INTRODUCTION:
The practice of employing ultrasonic-based intelligent pig technology to inspect serpentine coils in fired heaters is commonly implemented by refinery operators industry-wide. This method of inspection has proven invaluable in providing precise and comprehensive inspection results, enabling plant operators to avoid costly plant shutdowns or unanticipated failures. In years past, the presence of plug headers (mule ears) within heater coils has limited the inspection capabilities of ultrasonic-based intelligent pigs. However, recent advances in this technology have allowed for the inspection of fired heater coils that include plug headers, without requiring coil modifications such as radial or deflector inserts.

HISTORY:
Inspecting fired heater coils with a high degree of accuracy has proven to be challenging in years past, due to a number of significant factors. Conventional Non-Destructive Testing (NDT) has been used to inspect these types of coils, but is ineffective in determining 100% of the condition of fired heater coils. The inspection service was further complicated due to coil length, raised surfaces, short radius return bends and the need for modifications in heater coils with plug headers. Because of these limiting factors, accurately determining the status of an entire piping coil was extremely difficult.

The intelligent pigging inspection technology mitigates these inspection limitations, and delivers an accurate and reliable method for assessing the internal condition of fired heater coils by providing up to 100% circumferential and axial coverage. Recent advances in this technology have allowed for the inspection of fired heater coils with plug headers, without the need for coil modifications prior to inspection. This cutting-edge technology in UT-based intelligent pigs is unparalleled in the inspection industry, and allows for operation managers to make critical plant decisions confidently and accurately.

MARKET DEMAND AND TECHNOLOGY ADVANCEMENTS:
The advancement of ultrasonic-based intelligent pig technology is largely important in the refining and chemical plant industries. Previous inspection methods have proven to be time-consuming and lack in overall inspection capability, creating an industry-wide need for an efficient and accurate technology.

Conventional NDT inspection services cannot inspect the full piping coil and are frequently unable to access coils located in a convection section of the heater. This lack of accessibility provides inaccurate or partial inspection results. Fortunately, the intelligent ultrasonic pigging technology supersedes typical NDT testing capabilities and is able to provide a comprehensive data set from which operation managers can determine remnant life and avoid costly delays.

The UT-based intelligent pigging inspection tool is capable of navigating a heater coil with plug headers without requiring time consuming or expensive
coil modifications. Because of this advancement in inspection technology, operation managers can ensure the longevity of plant assets, in a cost-effective and efficient manner.

Quest Integrity’s Furnace Tube Inspection System, or FTIS™, was developed to address the historical problems facing fired heater inspections, and has recently increased the capabilities of the technology and extended the benefits of ultrasonic intelligent pigging to heater coils containing plug headers – without the need for radial or deflector inserts. This significant advancement in technology further ensures the inspection of up to 100% of the entire piping coil, while providing excellent data quality and accuracy.

THE TECHNOLOGY:

The ultrasonic-based intelligent pig technology addresses the damage mechanisms associated with corrosion, pitting, erosion, fretting (mechanical damage), interior and exterior wall thinning, deformations (e.g. creep, swelling, ovality, denting and bulging), axial and circumferential flaws, and coke or scale build-up. Unlike typical NDT inspection methods, the UT-based pigging technology provides a comprehensive assessment of both the internal and external condition of a piping coil.

During a standard FTIS inspection, the UT-based pigging tool travels the interior of the serpentine coil through a liquid medium, and yields coverage of both the convection and radiant sections of coil, providing up to 100% circumferential and axial coverage of coil components, utilizing 48 to 168 ultrasonic sensors. When proper inspection speed is maintained, these sensors continuously pulse at a high rate in order to gather an accurate data range for the full circumferential and axial length of the coil.

Once the inspection run is complete, the data set is transferred from the pigging tool’s on-board memory to a laptop computer, where it is analyzed using proprietary software, specially designed to analyze and determine the damage mechanisms of the piping coil. Preliminary results can be provided on-site, typically within hours of the inspection. The data gathered during the inspection can then be used to perform remaining life assessments and fitness-for-service to assess overall coil condition, allowing plant operations to better manage assets.

INSPECTION DATA DISPLAY:

Data collected during the inspection run is analyzed in Quest Integrity’s proprietary software, LifeQuest™ Heater. The software imaging allows for the display of both 2D and 3D views of the piping, ensuring full visibility of flaws throughout the entire piping system. The viewing optimization of LifeQuest Heater also provides exceptional graphical visibility of coil flaws (see Figures 1 and 2, respectively).

LifeQuest Heater provides a complete analysis and assessment of a heater coil, utilizing API 579 industry standards. In addition to assessing current internal piping conditions, the software maintains the ability to manually or automatically import past operating conditions, inspection histories, and materials information, providing the industry’s most comprehensive analysis of coil life.

INSPECTION OF FIRED HEATERS WITH PLUG HEADERS:

Fired heaters, such as coker heaters, may contain plug headers (see figure 3) in order to allow access to the serpentine coil interior without cutting off a return bend. This access is sometimes
necessary in order to achieve recirculation in the event that flow through the coil becomes blocked, and circulation is not achievable at the optimal flow rate. Historically, the presence of plug headers has posed a major challenge to the inspection process due to difficulty in navigating the fittings. In past years, plant operators have needed to install specially shaped radial inserts in order for an inspection tool to navigate through a heater with plug headers.

Advances in Quest Integrity’s technology have increased the capabilities of the tool and extended the benefits of ultrasonic intelligent pigging to heater coils containing plug headers – without the need for radial inserts. This technology advancement opens up critical heaters in fouling services, such as cokers. Now, creep and metal loss damage mechanisms commonly seen in these services can be more accurately quantified, allowing for fitness-for-service and tube retirement planning.

This critical technological advancement allows for tool navigation of plug headers (see Figure 3), mitigating the need for most pre-inspection modifications. This eliminates the installation of radial inserts and provides increased inspection efficiency, allowing for optimal use of resources and cost-reduction.

**CONCLUSION:**

The use of ultrasonic-based pigging technology in the inspection of serpentine coils is vitally important for the life of a fired heater. With the advancement of

---

*Figure 2. Remaining Life Data*

*Figure 3. Plug Header*