Under Insulation – Results



CUI problems can be Repaired and Negated On Line using Specialized Solutions

CUI - Solution Criteria

Prevent Moisture from getting to the Metallic Substrate

1. Insulation Effectively Sealed
2. Coating that has excellent Immersion and Temperature Resistance

Coating Solution – Technical Properties

- High Adhesion
- Low Permeability for Immersion Resistance
- **Surface Preparation Tolerance**
- **Application to a range of substrate temperatures**

Commercial Considerations

- Simple to apply
- On-Line application
- Quick curing
- Long life Expectancy
- Minimal surface preparation
- Cost effective



Belzona Can Provide On Line Solutions to Corrosion Under Insulation Problems on Hot Substrates Including :



Bonding Doubler Plates



Filling of Pitting Corrosion

**HA – Metal
Paste Grade**

**HA – Barrier
Coating Grade**



Vessel Protection



Pipe Protection

Belzona® Heat Activated Products

Single pack product

- No weighing or mixing
- Effectively unlimited usable life

Heat-activated cure when applied onto hot pipework

- No equipment shutdown necessary
- Minimum cure temperature 70°C (158°F)
- Optimum performance up to 150°C (302°F)
- Rapid 15 minute cure at $\geq 100^{\circ}\text{C}$ (212°F)

Surface tolerant

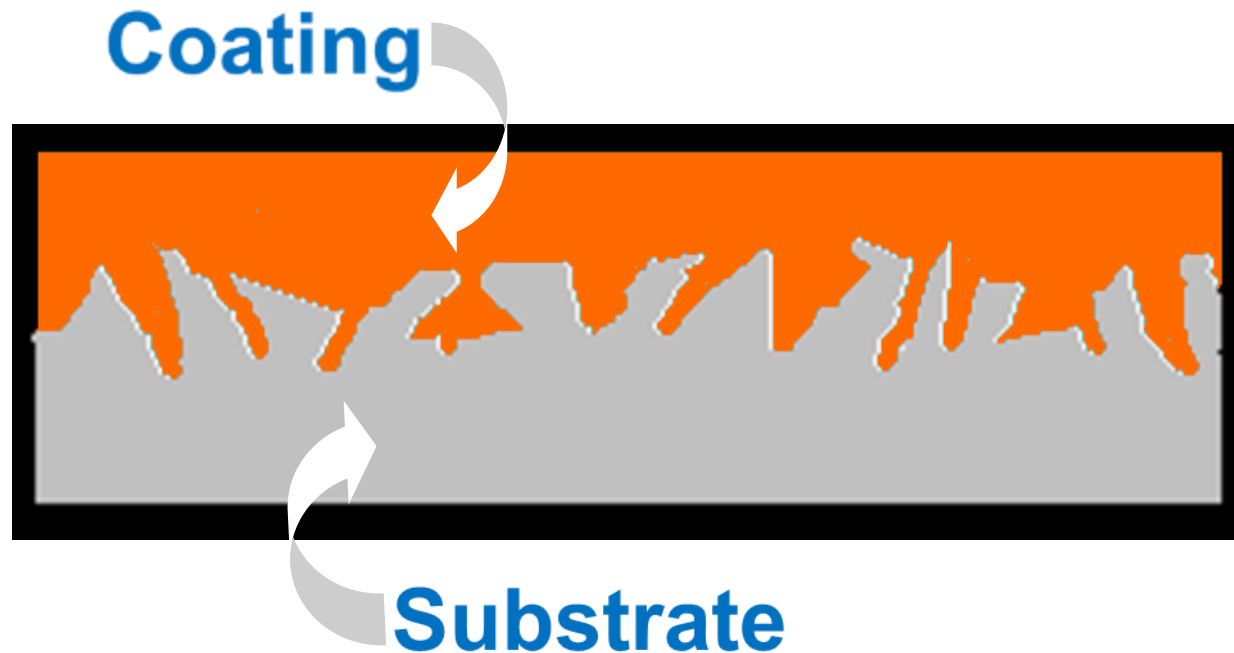
- Excellent adhesion even on manually prepared surfaces

Safe to apply directly onto hot surface

- No volatile components up to 150°C (302°F)

