

**NACE JUBAIL** TECHNICAL WORKSHOP (10<sup>th</sup> December, 2015)  
CORROSION UNDER INSULATION (CUI)



# CUI (CORROSION UNDER INSULATION) MECHANISM THEORY AND PRACTICE

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# INTRODUCTION

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In the process industry and petrochemical plants several hundreds of pipe lengths, equipments, storage tanks and assets are insulated for process requirements. The common types of insulation systems are:

- Hot thermal insulation
- Cold thermal insulation

In addition to the thermal insulation systems, fire proofing is also present in plant assets as per requirements.

CUI is a real threat to the parent metal of insulated equipments, pipelines and structures which are operating in the CUI susceptible temperature range  $[(-4) - 120]$  °C.

## CUI PHENOMENA

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Corrosion Under Insulation (CUI) is a localized corrosion occurring at the interface of a metal surface and the insulation on that surface.

CUI can be a particularly severe form of corrosion because of the difficulty in detection due to the corrosion occurring beneath the insulation.

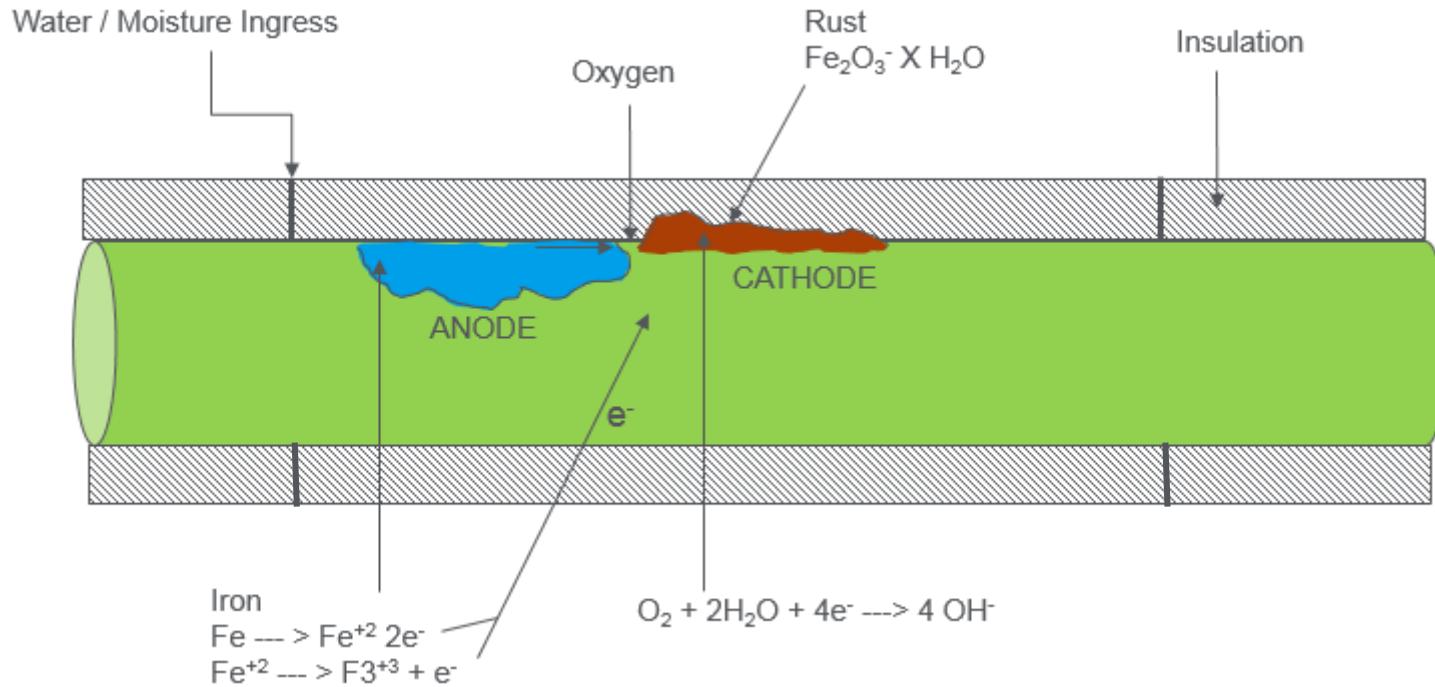
The most common forms of CUI are localized corrosion to the CS materials and chloride SCC of austenitic SS

Thermal insulation and fire proofing provide the cover for the corrosion to hide underneath .

