HP PIPING INSPECTION

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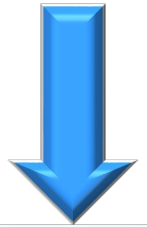
- Introduction
- Case histories
- RBI approach
- Inspection strategies
- Mitigation strategies
- Conclusions

Process lines in the HP synthesis section of a Urea Plant

INTRODUCTION

Failures in pipelines are more likely to occur compared to equipment

- Fragmentation of responsibilities
- Wide spread of pipelines in chemical plant
- Almost impossible to perform internal inspections



Inspection and maintenance of process pipelines needs a more systematic approach

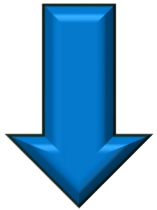
INTRODUCTION

- Risk Based Inspection
- Involve all stakeholders, also third parties
- Thorough understanding of failure modes
- Incorporate lessons learned, new insights
- Replacement with Safurex piping

Ruptured high pressure C-steel pipe (CO_2 supply line) as a result of atmospheric crater type attack

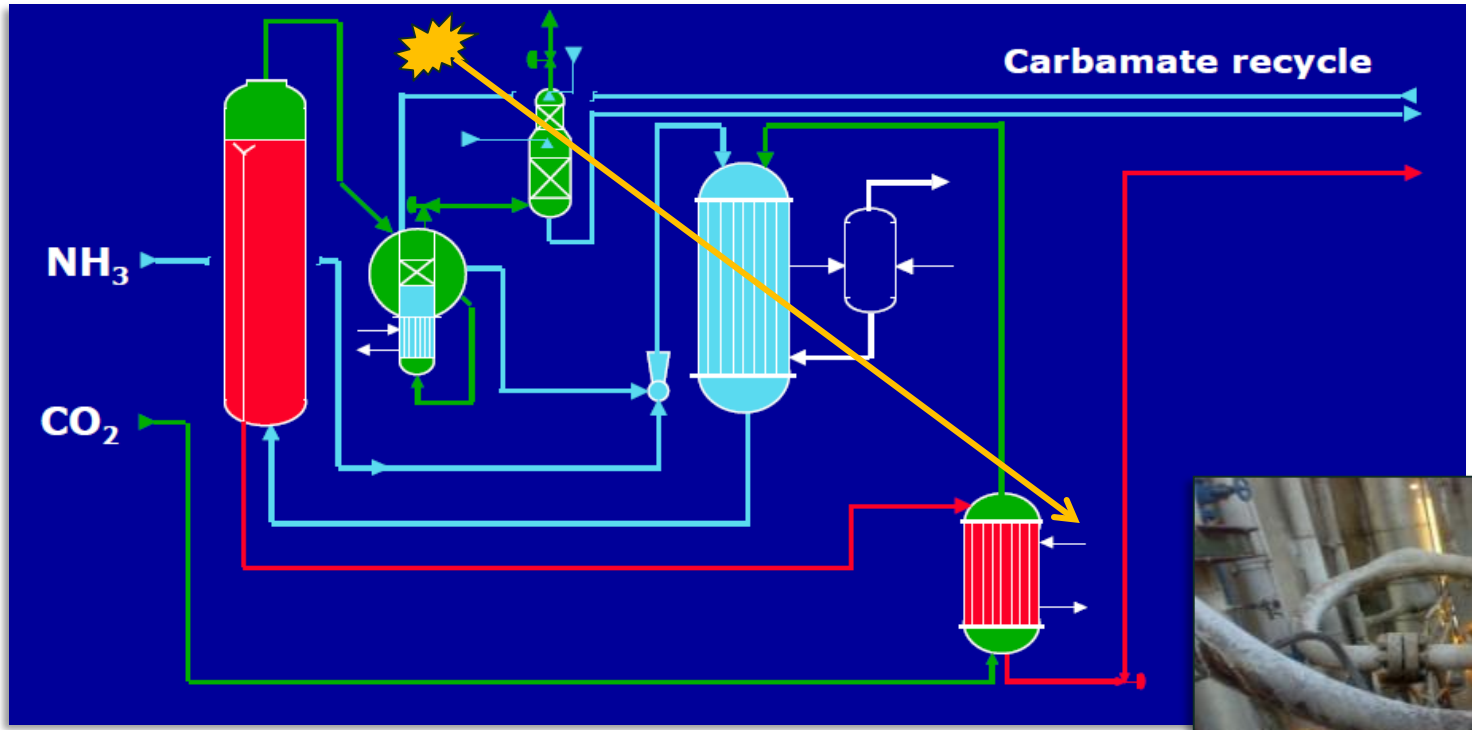
Examples of HP pipeline failures in Urea Plants