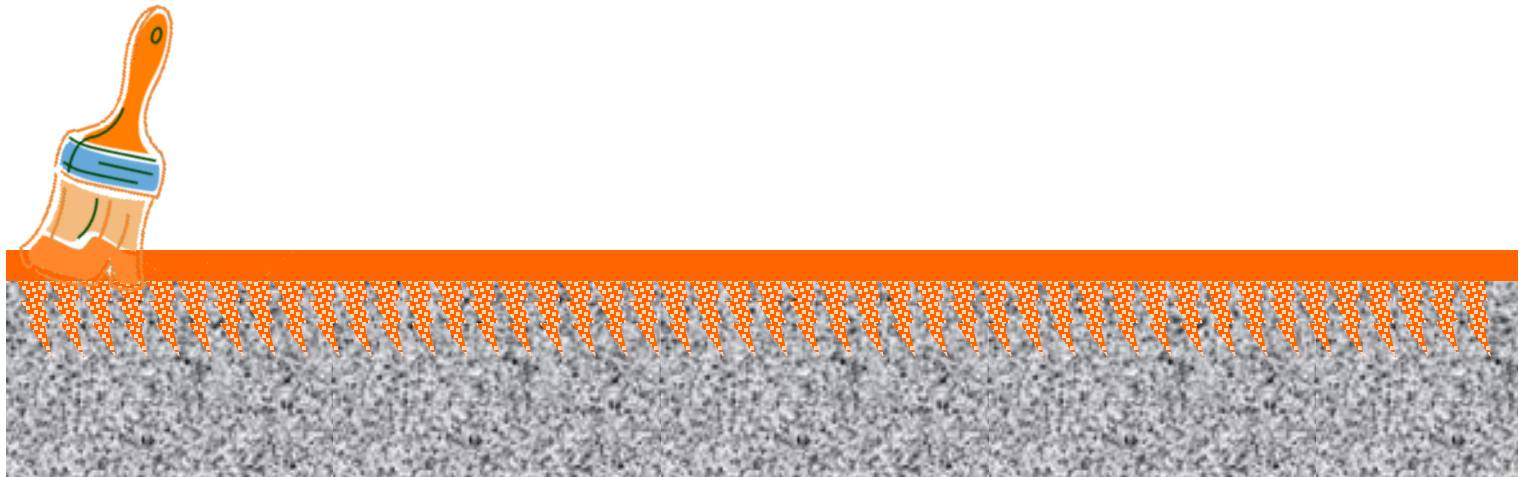
Adhesion on ambient temperature substrates

Is best achieved through mechanical locking such as by grit blasting.

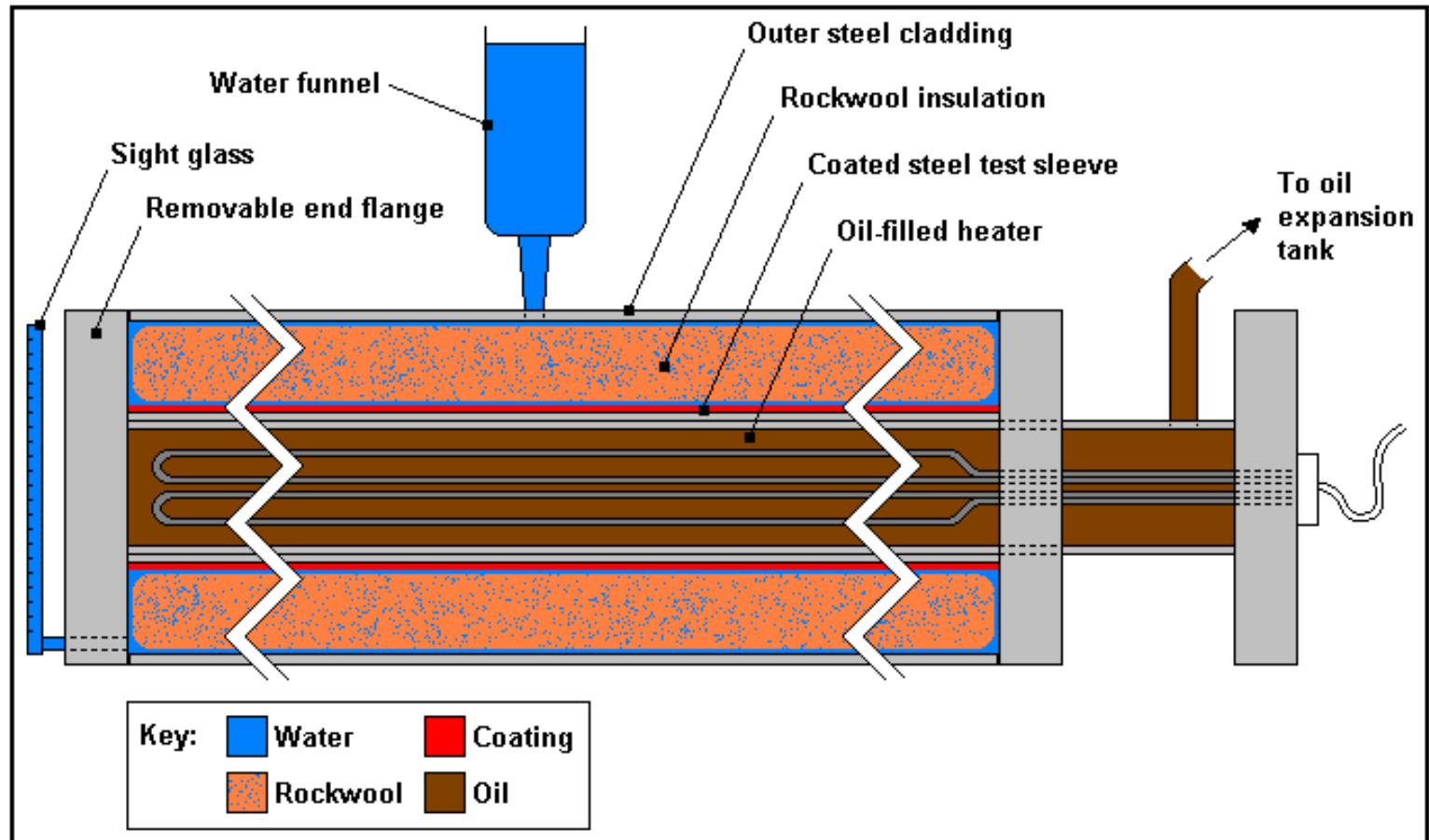


Adhesion on hot surfaces

Achieved by penetration of micro-pores in metal which increase in size on heating



CUI Simulation Performance Testing



CUI Simulation Testing

- Partially rusty test sleeve manually abraded using P36 abrasive paper is placed over heater.
- Test coating is applied onto the hot sleeve.
- End flange is bolted on and sealed.
- Mineral fiber insulation taped into place.
- Outer cladding/water funnel attached/sealed.



