

# Cleaning and Inspection of Steam Cracking Furnace Convection Coils Now Possible

## Overview

Ultrasonic-based smart pig inspections have become widely adopted within the refining industry as a best practice for maintaining fired heater tube integrity. However, many fired heater and furnace owner-operators within the Petrochemical industry are not familiar with the technology or are unaware it can be utilized for the inspection of steam cracking furnace convection sections, including coil configurations connected to common headers (manifolds).

Historically, little to no inspection data has been collected on these coils due to the lack of an entry point into the convection box and the challenges associated with conducting external inspections on tubing with raised surfaces (e.g., fins and studs). Due to these accessibility issues, many convection sections are not inspected and are instead maintained using conservative life-cycle predictions based on operating conditions, tube metallurgy and feedstock type. Though steam cracker convection sections typically operate in less harsh environments (e.g., lower temperatures, less corrosive feedstocks) as compared to many heaters in refining operations, tube failures do occur from wall loss and creep growth.

To mitigate possible future tube failures and obtain much needed integrity data, an Olefins plant located in Europe contacted Quest Integrity to perform an FTIS™ (Furnace Tube Inspection System) smart pigging inspection (see Figure 1) on a Feed Preheater bundle consisting of 10 coils. The bundle had never been cleaned before and internal fouling was suspected based on findings from a Feed Preheater Bundle in a sister furnace. Tubes from that furnace contained visible discoloration from overheating, which was most likely caused by a buildup of scale on the inside of the tube walls. Given the possible integrity concern and restriction in product flow from the buildup, Quest Integrity was requested to clean the coils in addition to pumping the FTIS tool through the coils using its Advanced Mechanical Cleaning and Pumping Technology.

## Project Execution

Quest Integrity was awarded the contract to clean and inspect the Feed Preheater Bundle using its proven Advanced Mechanical Cleaning and FTIS technologies.

Advanced Cleaning uses state-of-the-art pumping trucks and mechanical cleaning pigs to effectively remove internal fouling from tube walls, restoring proper heat transfer and thermal efficiencies. FTIS is a high-resolution ultrasonic in-line inspection technology that detects and measures coil damage such as internal



Figure 1. FTIS Smart Pig

and external corrosion, erosion, pitting and fretting as well as deformations such as bulging, swelling, denting and ovality. This technique provides owner-operators with a complete and quantitative mapping of a coil's wall thickness and geometry.

Common headers were attached to the inlet and outlet of each Feed Preheater coil adding to the complexity of the project, since the cleaning pigs and FTIS tool would need to travel through the header first for entry into the coils.

For successful navigation through the furnace, Quest Integrity's Header Delivery System (HDS) was installed inside the inlet and outlet common headers of each coil. The HDS connected the coils via hoses to the water pumps installed on Quest Integrity's cleaning truck (see Figures 2 and 3). This created a closed loop system, allowing water to enter the coils to provide a couplant for the ultrasonic inspection while also propelling cleaning pigs and the FTIS tool through the coil using the cleaning truck pumps.

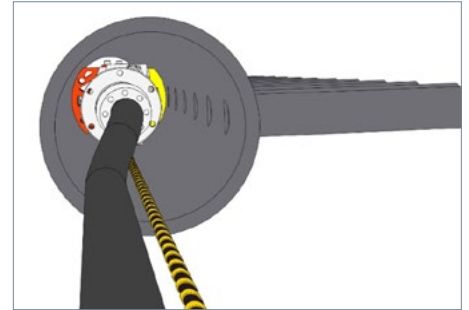


Figure 2. HDS Inside a Common Header



Figure 3. Typical Fired Heater Set Up for Advanced Cleaning and FTIS Inspection

Over a 36-hour period, cleaning and inspection operations were conducted. As suspected, internal scale was present in each of the coils and removed during cleaning operations, improving thermal efficiency and heat transfer and allowing for the highest quality FTIS ultrasonic inspection. The inspection was performed successfully, and a comprehensive high-resolution ultrasonic data set was obtained.

### Inspection Results

The FTIS inspection revealed numerous integrity concerns. Extensive external localized wall loss was detected in a majority of the coils at the beginning of the straight pipes just after the upstream 180-degree return bend (see Figure 4). Each of the 10 coils had wall loss in excess of 40 percent with 53 percent being the worst loss detected in the Preheater section. Furthermore, numerous return bends contained significant internal wall loss reaching as high as 47 percent. Pipe deformations exceeding Quest Integrity's predetermined threshold of 2 percent were also detected throughout the Preheater section with over fifty areas of ovality and seven dents detected (see Figure 5).

