CASE STUDY

FTIS™ DETECTS METALLURGICAL CHANGES

OVERVIEW:

A client contracted with Quest Integrity Group (Quest Integrity) to conduct an FTIS™ (Furnace Tube Inspection System) inspection on tubing coils in a Monomer Furnace during a scheduled maintenance turnaround as part of its mechanical integrity program. After the heater coils were cleaned using mechanical decoking, Quest Integrity conducted an FTIS smart pig inspection of the coils utilizing proprietary ultrasonic technology. The purpose of the inspection was to identify and quantify areas of deformation or wall loss. As expected, upon review of the inspection data several areas of wall thinning were detected. Additionally, several distinct areas of increased wall thickness were detected (see Figure 1). Based upon our experience, such areas are generally the result of internal or external build-up on the pipe wall. However, in this case, visual inspection of the external surface combined with a detailed review of the FTIS inspection data from the interior surface did not indicate such build-up. Manual UT readings in the field confirmed the presence of these anomalies. The client reported previous observation of areas where fluid appeared to be seeping through the coils near the end of tube life. The client determined, based upon its extensive experience, the heater was safe for operation for another year, at which time a second FTIS inspection would be conducted.

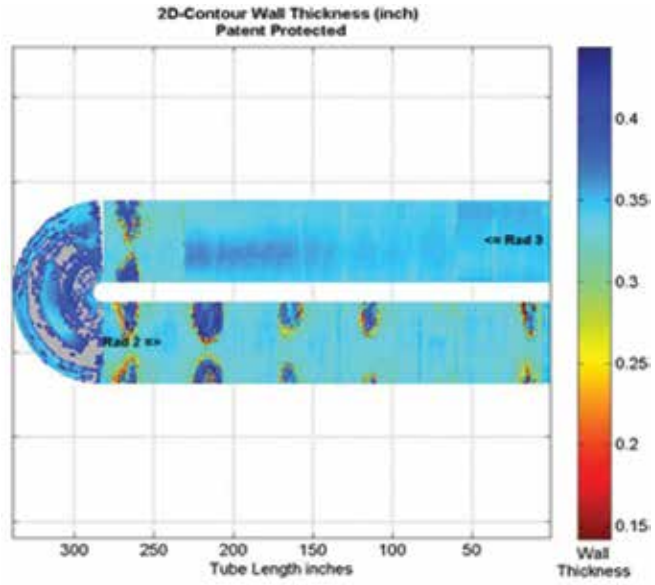

Figure 1. Anomalies as seen in two tubes joined by a return bend

Figure 2. View of anomaly on exterior tube surface

In the meantime, Quest Integrity conducted detailed engineering evaluations of specific coil sections removed from the heater. It was not known if these tubes would show similar results. These tubes were inspected at our Seattle facility and similar anomalies were detected (see Figures 2 and 3). Both the internal and external surfaces were visible to the unaided eye, and it was clear there was no build-up on the tube wall to account for the apparent increase in wall thickness. Subsequently, the anomaly locations were marked and the tubes were sent to our Denver office for metallurgical analysis. It was determined a unique, high temperature corrosion process was taking place, resulting in a depletion of chromium (e.g. de-alloying) from the base metal and leaving behind a porous magnetic nickel iron alloy corrosion layer. This change in the composition affected the physical properties (e.g. UT sound velocity) of the corroded layer and caused an apparent increase in measured tube wall thickness versus the intact base metal. A detailed assessment of the corrosion process determined that the base metal material, while subject to this unique corrosion mechanism, was the best alloy choice for this service.

One year later a follow-up FTIS inspection was conducted with results similar to those in the previous FTIS inspection. Additionally, while the exact wall thickness could not be determined due to the previously described metallurgical changes, it was determined that in several locations the size of the affected area increased, thus indicating a continuation of the corrosion process (see Figures 4 and 5).

Future plans include annual monitoring of these areas with the FTIS technology until the client determines the unit is no longer fit for service and schedules coil replacement.

Without the 100% inspection coverage provided by FTIS, it is unlikely this unique damage mechanism would have been detected prior to tube failure. Moreover, the client and Quest Integrity can monitor the heater going forward, thus mitigating risk to personnel, equipment and the environment.

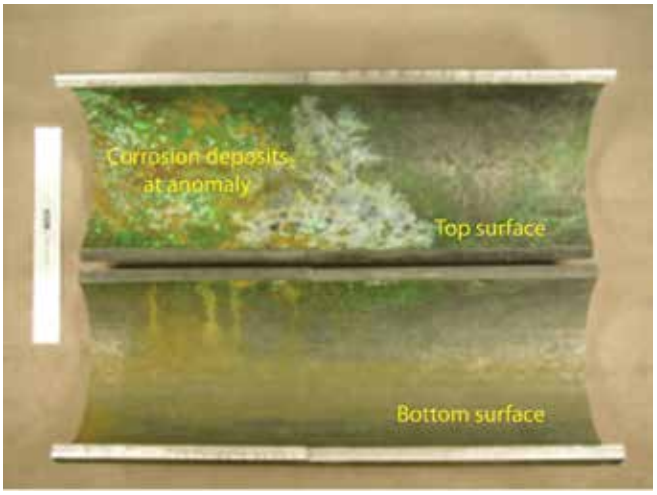

Figure 3. View of top and bottom interior surfaces of the tube

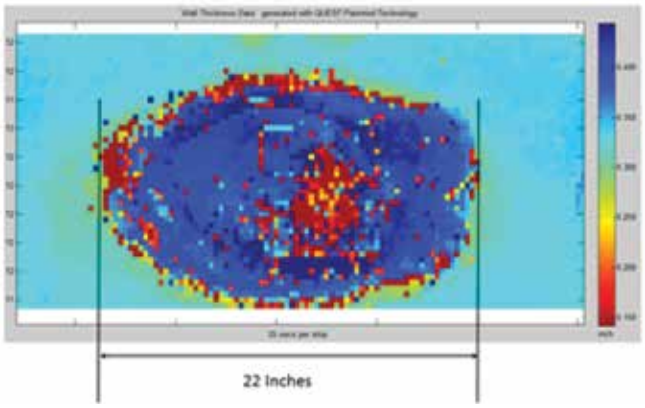

Figure 4. Initial inspection results showing anomaly

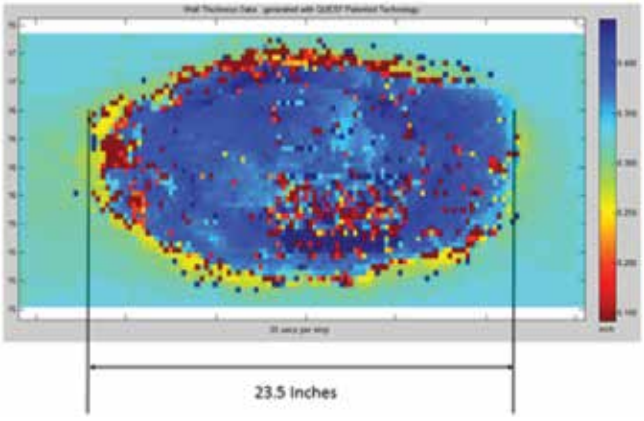

Figure 5. Second inspection (one year later) results showing anomaly