CUI Simulation Test Results

➤ Two litres of water added each week

1 litre of water and 1 litre of 5% salt water solution

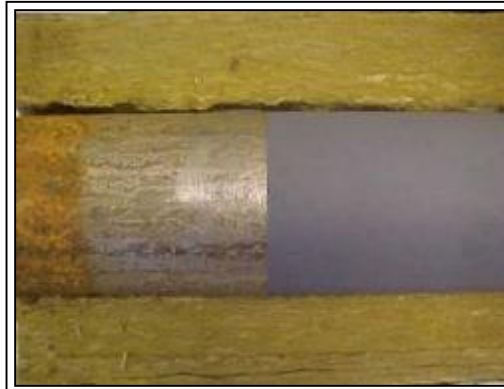
➤ Results

No attack or corrosion at 70°C to 90°C

Negligible attack/corrosion at 100°C to 150°C

Very slight surface erosion in full immersion areas Belzona®5851

No attack or corrosion in full immersion Belzona®5841



Salt spray testing

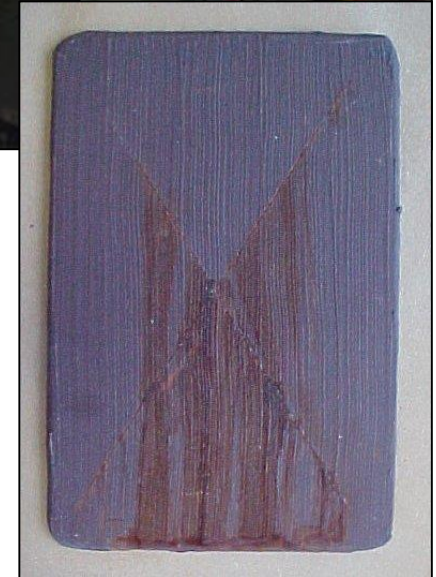
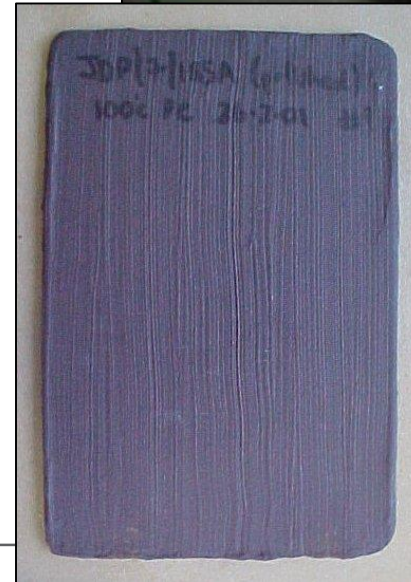
Generates a very corrosive fog of warm salt water
Coated panels are exposed to the salt water fog,
with a scribed "X" cut through the coating
Tested in accordance with ASTM B117
Test not ideally representative of CUI but industry
standard test for corrosion resistance

Salt Spray Results

Steel test panels prepared by abrading manually
(no profile)
HA Coating applied onto hot panels and oven
cured
Panels exposed for 1000 hours at 35°C (95°F) in
saturated salt fog atmosphere

Results

No field blistering or corrosion
Minimal corrosion creep under the
scribe mark



Adhesion testing

Substrates:

Unprepared Steel

Unprepared, uncorroded steel direct from the manufacturers.
Surface covered in firmly attached millscale.



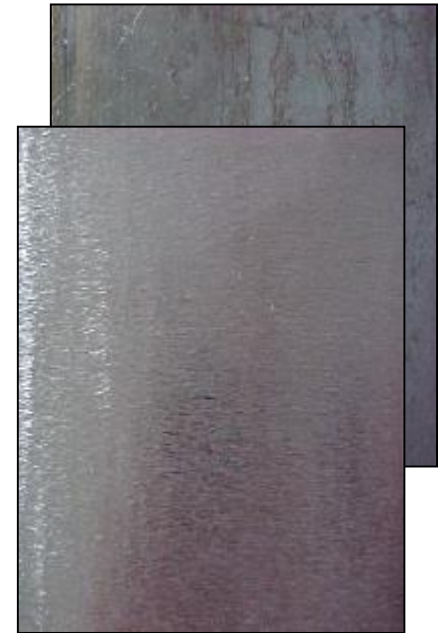
Adhesion testing

Substrates:

Unprepared Steel

Ground Steel

Unprepared steel ground using belt sander (with P36 abrasive).
Clean metal surface exposed, but negligible profile.