- Failure of HP gas pipeline
- Failure of a drain line header



Lessons learned

CASE 1: FAILURE HP GAS PIPELINE



Ruptured HP gas line

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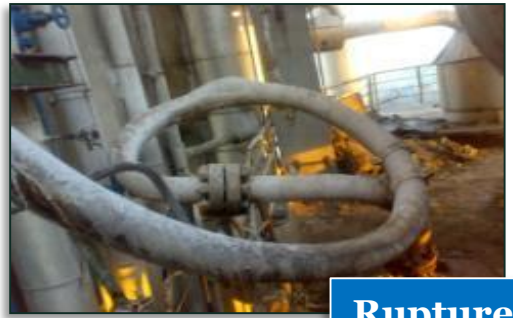
CASE 1: FAILURE HP GAS PIPELINE



Ruptured pipe

contamination

Stress Corrosion Cracks at process side

- Upset conditions
- Chloride contamination not recognized
- HP Equipment were cleaned, inspected
- HP pipin were cleaned, but not inspected

Incorporate upset conditions in RBI program

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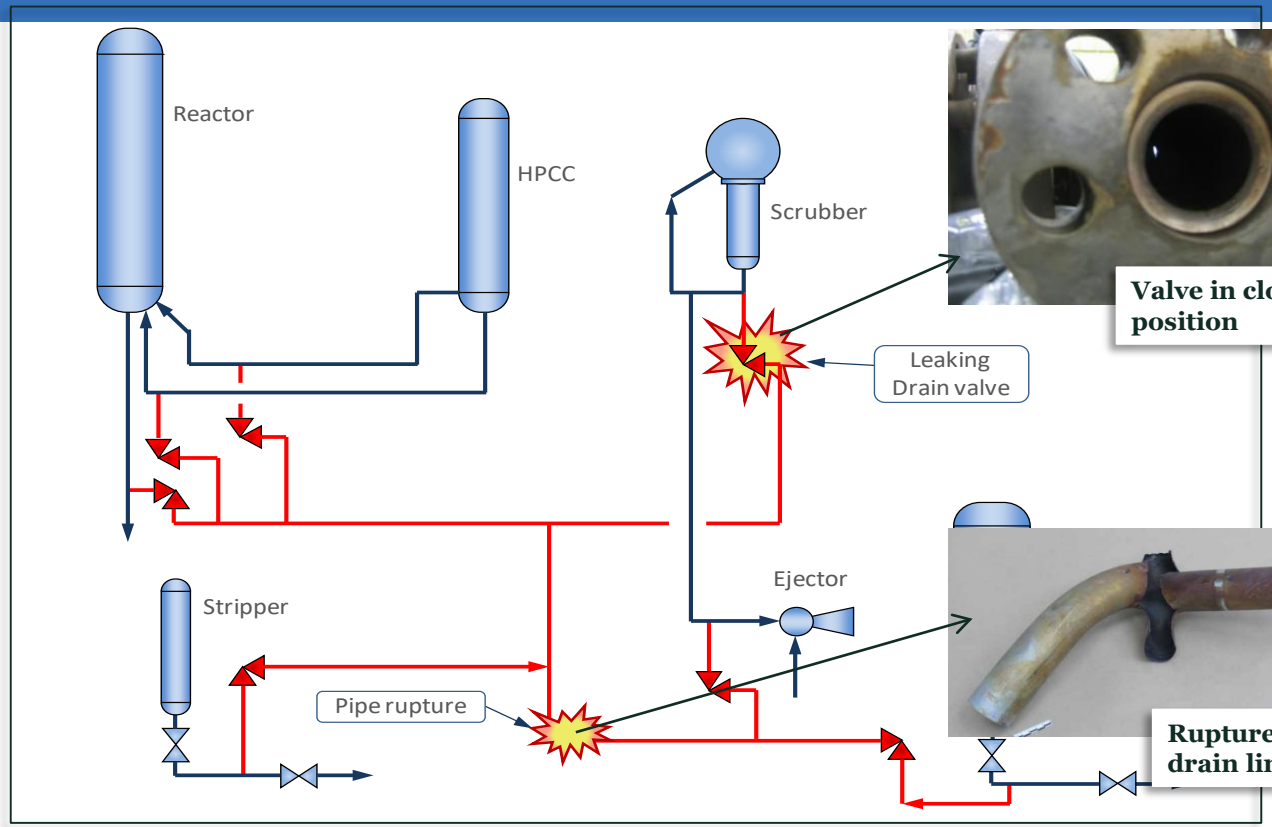
CASE 2: FAILURE DRAIN LINE HEADER



