Corrosion Under Insulation (CUI)

New Insights into Managing CUI Corrosion Using Explainable AI

Corrosion under insulation (CUI) can be a nuisance when it comes to damage mechanisms in refining, petrochemical, chemical, and many other industries, yet it's commonly accepted that existing inspection methods are ineffective, and facilities continue to have significant problems managing CUI.

CUI damage can easily go undetected and grow exponentially because of the massive surface area of insulated fixed equipment and piping, extremely localized growth that is difficult to find, and limited annual maintenance budget. Our novel CUI solution, leveraging explainable AI (XAI), solves this problem once and for all.

Corrosion Under Insulation: Two Common Issues

We predict the proper balance between the two most common issues and will optimize your inspection and maintenance decision strategies.

Undetected CUI Leads to Downtime and Production Loss

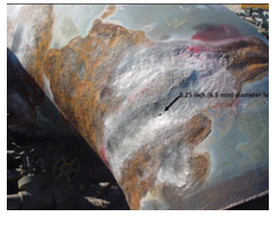
- Massive surface area to inspect
- Damage is lurking beneath the insulation and can't be seen
- Damage is localized with regards to total surface area

Excess Inspection Costs Trying to Locate and Detect CUI

- Extremely costly to remove insulation and inspect everything
- Inspecting too much, blindly
- Inspecting too frequently, without prescriptive guidance

WHAT WE SEE!

WHAT WE DON'T SEE!



Predict & Guide CUI Inspection

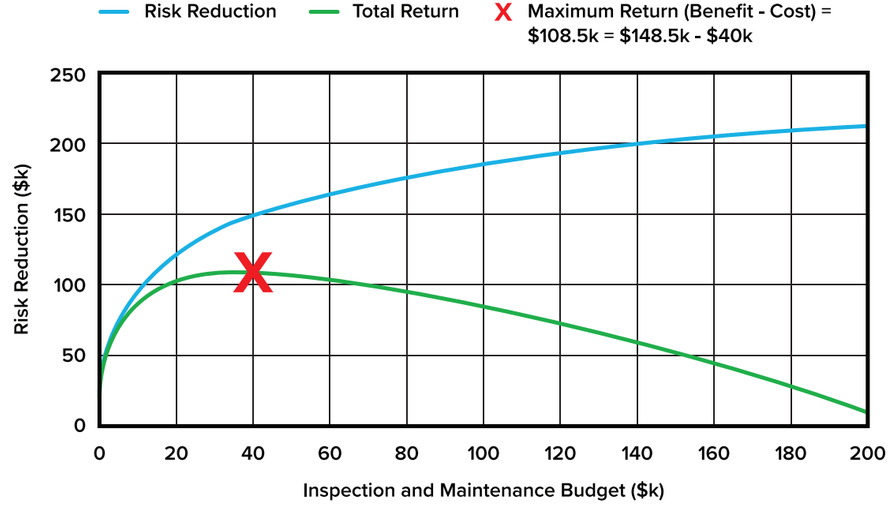
The Equity Research CUI methodology is the industry's first application of XAI to solve this complex problem. Using XAI, we have developed a two-stage probabilistic model that properly blends disparate data (e.g., inspection data, expert knowledge, physical models, operator experience, etc.) and continuously learns as new data/knowledge becomes available. The first stage is a physics-based probabilistic model that is rooted in the fundamental of CUI damage evolution (e.g., jacket failure, coating failure, corrosion initiation, corrosion propagation, and failure) to deliver accurate predictions of damage and failure. The second stage is a probabilistic, financial-based decision optimization model that determines optimal lifecycle decision strategies that maximize total return (e.g., where, when, and with what technique to inspect and perform maintenance). This new method is coupled with the Equity Engineering Practices (EEPs) and supplemental subject matter experts (SMEs) to provide more prescriptive recommendations and guidance to the model's predictions.

BENEFITS

MAXIMIZE RETURN

MINIMIZE CUI FAILURES

REDUCE INSPECTION AND MAINTENANCE COSTS



CONDUCT MORE EFFECTIVE INSPECTIONS

APPLY XAI DECISION OPTIMIZATION TO INSPECTION AND MAINTENANCE PLANNING

What is Explainable Artificial Intelligence (XAI)?

Bengi

BENGI, our proprietary next-generation XAI technology, overcomes the shortcomings of traditional AI by incorporating all historical and future knowledge into a single decision-making system. XAI properly blends expert knowledge, inspection findings, maintenance data, and field observations to improve asset life prediction.

The CUI methodology is one of several practical decision-making and lifecycle optimization tools we are developing that utilize extreme scale Bayesian Networks with a high-dimensional tensor algorithm design, delivered via Equity Software cloud-native software. The mechanical and metallurgy experts at Equity Engineering will review all data outputs to tailor the inspection and maintenance plan specifically to each client's operational needs. In the future, these capabilities will be integrated into PlantManager 6.0 for next-generation asset integrity management.

The four main steps to smarter asset integrity management, leveraging XAI, are illustrated in the figure below.

IDENTIFY — All possible damage mechanisms and estimate prior damage rates

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PREDICT — Life using the most accurate probabilistic damage models

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RECOMMEND — Best inspection and maintenance strategies to detect, measure, and mitigate damage

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ANALYZE — Inspection data to assess health and update life predictions in real-time

CUI Special Emphasis Inspection & Maintenance Program

We use our newly developed CUI methods to deliver a smarter CUI program that will guide future inspections and provide insights into insulated assets. Developing a special emphasis CUI inspection and maintenance program will save you money, reduce CUI maintenance budget, and increase your likelihood of finding CUI.

STEPS

1 DATA GATHERING

a. CUI program review and gap assessment
b. Gather isometric drawings, PIDs/PFDs, maintenance records, and exports from IDMS
c. Determine relative financial cost of failure (COF) per circuit/line

2 BASELINE ANALYSIS USING ALL AVAILABLE HISTORICAL DATA

a. Environmental analysis (geographical location determines weather conditions, wind speed, rainfall, etc.)
b. Local unit environments (e.g., cooling tower spray, frequent deluge, etc.)
c. Assign baseline CUI suspect areas using isometrics and historical inspection and maintenance records
d. For each suspect area, create input files, run analyses, and generate report per location

3 CUI-FOCUSED FIELD WALKDOWNS

a. Equity-facilitated field walkdown to gather additional key inputs for CUI models
b. Confirm CUI suspect areas

4 UPDATED ANALYSIS

a. Update isometrics with confirmed or newly identified CUI suspect areas
b. Run updated analysis using all newly gathered data/findings
c. Determine financially optimal inspection and maintenance strategies
d. Deliver digitized inspection and maintenance plan for all assets in a software product that can be maintained, post-implementation

5 OPTIMIZED INSPECTION AND MAINTENANCE PLAN

a. Timing for focused follow-up CUI inspections
b. Schedule for CUI maintenance activities
c. Report tailored specifically to client's unique operational needs

VISIT E2G.COM
CONTACT OUR TEAM SOFTWARE@E2G.COM
TECHNOLOGY FORWARD
P: +1.216.283.9519
EQUITY RESEARCH