

ETHYLENE PYROLYSIS TUBE INSPECTION SYSTEM



Carburization of ethylene pyrolysis tubes causes issues such as loss of weldability, corrosion resistance and ductility, and can result in micro-cracking.

Quest Integrity has developed the Ethylene Pyrolysis Tube Inspection System, which enables comprehensive inspection of carburization damage in ethylene pyrolysis tubes. The system utilizes advanced eddy current technology to measure diameter increase and magnetic permeability increase due to carburization. It is the only tool which allows inspection along the entire length of tubes without scaffolding.

The Ethylene Pyrolysis Tube Inspection System provides operators with accurate information to assist in predicting tube remaining life, scheduling timely tube replacement and avoiding onstream tube failures.

FEATURES AND CAPABILITIES

- Eliminates the need for staging, by instead using an automated crawler-deployed inspection and data logging system
- Provides highly accurate and repeatable results
- Provides increased confidence in ethylene tube inspection results through combined NDT methodologies
- Maximizes efficiency and accuracy with eddy current technology

BENEFITS

- Minimizes risk of unplanned shutdown due to premature tube failure
- Reduces turnaround time required for furnace tube inspection
- Enables comprehensive coverage
- Allows plant engineers to optimize furnace scheduling, with the possibility of extending life beyond planned replacement, resulting in cost savings
- Provides essential support to operational excellence as it relates to best practice operation and maintenance cost management
- Facilitates monitoring of ethylene tube life over entire life cycle



Cracking in a carburised tube, shutdown with an intact coke plug.

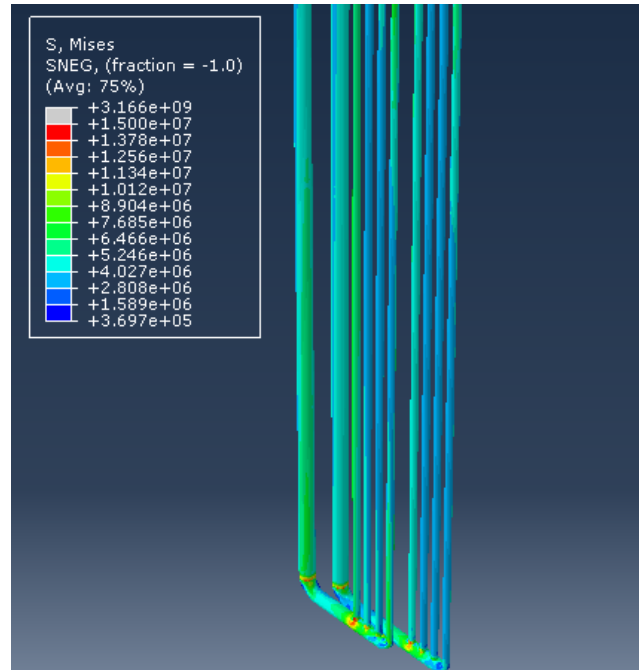
REMAINING LIFE ASSESSMENT

Data from the inspection is used to provide remaining life assessment of the ethylene pyrolysis tubes, using:

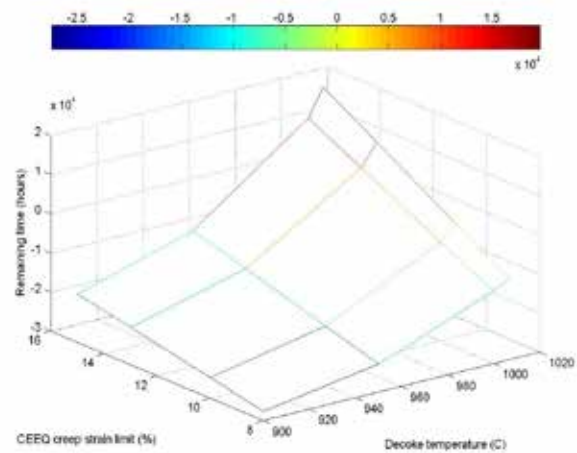
- Finite Element Analysis (FEA) of the coil and hanger geometry to predict stress and strain changes during startup, typical production runs and decoke cycles. The FEA incorporates plastic and creep material properties. Strain accumulation during repeated production and decoke cycles is compared to strain limits to predict remaining life.
- A database of tube alloy mechanical and microstructural properties. This allows a correlation between the magnetic permeability properties of the tubes recorded during the inspection with key mechanical properties necessary for predicting integrity and remaining life. The database consists of property data for new and used tubes fabricated from the most commonly used alloy classes (e.g. HP50, HK40, ET45).

INSPECTION PROCESS

Furnace drawings are required before a site visit to check alloy type, tube diameter and clearance between tubes. The current crawler is optimized for 5" to 6" diameter outlet tubes, however this can be adapted with sufficient advance notice. The inspection process involves a two or three person crew visiting the site to collect the crawler data over a period of two to three days. An FEA model of the furnace geometry is created off-site and used to predict remaining life, which is presented in a formal report.



Abaqus Finite Element Analysis (FEA) used to predict remaining life by modelling temperature cycles including decoke effects.



Remaining life predictions for various creep strain limits and decoke temperatures.