HP PIPING INSPECTION

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• Introduction
• Case histories
• RBI approach
• Inspection strategies
• Mitigation strategies
• Conclusions
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 (CO₂ 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

Stress Corrosion Cracks at process side

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

Incorporate upset conditions in RBI program
CASE 2: FAILURE DRAIN LINE HEADER

Valve in closed position

Ruptured drain line

Pipe rupture

Leaking Drain valve

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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

CASE 2: FAILURE DRAIN LINE HEADER

In cooperate drain system in inspection program
Change material of construction drain system
Avoid direct contact steam tracing with piping
On-sided corrosion
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
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)
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 NH₃ line

Stress Corrosion Cracking (SCC) due to nitrates in C-steel 3 bar steam pipeline near nozzle
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
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
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)
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
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 damaged or wrongly installed insulation

Incorrect application of a coating system on a carbon steel NH₃ pipeline in urea plant
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)
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?