Adhesion testing

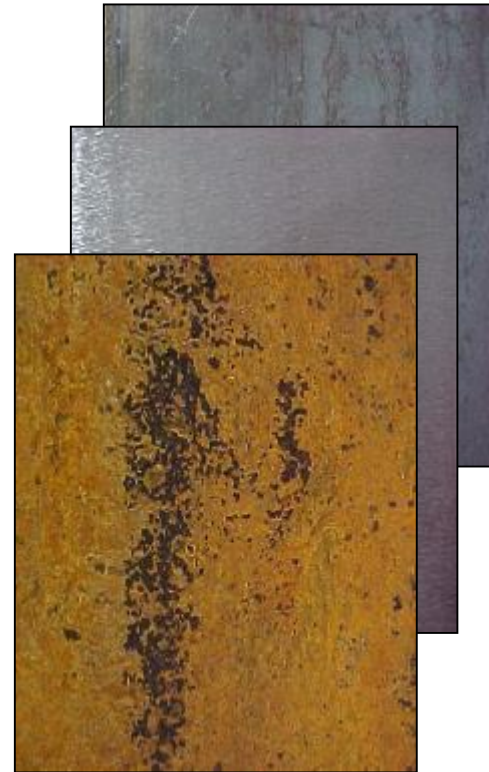
Substrates:

Unprepared Steel

Ground Steel

Rusty Steel

Steel weathered externally for 3 months. Rusted to ISO 8501-1 grade C, i.e. significant rusting with some pitting.
Loose surface rust brushed away, but no other preparation.



Adhesion testing

Substrates:

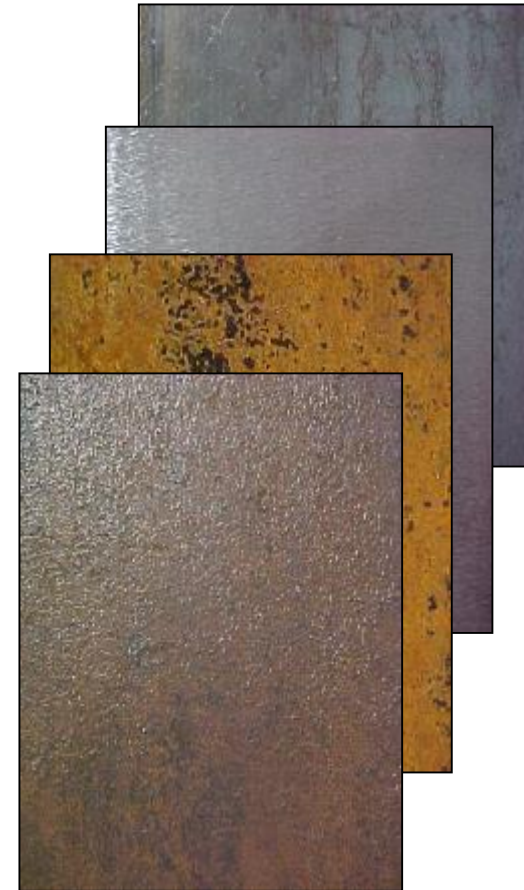
Unprepared Steel

Ground Steel

Rusty Steel

Wire-Brushed Rusty Steel

Started with rusty steel panel (ISO 8501-1 grade C)
Thoroughly abraded with wire brush to ISO 8501-1 St 2.
Pitted surface covered in firmly attached rust.



Adhesion testing

Substrates:

Unprepared Steel

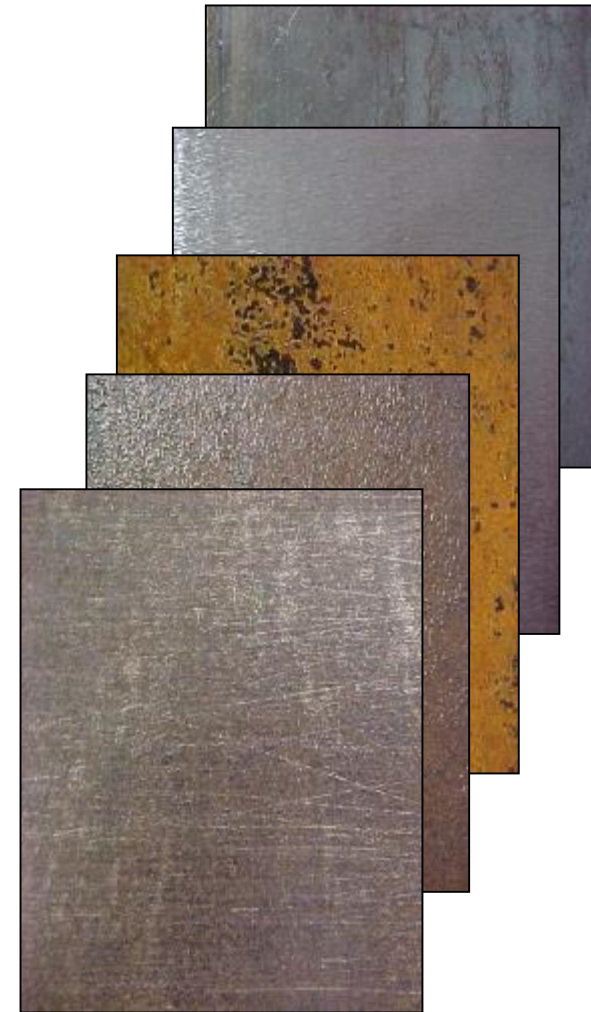
Ground Steel

Rusty Steel

Wire-Brushed Rusty Steel

Abraded Rusty Steel

Started with rusty steel panel (ISO 8501-1 grade C)
Initially abraded with wire brush, then further abraded by hand with P36 abrasive paper to ISO 8501-1 St 3 surface;
a combination of firmly attached rust with some clean steel showing through.