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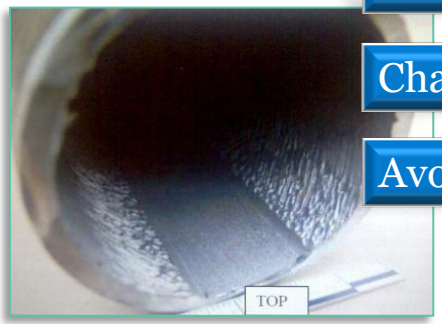
CASE 2: FAILURE DRAIN LINE HEADER

Operation of Drain system

- Leaking block valve, carbamate entering drain system
- Line was kept under pressure by steam condensate
- Stagnant carbamate conditions; increased corrosion
- Local heating by tracing
- Material of construction: 316L (not Urea Grade)
- Drain line not part of inspection program



In cooperate drain system in inspection program

Change material of construction drain system

Avoid direct contact steam tracing with piping

On-sided corrosion

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RBI APPROACH

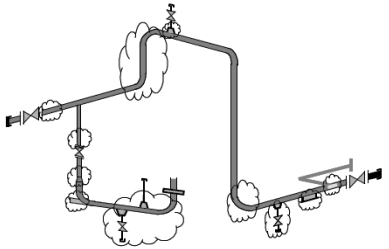
- Special measuring techniques for piping is required after 10-15 years of operation with 25.22.2 or SS316L UG

- Criticality ranking from process point of view

- Criticality ranking from atmospheric point of view

- Total life cycle approach
  - engineering - materials selection
  - procurement - QA/QC
  - construction phase; Inspections
  - painting - insulation systems; inspections
  - operations, inspection, maintenance, repairs

- Clear segregation of responsibilities
- RBI multidisciplinary team
- Involve contractors in RBI teams



RBI APPROACH

Potential degradation mechanisms at process side

- Stainless steel process lines:
  - Active carbamate corrosion in liquid phase
    - depletion of oxygen
    - stagnant conditions
  - Condensation corrosion in gas phase
  - Pitting corrosion due to contaminants (Chlorides, Sulphides)

Condensation corrosion in HP gas line due to insufficient insulation

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RBI APPROACH

Potential degradation mechanisms at outside

- Carbon steel lines:
  - Nitrate Stress corrosion cracking
  - Crater type attack at damaged coating
  - Crevice corrosion at supports
  - Crater type corrosion by intermitted use

Severe corrosion under clamp due to damaged coating in C-steel NH_3 line

Stress Corrosion Cracking (SCC) due to nitrates in C-steel 3 bar steam pipeline near nozzle

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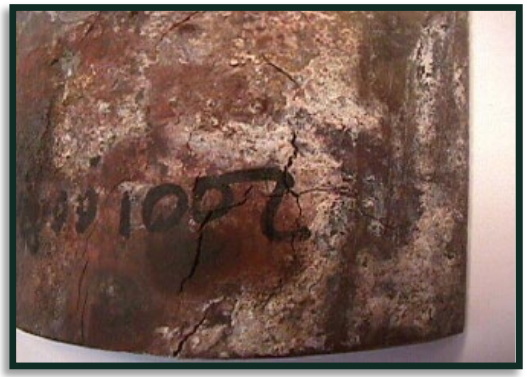
RBI APPROACH

Potential degradation mechanisms from outside

- Stainless steel process lines:
  - Chloride Stress Corrosion cracking under insulation or clamps



C-steel clamp allowing ingress of water and serious chloride SCC in AISI 304L pipeline underneath the clamp

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INSPECTION STRATEGIES

Challenges for inspection piping systems
- Large spread
- Difficult accessibility
- Almost no internal inspection possible
- Insulation

Purpose of inspection
- Survey
- Assessment of damages
- With or without removal insulation
- Combination of NDE methods

Daily observations
- Awareness plant personnel to report
    - all damages
    - improper application of insulation