The insulation cover may trap moisture or spilled chemicals which can form corrosive media that attacks the parent metal.

Because the corrosion is hidden from sight, the phenomena often progress undetected for long time.

## CUI PHENOMENA



Moisture combined with Oxygen is the largest contributing factor to corrosion. The closed environment of the insulation material over the metallic component, creates conditions that encourage build up of moisture and initiating corrosion reaction. In general, corrosion is in the form of pitting type corrosion

## THE WET INSULATION

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- Promote corrosion and provide the “cover” for corrosion to hide underneath.
- Right environment for corrosion to start & grow in.
- Spread corrosion to other areas.
- Trap the moisture / spilled chemicals.
- The corrosion is often more severe because the insulation material not allowing evaporation and the insulation acting as a carrier.
- Moisture occurring in one area moves through the insulation to another area causing the corrosion to spread more rapidly.
- Acids, acid gases and strong bases like caustics and salts are aggressive corrosive agents and will accelerate existing CUI.

## CYCLIC TEMPERATURE EFFECT

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Cyclic temperatures that vary from below the dew point and above the ambient temp.

Wet/dry cycle develops water condensation, then baked off during hot/dry cycle.

Transition from cold/wet to hot/dry includes intermittent period of damp/warm condition with attendant high corrosion rate.

## CUI CONTRIBUTING FACTORS

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- ➡ Inadequate design of weather barrier
- ➡ Improper application of insulating system
- ➡ Improper installation of weather barrier
- ➡ Workmanship
- ➡ Physical abuse
- ➡ Insufficient stage inspection
- ➡ Insufficient maintenance



## DESIGN OF COLD INSULATION SYSTEM

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- ➔ Temperature of the product
- ➔ Design life
- ➔ Protective coating
- ➔ Insulating material & its thickness
- ➔ Sealing of the gaps
- ➔ Vapor barrier
- ➔ Metal jacketing
- ➔ Water proofing for metal jacketing

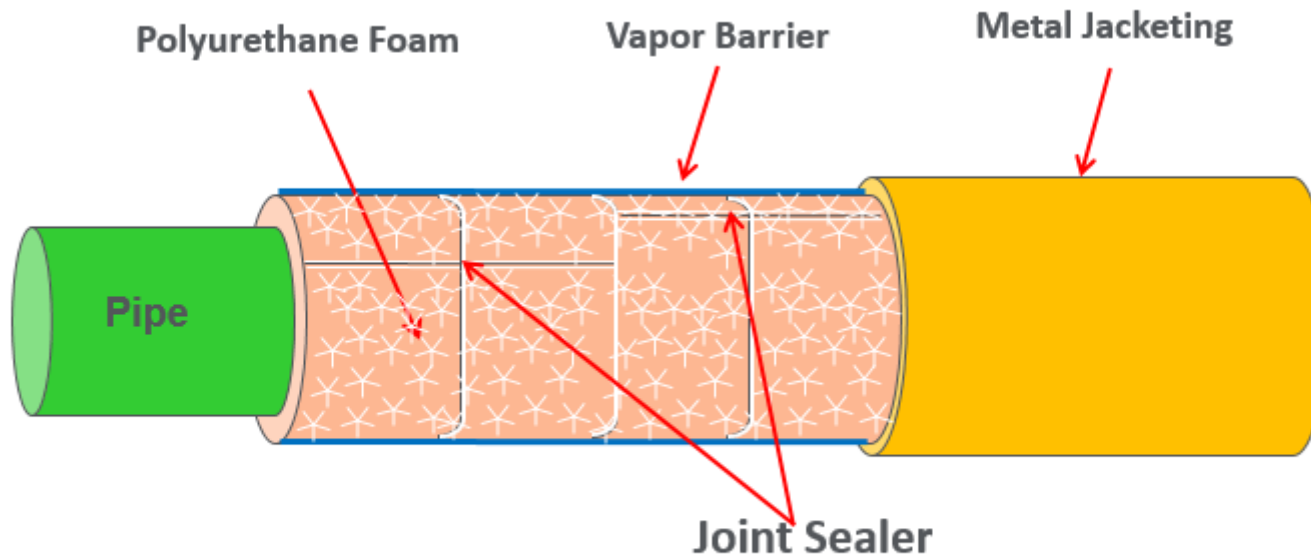
## MAIN COMPONENTS OF THE COLD INSULATION SYSTEM