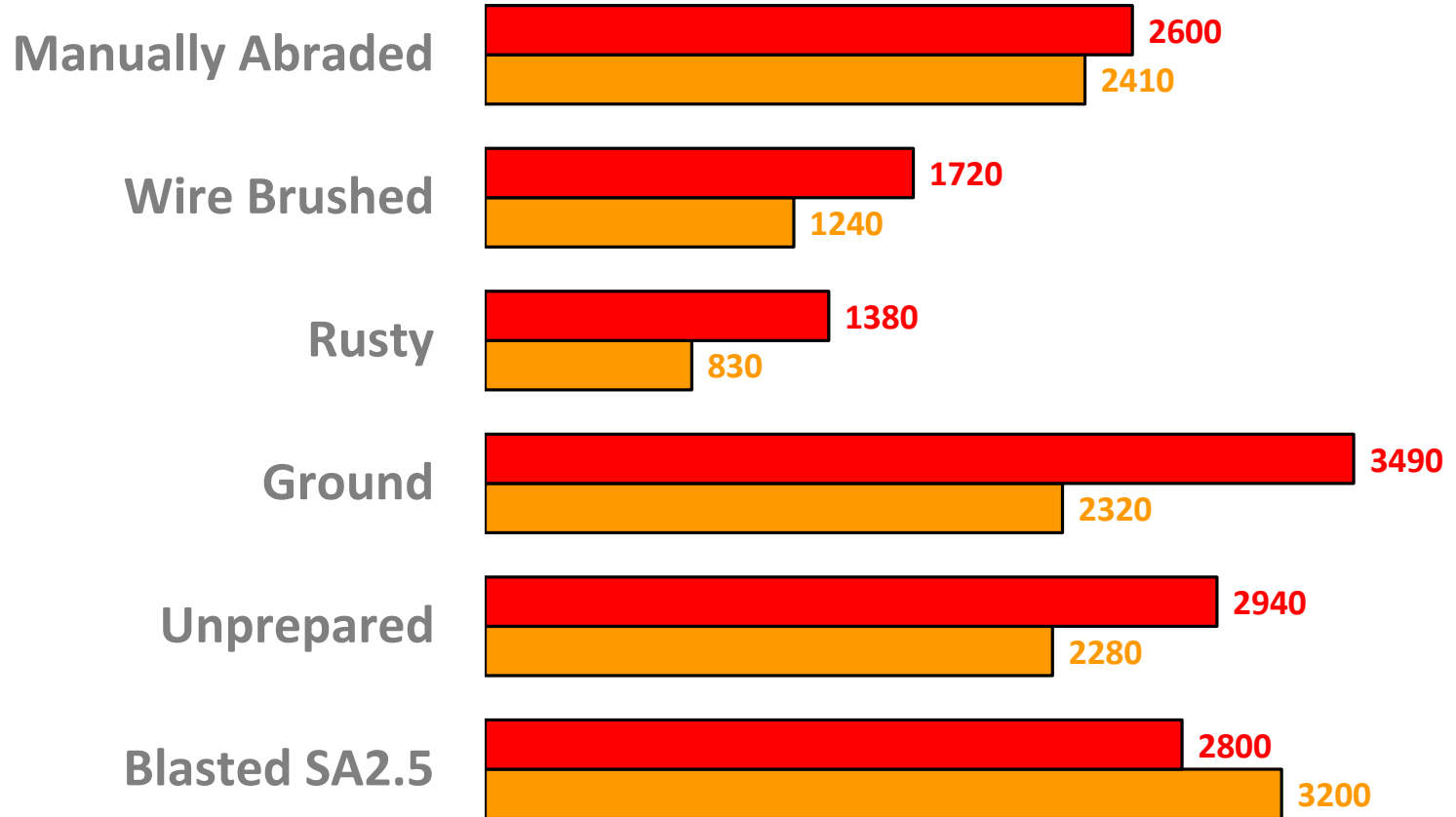


Belzona® 5851 performance

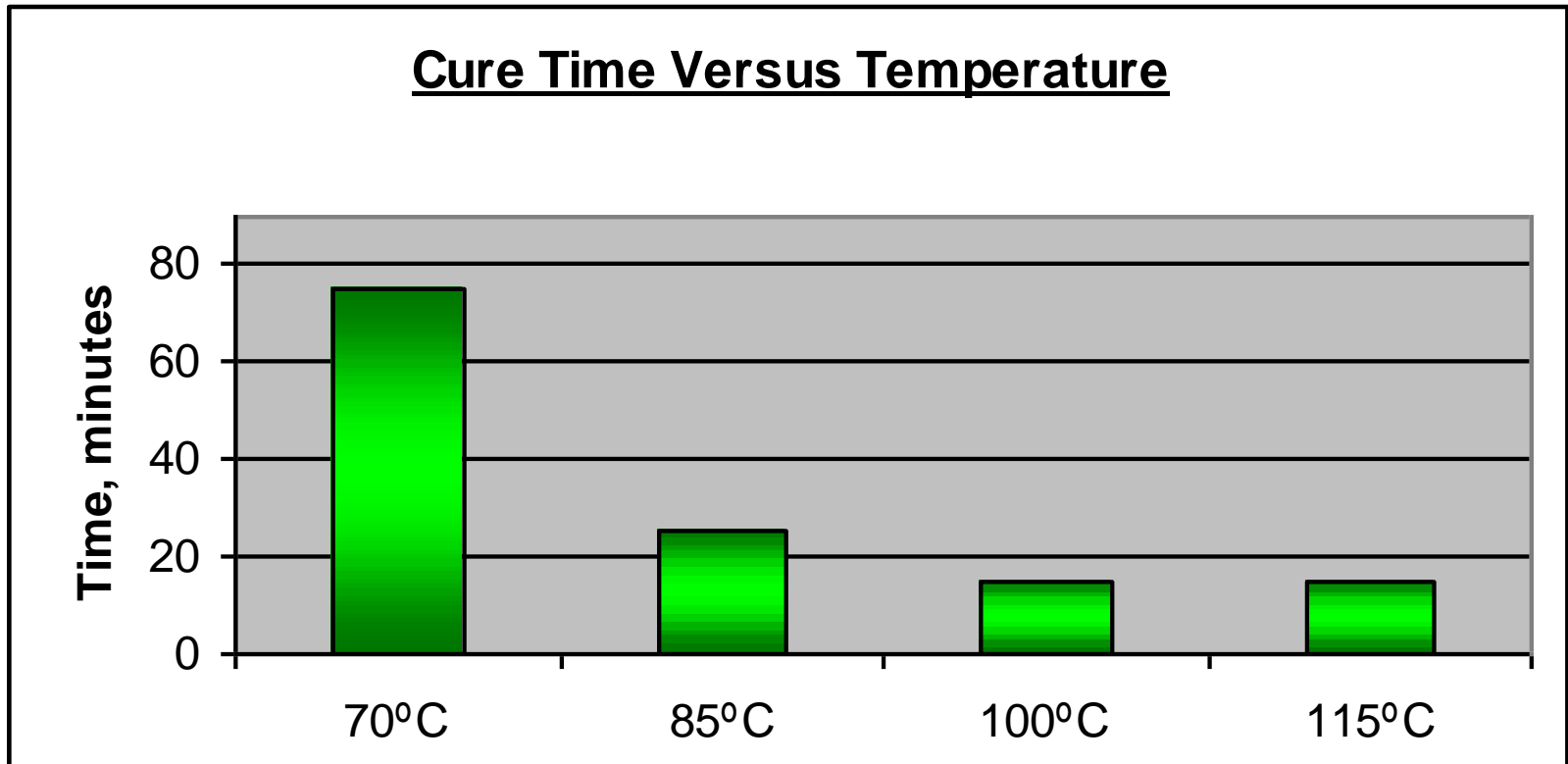
Adhesion

HA-Metal

HA-Barrier



Cure Time



- Cure time decreases with increasing cure temperature
- Rapid 15 minute cure at 100°C/212°F


Cathodic disbondment testing

Re: TECHNICAL INFORMATION No. #29 – December 12, 2003

1. **Cathodic Disbondment Test**

We are pleased to provide you with this report on the cathodic disbondment test performed on the G8 steel pipe.

This test is used to determine the amount of steel coating that has disbonded from the steel pipe. The test is performed by applying a cathodic current to the steel pipe in a solution of an electrolyte. The amount of disbonded coating is measured and recorded. The result in this particular test of 0.01367 in² of equivalent circle diameter of disbondment is excellent.



Corrosion Technology
Pipe & Plate Mill Inspection
Coatings Inspection
Vendor Surveillance
Laboratory Testing
Expediting

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Houston, Texas 77036
Telephone: (713) 771-0688
Fax: (713) 776-0634
www.iti-anti-corrosion.com

Technical Report No. 03-1528

Mr. Kevin McGinley
BELZONA, INC.
Americas' Gateway Park
2000 N.W. 88 Court
Miami, Florida 33172

Laboratory Testing:
Cathodic Disbondment on
Belzona 5851

P.O. No. 1599

Friday, December 12, 2003

Prepared by Karl Kelso

I.T.I. Contract No. 7513

Page 1 of 2

An Affiliates of MICROALLOYING

ASTM G8

Criteria

5851
-1.5 volts for
30 Days (720 hrs)

Results

Av disbonded radius
= 0.01367 inch²
