A Corrosion Under Insulation Prevention Strategy For Petrochemical Industry Piping

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Corrosion Under Insulation- Have You a Problem?
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Discussion Outline

- CUI Background and Examples
- CUI Leak Data & Maintenance Costs
- CUI Prevention Measures
- CUI Prevention Costs
- CUI Prevention Strategy

Corrosion Under Insulation:
Background

- Affects carbon steel and SS equipment in the operating range of -4 C to 150 C
- Wet insulation is the root cause
- CUI rate depends on temperature and internal/external contaminate sources

- Highly unpredictable and difficult to detect
- One of the top causes of equipment leaks & near misses
- Maintenance costs are significant

Corrosion Under Insulation Example

- This is a 3-inch, sch 40 propane line that is 20 years old.
- The line was found to have very thin areas as a result of the CUI.

- The line was replaced with stainless steel
- The cost to replace was only slightly more than the cost to refurbish in place.

Corrosion Under Insulation Example

•This is a 30 inch, sch ST, light hydrocarbon line that was in service 4 1/2 years.

•The line had severe CUI and thin sections in the bottom center area of the pipe.

•The line operated at 150 psig at 180 F (82 C)

•Cost to refurbish was $435K.

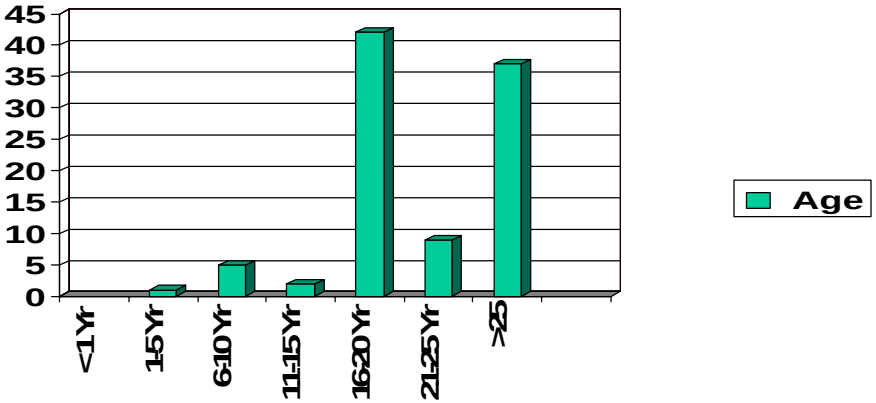
Corrosion Under Insulation Example

- This 6 inch, sch 40, hydrocarbon vapor line was in service for 12 years
- The line had severe CUI and wall thinning at each insulation section joint.

- Cost to refurbish line was $460K

CUI Leak Data Analysis

- **84% of all CUI leaks are in piping**
- **81% of piping CUI is on pipe < 4 inches NPS and**



- **Pipe wall thickness is key to failure frequency**
  - **The 16-20 year population is mainly < 4” NPS / low WT pipe**
  - **The over 25 year population is mainly > 6” NPS / heavy WT pipe**

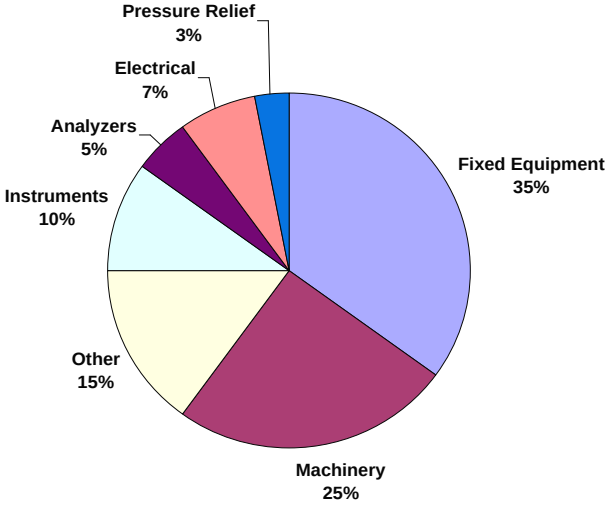
Maintenance Costs Today

- Fixed Equipment is the largest maintenance cost item.

- Fixed Equipment issues are longer-term so it is difficult to justify improvements unless the focus includes life cycle costs.

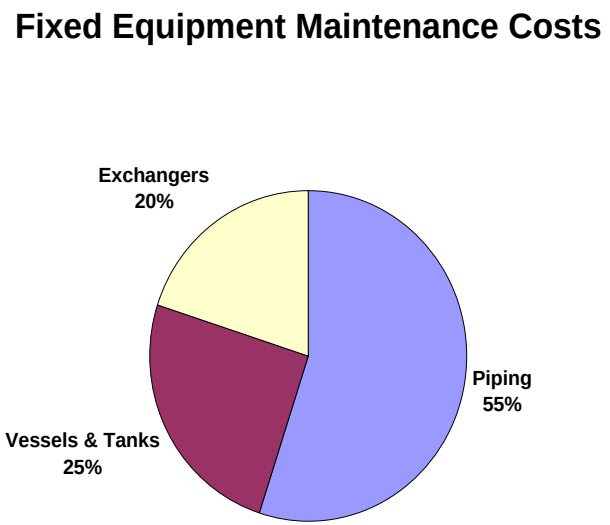
- 35 cents of every maintenance dollar is spent on fixed equipment

Maintenance Cost by Equipment Type



Fixed Equipment Maintenance Costs Today

- Piping accounts for 55% of Fixed Equipment maintenance costs or about 20 cents of every maintenance dollar.
- CUI accounts for 40-60% of piping maintenance costs or about 10 cents of every maintenance dollar.