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- ➡ Preformed Polyurethane Foam with pre-laminated vapor barrier
- ➡ Jacketing Cover Material.
- ➡ Fastening material
- ➡ Joint sealer.
- ➡ Cradle wooden block or urethane block for supports.
- ➡ Stainless steel band and clips

## COLD INSULATION SYSTEM

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## APPLICATION OF COLD INSULATION SYSTEM

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- ➡ Blast clean the surface
- ➡ Apply protective coating
- ➡ Coat joints with adhesive material
- ➡ Attach insulating material
- ➡ Attach vapor barrier
- ➡ Metal jacketing
- ➡ Water proofing

## SPECIAL CARE FOR INSULATING

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- ➔ Valves
- ➔ Flanges
- ➔ Expansion bellows
- ➔ Nozzles
- ➔ Pipe supports
- ➔ Hangers
- ➔ Attachments

## COMMON LOCATIONS SUSCEPTIBLE TO CUI

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- ➡ All penetrations or breaches
- ➡ Dead legs
- ➡ Pipe hangers & supports
- ➡ Valves & fittings
- ➡ Pipe support
- ➡ Steam tracer tubing penetration
- ➡ Termination of insulation at flanges
- ➡ Damages or missing insulation jacketing
- ➡ Low points in the piping system

## SYSTEMS SUSCEPTIBLE TO CUI

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- ➡ CS piping systems operating between  $[(-4)- 120]$  °C.
- ➡ CS piping systems operate in service above 120 but are intermittent service.
- ➡ Austenitic SS piping systems that operate between  $(60 - 204)$  °C are susceptible to chloride SCC
- ➡ Vibrating piping systems that cause damages to the insulation jacketing
- ➡ Dead legs and attachments
- ➡ systems Areas exposed to mist overspray
- ➡ Areas exposed to steam vents
- ➡ Areas exposed to deluge systems
- ➡ Areas subject to process spills, ingress of moisture or acid vapors
- ➡ Steam traced piping systems that might experience tracing leaks
- ➡ Pining with deteriorated coating and or wrapping

# CUI INSPECTION METHODS

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## External Visual Surveillance

- ➡ External damages
- ➡ Visible wet spots
- ➡ Random stripping of insulation

## NDT Methods

- ➡ Profile Radiography (RT)
- ➡ Infrared to detect Damp Spots
- ➡ Pulse Eddy Current (EC)



## CS AFTER INSULATION STRIPING



## CS AFTER INSULATION STRIPING

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## CS LINE AFTER INSULATION STRIPPING



## CONCLUSION REMARKS

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- 1) Intermittent service temperature in the CUI susceptible range highly promotes CUI attack.
- 2) Regular inspection program of insulated piping and equipment, external visual surveillance.
- 3) Important factors:
  - Proper design and application of the insulation system.
  - Stage wise inspection of the insulation system during application.
  - Proper coating system of the substrate.
  - Inspection of insulation repaired locations
- 4) Workmanship is essential factor for healthiness of the insulation system.

THANK YOU