GLOBAL REFINING INDUSTRY EMBRACES APPROACH OF UTILIZING ULTRASONIC INTELLIGENT PIGGING INSPECTION TECHNOLOGY COMBINED WITH API-579 / ASME FFS-1 REMAINING LIFE ASSESSMENT METHODOLOGY FOR PROACTIVE MANAGEMENT OF FIRED HEATER COILS

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ABSTRACT. The refining industry has been applying ultrasonic based intelligent pigging to inspect serpentine coils in fired heaters since the late 1990s. Many plants have reduced the practice of applying manual NDE spot checks and now use ultrasonic based intelligent pigging. Best practices now recommend the use of ultrasonic based intelligent pigging as part of their heater management programs.

Remaining life assessment approaches have evolved in parallel to the inspection approach. With the latest release of the API-579/ASME FFS-1 Standard, a comprehensive evaluation can be performed while considering the interactive effect of corrosion, erosion, creep, and other damage mechanisms. Software has been developed to automatically utilizing 100% of the ultrasonic inspection data in the complex calculations.
INTRODUCTION

The refining industry has been applying ultrasonic based intelligent pigging to inspect serpentine coils in fired heaters since the 1990s. Today thousands of serpentine coils in fired heaters are inspected annually at process facilities around the globe, utilizing the advanced FTIS™ technology. Many plants have drastically reduced or completely eliminated the practice of applying manual NDE spot checks (e.g. ultrasonic, diametrical tube strapping, etc.) and now apply ultrasonic-based intelligent pigging as a matter of routine practice. Based on years of experience and success, many corporate best practice guidelines within major refinery and chemical facilities mandate the use of ultrasonic based intelligent pigging as a significant component of their standard heater management program. These changes are easily justified considering the increased inspection coverage, accuracy of test results, repeatability of test results and time required to complete inspection of a heaters coils. Industry accepted recommended practices such as RP API-573 have also acknowledged and documented the benefits of applying intelligent pigging as part of a heater inspection program.

THE CHALLENGE

Serpentine coils in heaters are a challenge to properly inspect when applying conventional Non-Destructive Testing (NDT) approaches. Limited access to the Convection section within the coil combined with external raised surfaces (i.e. Fins, Studs) make this portion of the coil nearly impossible to inspect. Within the coil’s Radiant section it is also common for external scale (see Figure 1) to build up on the exterior surface, limiting the effectiveness of both visual and contact NDT approaches. Use of the internal FTIS ultrasonic based intelligent pigging provides an alternative which eliminates the challenges associated with most of these features.

THE TECHNOLOGY

The evolution of the FTIS intelligent pigging technology has been continuous since its introduction in the 1990s. When the technology first surfaced within the refining and
petrochemical markets, inspection coverage, resolution and accuracy was limited at best. Today’s advanced models contain dozens of fixed mounted ultrasonic transducers mounted in each tool, ensuring that 100% overlapping inspection coverage is achieved. Advancements in ultrasonic transducer technologies, signal processing software and high speed electronics have had a significant positive impact on both resolution and accuracy. The combinations of all noted advancements have evolved the technology beyond what anyone originally thought obtainable (see Figure 2).

FIGURE 2. FTIS TOOL IN COIL

The initial FTIS tool design in the 1990s contained limited ultrasonic (UT) sensors, sometimes as few as 8-16 per tool. The limited number of UT sensors mounted within the early prototype systems provided limited inspection coverage (20-30%) of the heater coil’s surface, which resulted in the inability to detect small flaws such as fretting, pitting, etc. In reality, the earlier versions of the FTIS tools were nothing more than a glorified thickness measurement device, which were very poor at detecting flaws unless the physical size of the flaw encompassed a very large surface area. Today’s advanced FTIS tool designs contain significantly more sensors (e.g. 48 – 288, depending upon tool size), ensuring 100% overlapping inspection coverage. Ultrasonic based intelligent pigs with this number of UT sensors provide a much higher level of assurance that small flaws such as fretting and pitting are detected.

DATA ANALYSIS SOFTWARE

There have also been significant improvements within the data processing software, used to analyze the inspection data as well as present it in several useful intuitive formats. Millions upon millions of ultrasonic data points (between 7,000 – 35,000 per meter) captured over the full length of a fired heater’s serpentine coil are easily converted into two-dimensional (2D) and three-dimensional (3D) and other high resolution graphical models, clearly illustrating the areas of concern visually within the coil as well as general degradation patterns, regardless of severity (see Figures 3 and 4). Additionally, individual data points can be exported at selected positioning intervals allowing engineers to drill down and interrogate the data as required.
REMAINING LIFE ASSESSMENT

Remaining life assessment and fitness for service approaches have evolved in parallel with the inspection technology. With the latest release of the API-579/ASME FFS-1 Standard, a comprehensive evaluation can be performed while considering the interactive effect of corrosion, erosion, creep and other damage mechanisms. The LifeQuest™ Heater software was developed to automatically apply the API-579 / ASME FFS standards, utilizing 100% of the ultrasonic inspection data within the complex calculations. This is the most advanced and comprehensive RLA/FFS approach applied in the industry today.

Capturing inspection data which encompasses 100% of the piping coil can lose a significant portion of its value if not utilized properly. The LifeQuest Heater software is capable of importing 100% of the inspection data. Fitness-for-Service (FFS) and Remaining Life Assessment (RLA) calculations are then performed in accordance with API-579/ASME FFS-1 (see Figures 5 and 6, Remaining Life Assessment 2D Views). Plant reliability engineers then have the necessary confidence to make necessary repairs or extend run times. To ensure plant engineers are armed with the most advanced remaining life assessment software on the market today, several refineries have elected to incorporate LifeQuest Heater software as part of their day-to-day engineering software packages.
REFERENCES

1. R. Paul Dr., NEXT Energy New Horizons – Out of Pipe Thinking, Chevron, San Ramon California USA, 2008, pp. 1-3

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