

Cleaning, Inspection and Assessment of Steam Reformer Convection Coils Now Possible

Overview

Ultrasonic-based smart pig inspections have become a mainstay for maintaining fired heater and furnace tube integrity. However, many steam reformer owner-operators are unfamiliar with the technology or are not aware it can be utilized for the inspection of convection sections including coil configurations connected to common headers (manifolds).

Although it's a widely accepted practice to inspect the radiant tubes in steam reformers, inspection plans or options to help determine the condition of convection coils are almost non-existent. As such, little to no inspection data has been collected on these coils. This is due to the lack of an entry point into the convection box, accessibility to the inside of tubes connected to common headers and the challenges associated with conducting external inspections on tubes with raised surfaces (e.g., fins and studs). When considering all these accessibility issues, internal and external inspection technologies such as smart pigs, external crawlers and handheld UT solutions cannot be utilized without major modifications to the heater or sacrifices in the number of inspection data readings. Many convection sections, as a result of this, are not inspected and are instead maintained using conservative life-cycle predictions based on operating conditions, tube metallurgy and feedstock type. Though steam reformer convection sections typically operate in less harsh environments (e.g., lower temperatures, less corrosive feedstocks) as compared to some other fired furnaces and heaters, tube failures do occur from wall loss and creep growth.

To mitigate possible future tube failures and obtain much needed integrity data, a Methanol plant located in the Middle East contacted Quest Integrity to perform an FTIS™ (Furnace Tube Inspection System) smart pigging inspection (see Figure 1) and fitness-for-service screening assessment on 100 PNG Preheater coils. The coils had never been cleaned before and light internal fouling was suspected given the number of years in operation. As such, 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 Services and Execution

Quest Integrity was awarded the contract to clean, inspect and assess the PNG Preheater coils using its proven Advanced Mechanical Cleaning, FTIS and LifeQuest™ Engineering Assessment services.

Advanced Mechanical 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

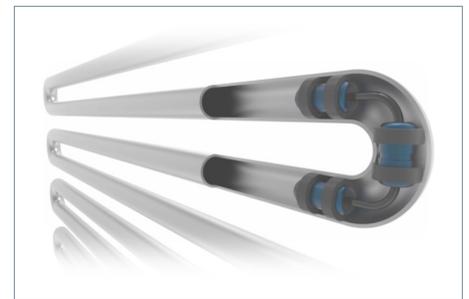


Figure 1. FTIS Smart Pig

ultrasonic in-line inspection technology that detects and measures damage such as internal and external corrosion, erosion, pitting and fretting as well as deformations such as bulging, swelling, denting and ovality in numerous coil configurations. This technique provides owner-operators with a complete and quantitative mapping of a coil's wall thickness and geometry. The inspection data from the FTIS service is then used along with heater design and operating parameters to conduct a LifeQuest fitness-for-service screening assessment following the API 579-1 Standard. This service provides owner-operators with the confidence that a furnace can be returned to service and safely operated until the next planned shutdown.

As with many steam reformers, common headers were attached to the inlet and outlet of each coil. This added 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 heater, Quest Integrity's Header Delivery System (HDS) was installed inside the inlet and outlet common headers of each coil. The HDS effectively 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 via the cleaning truck pumps.

Extremely heavy fouling was encountered during the cleaning process, which was not expected, with some coils completely blocked. Quest Integrity managed to clean all of the unblocked coils and assist the plant in unblocking a portion of the remaining coils. Removing the fouling greatly improved thermal efficiency and heat transfer and allowed for the highest quality FTIS ultrasonic inspection. The inspection was performed successfully and a comprehensive high-resolution ultrasonic data set was collected.



Figure 2. HDS Inside a Common Header



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

Inspection and Assessment Results

The FTIS inspection revealed moderate internal and external localized wall loss upwards of 40 percent in numerous pipes (see Figure 4). General internal wall loss upwards to 26 percent was also present in the 180-degree return bends. The result of the engineering screening assessment showed that the coils were fit for service for the next four-year operating period. A remaining life assessment was also performed on each coil as part of the screening assessment, showing an estimated remaining life of 15 years with a recommendation to re-inspect in four years to monitor corrosion rates and detect any other localized damage that may affect coil integrity.

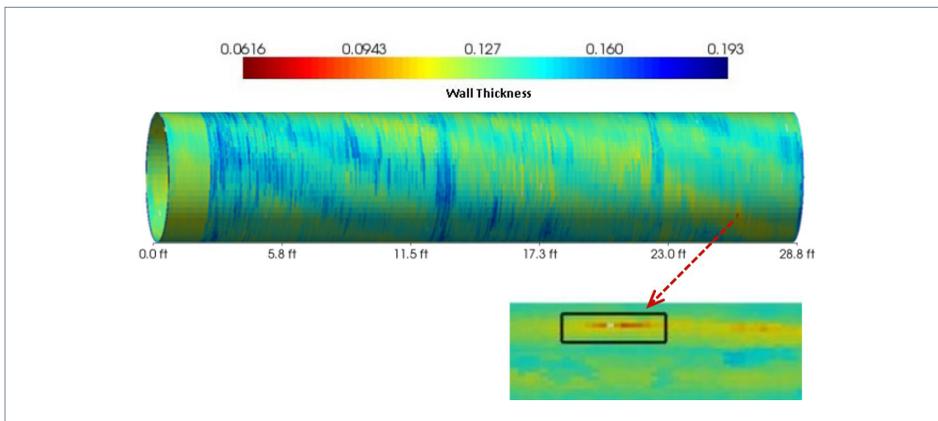


Figure 4. Wall Thickness Plot Showing Localized Wall Loss

Conclusion

Periodic in-line inspection is a sensible strategy for managing the long-term condition of steam reformer convection sections. The benefits realized by performing an Advanced Cleaning and FTIS inspection were numerous. Applying Quest Integrity's proprietary HDS system on assets that were previously deemed as un-inspectable with smart pigging technology opened up the opportunity for a cleaning and comprehensive assessment of the coils' conditions.

The Advanced Mechanical Cleaning of the PNG Preheater coils revealed significant fouling and flow restrictions that were previously unknown. As a result of the cleaning, the heat transfer efficiency increased over 60 percent and the product rate increased significantly as well, enabling the plant to produce an additional 1 MM USD of methanol a year.

The FTIS technology provided valuable insights on the actual condition of the coils and the fitness-for-service screening assessment provided assurances that the coils could be safely operated for the next four-year operating period. The three services combined provided the plant with a highly effective approach to optimizing the performance and reliability of the PNG Preheater coils, minimizing downtime and maximizing production and furnace profitability.