= 1.7mm rad
= 3.3mm dia.

Criteria

5831
-1.5 volts for
30 days (720 hrs)
@ 23°C

Results

Av disbonded radius
= 0.149 inches
= 3.8mm rad
= 7.6mm dia.

ASTM G42

Criteria

5841
-1.5 volts for
30 days (720 hrs)
@ 80°C

Results

Av disbonded radius
= 0.153inches
= 3.9mm rad
= 7.8mm dia.

On-Line Repair Solutions for Corrosion Under Insulation

Historical Case Studies in the Oil and Gas Industry

Proof of Performance and Testing Relevance

TOTAL Immingham Refinery UK

- Condensate vessel operating at 85°C suffering severe CUI
- Surface preparation – combination of hand wire brushing and power wire brushing to produce a tightly adherent rusted surface.
- Application carried out 16th March 2001
- Surface temperatures ranged between 110°C at the top of the vessel and 50°C lower down
- Two coats of product applied from top of the vessel down to approximately 2 thirds of the vessel height
- Coating application was halted when the vessel skin temperature dropped to 70°C
- Application completed in 4 hrs & the total cure time was under 3 hrs allowing vessel to be re-insulated.



First in service inspection of Belzona 5851 on vessel 8D91 carried out 27th February 2002.



The condensate vessel had been lagged and had been in continual service for approx 12 months.



Sections of the lagging at various points had been cut away to facilitate this first 12 month inspection.



This area was performing extremely well with no defects in the coating.



Second in service inspection of Belzona 5851 on vessel 8D91 carried out late 2008.