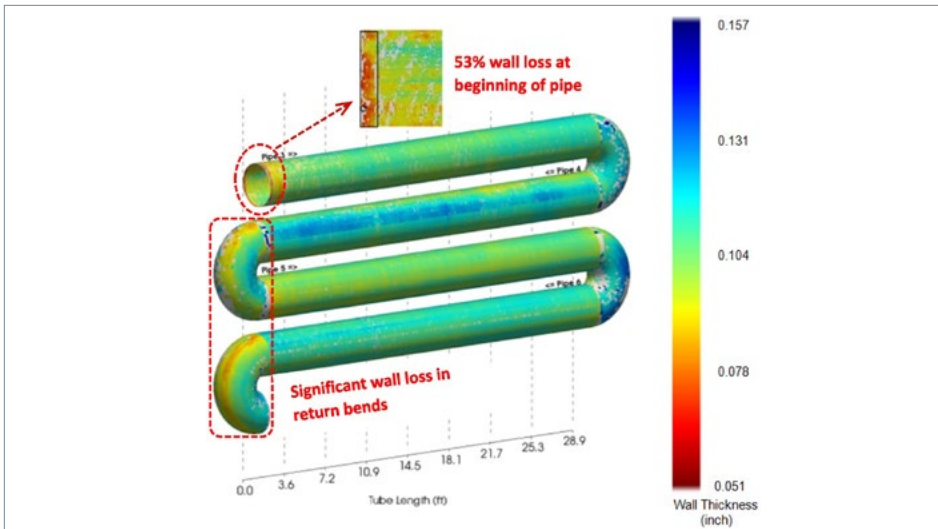


Figure 4. Wall Thickness Plot Showing Localized Wall Loss

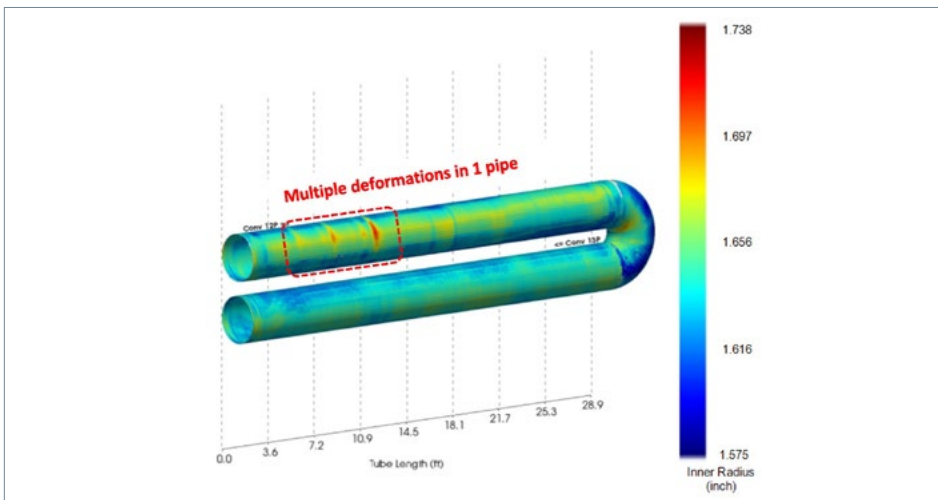


Figure 5. 3D Inside Radius Plot Showing Deformations

## Conclusion

Periodic in-line inspection is a sensible strategy for managing the long-term condition of steam cracking furnace convection sections. Applying Quest Integrity's Header Delivery System on furnaces that were previously deemed as un-inspectable with smart pigging technology has opened up the opportunity for a cleaning and comprehensive assessment of a coil's condition.

The benefits realized by performing an Advanced Mechanical Cleaning and FTIS Inspection for this Olefins plant were numerous. By cleaning the Feed Preheater coils, product throughput was increased and heat transfer efficiency improved, reducing the risk of damaging tubes from overheating. The FTIS technology provided valuable insights on the actual condition of the coils, which was previously unknown, preventing unplanned and costly outages from coil failures while also allowing for more effective asset integrity management and better operational assurances.