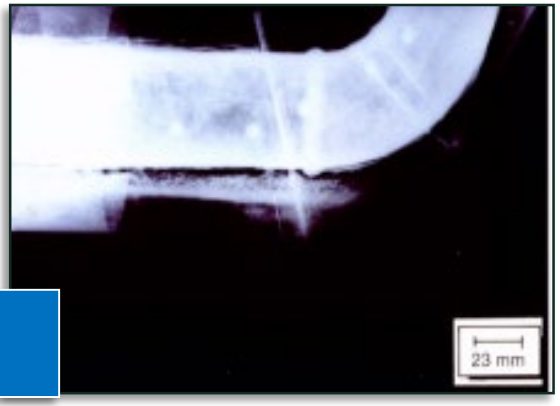
Improper application of insulation sheeting

INSPECTION STRATEGIES

Removal insulation
• Traditional NDE methods most appropriate

Inspection through insulation
• Several “non-intrusive” methods available
• Spot checks or survey methods

Inspection planning
• On-stream inspection
• Off-stream inspection (during TA)



Example of Flash Radiography Non-intrusive spot checks for Corrosion Under Insulation

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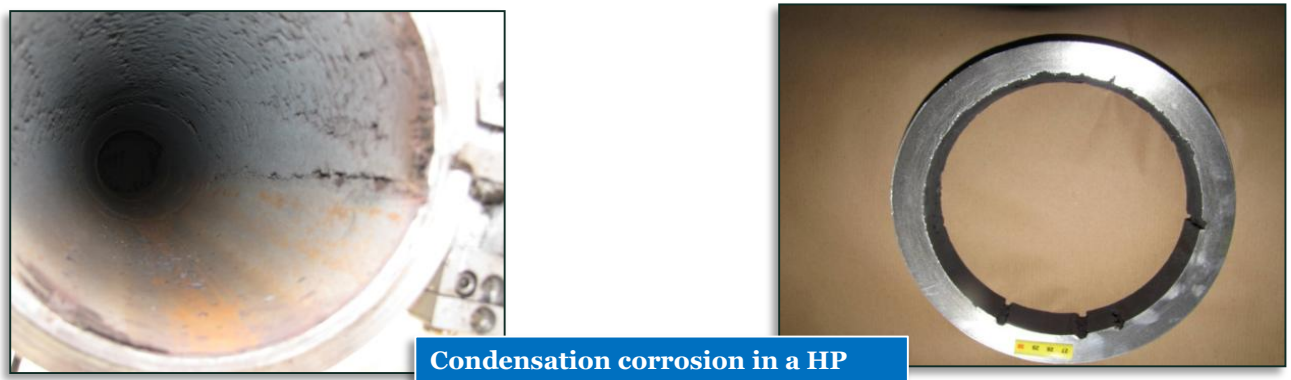
MITIGATION STRATEGIES

Process related corrosion in HP Urea pipelines

- Dosing of oxygen for passivation of austenitic SS pipes
- Application of insulation, steam tracing to combat condensation corrosion
- Selection of proper construction materials, i.e. SAFUREX
- Avoid dead pockets / stagnant conditions
- Avoid contaminations of Chloride / Sulphide



Condensation corrosion in a HP gas line in urea plant

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MITIGATION STRATEGIES

Atmospheric / corrosion undern insulation

- Appropriate and correct application of coating systems
- Appropriate insulation materials (no Chloride)
- Correct installation of tracing
- Correct application of water tight insulation covers
- Immediately repair dammaged or wrongly installed insulation

Incorrect application of a coating system on a carbon steel NH_3 pipeline in urea plant

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REPLACEMENT BY SAFUREX PIPING

Replacement project

- Equal piping routing
- Weight reduction due to lower piping schedule up to 20%
- Elimination of corrosion issues
- Inspection intervals is unlimited for main corrosion issues, i.e.:
  - Chloride Stress Corrosion Cracking
  - Condensation corrosion
  - Strain induced intergranular corrosion
- No painting required
- Piping engineering including stress calculation
- Updating the ISO metrics

CONCLUSIONS

- Piping systems deserve more attention
- RBI methodology throughout total life cycle
- RBI team: Involve all stakeholders (including external parties)
- Clear segregation of responsibilities
- Awareness and commitment of all stakeholders
- Risks from process side as well as from atmosphere
- In cooperate lessons learned from failures in RBI program
- Select Safurex piping material

Awareness to take timely actions to lower risk for atmospheric corrosion (example in urea plant)

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QUESTIONS

1. After how many years of operation you should inspect your HP piping in a non Safurex plant with special measuring techniques (Life time assessment)?

2. Are insulated piping systems not sensitive for corrosion?

3. What will be the weight savings when applying Safurex piping instead of SS316L UG?

4. What is the inspection interval for Safurex piping?

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