Belzona's long-term CUI solution

The Belzona online CUI solution has enabled global energy giant TOTAL, to substantially reduce asset life costs of a number of its vessels, based at its Lindsey Oil Refinery, Immingham. The initial application at this site remains in good condition, protecting the asset well into its eighth year in service.

In 2001 the client identified areas of Corrosion under Insulation (CUI), on an outdoor condensate vessel. Left untreated the corrosion could have caused substantial damage but the client did not want to shut

"We really possible whilst online

A solution the vessel

Belzona was Barrier) is an activated surface pre outstanding abrasion ar

Prior to the tools to remove corrosion. Then, Belzona 5851 was applied in-situ, by the client's contractors, directly to the vessel operating between 40 and 110°C (104 to 230°F).

During the application Belzona provided training to the client's contractor team. This was found to be extremely valuable and the client commented on how "the contractors found the product easy to use as it required no special equipment and could be applied simply by brush thus ensuring the works were completed within the original time scale."

Commenting on the longevity, and his overall satisfaction with the Belzona CUI solution, Emlyn says:

"The most recent vessel inspection completed in late 2008 has confirmed that the original application, which was carried out in 2001, still remains in good condition to date and required no further action. We are very satisfied with the performance, durability and overall cost-effectiveness of the product.. We have since carried out a number of subsequent applications on site using this product with no problems encountered."

Know-How In Action

BELZONA'S® LONG TERM CUI SOLUTION

CUSTOMER

TOTAL, Lindsey Oil Refinery, Immingham



"The most recent vessel inspection completed in late 2008 has confirmed that the original application, which was carried out in 2001, still remains in good condition to date and required no further action. We are very satisfied with the performance, durability and overall cost-effectiveness of the product.. We have since carried out a number of subsequent applications on site using this product with no problems encountered."

Prior to the application, the areas to be coated were prepared with hand and power wire brushing tools to remove corrosion. Then, Belzona® 5851 was applied in-situ, by the client's contractors, directly to the vessel operating between 90 and 100°C (194 to 212°F).

During the application Belzona provided training to the client's contractor team. This was found to be extremely valuable and the client commented on how the contractors found the product easy to use as it required no special equipment and could be applied simply by brush thus ensuring the works were completed within the original timescale.

PICTURES

1. An overall view of the vessel, complete with lagging while in service
2. Surface preparation was carried out via wire brush and power wire-brushing tool
3. Belzona® 5851 (HA-Barrier) is being applied via brush



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ISO 9001
CERTIFIED
MANUFACTURE

BELZONA®
Repair • Protect • Improve
BELZONA P08008

Shell Stanlow Refinery - UK

- Existing coating system failed resulting in severe CUI on distillation columns and fractionator towers operating at temperatures between 50-120°C Shutdown for repairs was going to be very costly
- Manual preparation of the steel substrate using scrapers and wire brushes followed by two coats of Belzona® 5851, March 2006
- The vessel wall temperatures were above 70°C but the insulation support rings were between 55°C and 65°C .
- Wire brush to remove all loose & flaking paint the apply Belzona® 5841 to the areas up to 75°C
- This successful application has led to significant use of these systems at the Stanlow refinery.



Ease of Application + Cost and Time effective

- Belzona® 5841 and Belzona® 5851 developed for on line application onto pipework and vessels operating at elevated temperatures reducing application time from several weeks to a couple of days

Hertel (Shell Stanlow incumbent Coating and Insulation Contractor) application trials

Ian Land, CUI / LIP Project Manager Shell Stanlow

“Everyone is both surprised and impressed with the ease of application and the results



.....Completed the top half of a column in 4 days against 6 weeks using existing alternate material”.

Corrosion Under Insulation – On-Line Solutions for Elevated Temperature CUI Problem Areas

- Two years into a six year programme of work, Shell were able to conduct direct comparison with TSA and with other organic coating technologies
- **Heat Activated System Advantages over TSA**
 - No need to blast clean substrate.
 - No need to tent in area to retain blast media.
 - Not creating confined spaces to manage emergency plans for.
 - Application of two coats onto hot surfaces easy.
 - Avoiding equipment “hot work”.
 - Less risk of misses.
 - Less risk of coating failure due to thin film or missed areas.
 - Significant savings in time and money.



Heat Activated Composite Repair Solution – Shell Refinery New Zealand Year 2003



De-Asphalting Column
in service with operating
of 120 C



Surface Preparation Carried
out Using High Pressure
Water Jetting



Application of Heat
Activated Coating System
using rollers and brushes

**Ongoing Inspection shows no deterioration of the coating
after 12 years in Service.**

Heat Activated Composite Repair Solution – Exxon Refinery Singapore Year 2001



Fractionator Tower T102
in service operating
at 120C



Surface preparation carried
out using scrapers to remove
loose rust to ST2 finish



Application of Heat
Activated Coating System
using rollers and brushes

**Ongoing Inspection shows no deterioration of the coating
after 14 years in Service.**

Heat Activated Composite Repair Solution – British Gas Offshore Platform Year 2005



Gas - Condensate Pipework
operating at temperatures
up to 115C



Surface preparation carried
out using high pressure
water jetting



Heat Activated Composite
wrapping and coating carried
out on-line

**Ongoing Inspection shows no deterioration of the repairs and
after 10 years in Service.**

Corrosion Under Insulation – On-Line Solutions for Elevated Temperature CUI Problem Areas

Client Testimonials

Emlyn Roberts
Works Engineer
Total Refinery , UK

“The most recent vessel inspection completed in late 2008 has confirmed that the original application, which was carried out in 2001, still remains in good condition to date and required no further action. We are very satisfied with the performance, durability and overall cost-effectiveness of the product.. We have since carried out a number of subsequent applications on site using this product with no problems encountered.”