CUI Prevention Measures

CUI Prevention Tool Suite:

•TSA coating of carbon steel
• Organic coating of carbon steel
• Replace personnel protection insulation with wire cages
• Stainless steel for small diameter pipe
• Al-foil wrap to prevent external SCC of stainless steel under insulation
• Low-dust abrasive blasting for surface preparation

Driver - Inspection-free; Maintenance-free Concept:

• Do it once while keeping initial cost reasonable with focus on life cycle cost
• Want 25-30 years service life; this is a challenge for organic coatings
• Life cycle savings by reduction of future maintenance and inspection costs.
    • Inspection with high CL for detecting CUI is approximately same cost as CUI prevention deployment

CUI Prevention Costs:
Tool "Suite" Cost Comparison

CUI Prevention Strategy	Initial TEC[1]	DCF RR[1]
1. Thermal Spray Aluminum		
▪ New Construction	95% to 105%	30% to 40%
▪ In-situ maintenance	105% to 120%	20% to 30%
2. Use of Personnel Protection Cages[2]		
▪ New Construction	95% to 100%	
▪ In-situ maintenance	85% to 90%	
3. Al-foil on Stainless Steel		
▪ New Construction	97% to 99%	
▪ In-situ maintenance	93% to 95%	
4. Small Diameter Stainless Steel Pipe		
▪ New construction	115% to 125%	15% to 25%
5. Non-Painted (Bare) CS Pipe		
▪ New Construction	60% to 80%	
6. NDE @ hgh confidence level		
▪ In-situ maintenance	95% to 100%	

Note 1: Organic paint = 100%
Note 2: vs. insulation costs

Life Cycle Comparison:
1500 ft of NPS 8 Pipe

	Replace Existing CS Pipe w/ TSA CS Pipe	Replace Existing CS[5] Pipe w/ Painted CS Pipe; paint every 10 Yr	TSA Existing CS Pipe In-situ; strip coat, re-insulate	Paint Existing CS[5] Pipe In-situ; strip, paint, re-insulate; re-paint every 10Yr
Initial Cost (Yr 0)	643,030	628,950	308,566	255,400
Yr 10 Cost	----------	378,000	----------	378,000
Yr 20 Cost	----------	560,000	----------	560,000
Life Cycle Cost	643,030	1,566,950	308,566	1,193,400
NPV @ 10%	643,030	858,105	308,566	484,554
DCF Rate of Return	**39%**		**24%**	
Initial Cost per Ft^2	189.00	185.00	91.00	75.00
Annualized Cost/ sq ft/yr (20 Yr)	**9.44**	**23.01**	**4.53**	**17.52**

Notes:
1. Cost basis is 2002 U.S. Gulf Cost data; inflation assumed at 4%
2. TSA to Paint costs used for this analysis. 7:1 ratio for Replacement cases & 12:1 ratio for In-situ cases
3. At NPS 3 and below 304 stainless steel pipe may be cost competitive
4. Personnel Protection Cages should be used to eliminate thermal insulation when ever possible
5. Re-paint costs may be painting or NDE costs

CUI Prevention Strategy:

Conventional CUI Management

- Application of protective systems along with NDE/inspect is usually used to fight CUI
- Conventional paint systems have a life 5-13 years. Re-paint to prevent CUI; on-going NDE/inspection to mitigate CUI
- De facto “run-to-failure” in place if maintenance is not done. NDE improves CUI damage estimate but does not reduce CUI
- Cost to field strip insulation, surface prep, paint and insulate (including scaffolding) is 13 times more than original painting cost.

CUI Prevention Strategy

- Based on “suite” of tools in use within industry
- Tools capable of CUI prevention; break the inspect & maintain cycle
- CUI prevention means “do it once” and move toward “inspection-free & “maintenance-free” operating mode
- Deployment based on economic reality and life cycle savings. Significant risk reduction may also be obtained by elimination of de facto “run-to-failure”

CUI Prevention Strategy
Summary

- Piping systems are prone to CUI and they contribute significantly to piping maintenance costs.

- Significant maintenance savings are possible with a CUI Prevention Strategy focused on an “inspection-free; maintenance-free” philosophy

- The full range of CUI Prevention “tools”, including organic coatings, needs to be evaluated on a TEC and life cycle basis to reach the optimum choice.