Bertrand Van Der Hayden
Fixed Equipment Reliability
Inspector
Caltex South Africa

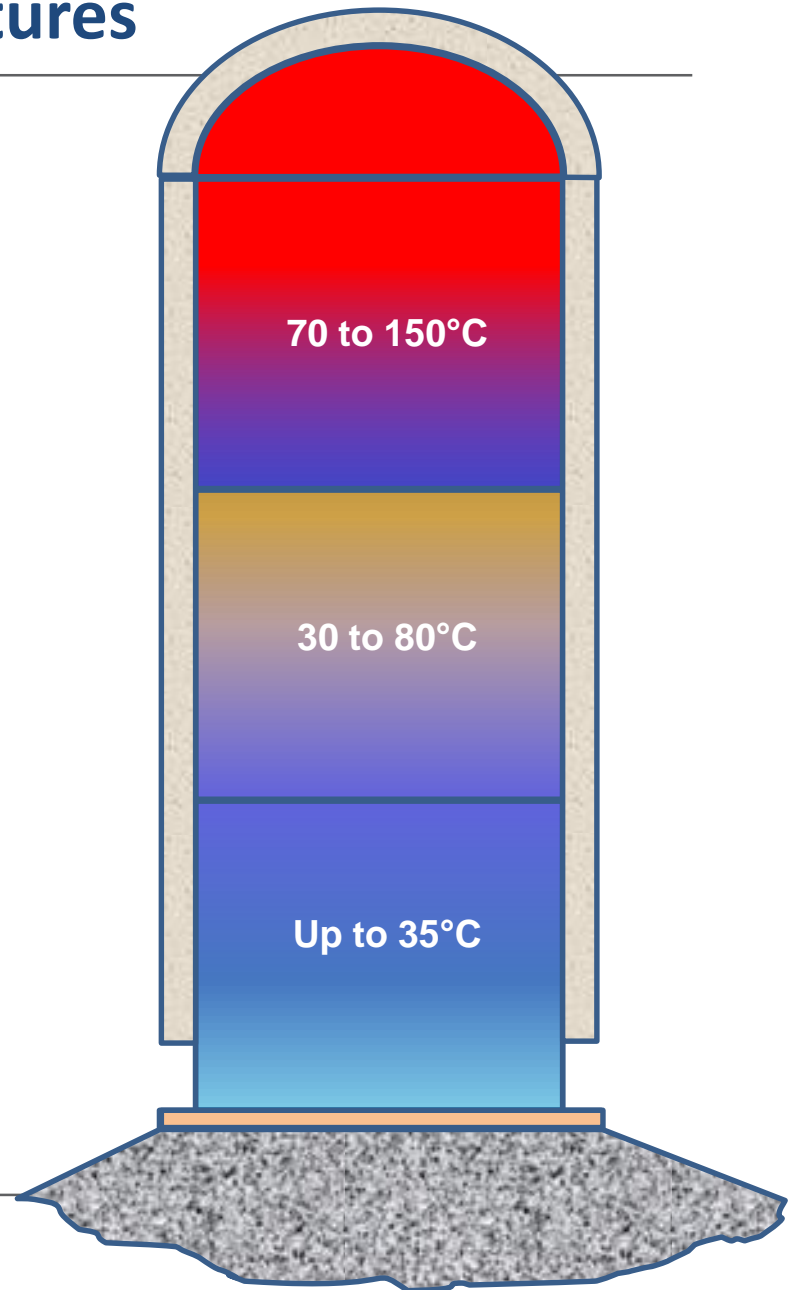
With our trial now having run to completion, we can confidently say that these products should perform in the long-term as they have been designed to do. We have no reservations in recommending these products for similar applications within the petrochemical industry. The attached photographs illustrate the surfaces prior to, during, and after application.

Bob van den Beuken
Maintenance Team Leader
Mechanical
Vector Kapuni , New Zealand

The absorber column at the Vector Kapuni Gas Treatment Plant in Taranaki required painting. It was not possible to take the column out of service long enough to complete the painting programme using normal painting specs. The column runs at approximately 100 degree C so the search began for a product that could be applied at this temperature while the plant remained online. Belzona 5851 was the pick of the products as it had already proven itself at Marsden Point. Belzona 5851 has now been in service for about 2 ½ years and as the pictures show remains in good condition. We have since applied the same product to our Regeneration tower which also runs at similar temperature with no problems encountered.

Systems Application Temperatures

- 70°C - 150°C - Belzona® 5851
- 30°C - 80°C - Belzona® 5841
- Up to 35°C - Belzona® 5831



On-Line Repair Solutions for Corrosion Under Insulation

Heat Activated and CUI Repair and Protection Systems

- Can Be applied to Hot Surfaces
- Surface Temperatures of 10C – 180C
- Minimal Surface Preparation (ST2)
- High Adhesion
- Resists Insulation Saturation / Immersion
- Simple to Use
- Long Service Period



QUESTIONS ?

Presented By : Mr Rob Dawson

Belzona® Product Manager

Hajjan Trading & Industrial Services Co. Ltd. (HATCON)

Composite Repair Solutions for Corrosion Under Insulation

