Digital Asset Integrity Monitoring Program Yields >$4M Win with Asset Life Extension in SRU

The Problem: One of the more critical areas for refineries to be able to manage and maintain from an Environmental Compliance and Safety perspective is the Amine Treating Unit, often part of Sulfur Recovery and Tail Gas Treating Units (SRU and TGCU) (Figure 1). The TGTU is designed to convert the minimal remaining sulfur compounds, not converted originally in the SRU, into hydrogen sulfide (H2S), which is then reprocessed by the SRU. The SRU tail gas is heated and sent to a catalytic reactor where it is cooled and sent to the absorber column in the Amine Treating Unit (ATU) where amine removes the H2S and some CO2. It is during this and succeeding processes where many find corrosion/erosion events which can cause setbacks in asset integrity planning (See Simplified PFD).

Figure 1: SRU & Tail Gas

During the Amine Treating process, the "sour" gas (H2S or CO "rich") counter flows the clean ("lean") amine liquid and absorbs the gases. In this continuous cycle, corrosion may occur due to high Heat Stable Amine Salts (HSAS) that will form over time. In addition to this mechanical erosion damage, other areas may "flash" gases due to pressure drops and cause severe highly localized piping wall loss. As suggested in industry Recommended Practice API 571, HSAS above 2 wt.% may cause corrosion high rates and depending on velocity, this may occur at lower concentrations and higher flow rates. H2S is corrosive because they lower the pH, increase solution conductivity, and can destabilize the protective sulfide layer (film) in equipment/piping. HSAS, in high flow or coupled with areas of high turbulence/changes in flow also cause tremendous, localized wall loss erosion-corrosion. In this case, it was determined that the design of a nozzle in the horizontal position of the exchanger is a bad industry design and causes turbulence (eddy's) that increase the corrosion rate in specific areas.

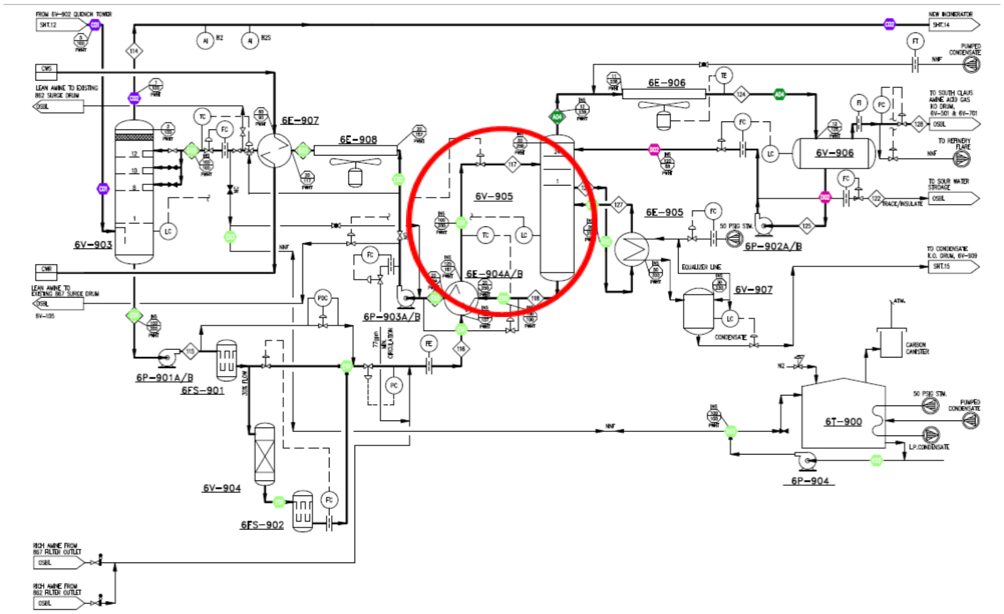

Figure 2: Piping & instrumentation diagram with affected areas highlighted

<u>The Solution</u>: Due to the intermittent nature of this erosion-corrosion damage mechanism, achieving reliable corrosion rate and zeroing-in on the most likely affected locations, can be challenging. After years of repeated manual ultrasonic thickness inspection at different intervals with limited success which ultimately resulted in unplanned leaks and downtime, the asset owner decided it was time to go in a different direction. Instead of a periodic manual inspection approach, they decided to monitor. This asset owner, using the help of the inspection, corrosion, and operations teams, mapped out the most likely areas of concern and performed some baseline screening/inspection to identify where to monitor. Then, using automated, wireless, battery-operated Ultrasonic (UT) sensors, which were temporarily installed at strategic locations on the asset, the asset owner was able to program reading intervals for the sensors to take daily wall thickness measurements which were then plotted over time. The installation process took only one day and each sensor was installed in <20 mins per location by their own site personnel after being trained on the first few designated monitoring locations. Figure 3 below depicts the data which was collected over the course of a year.

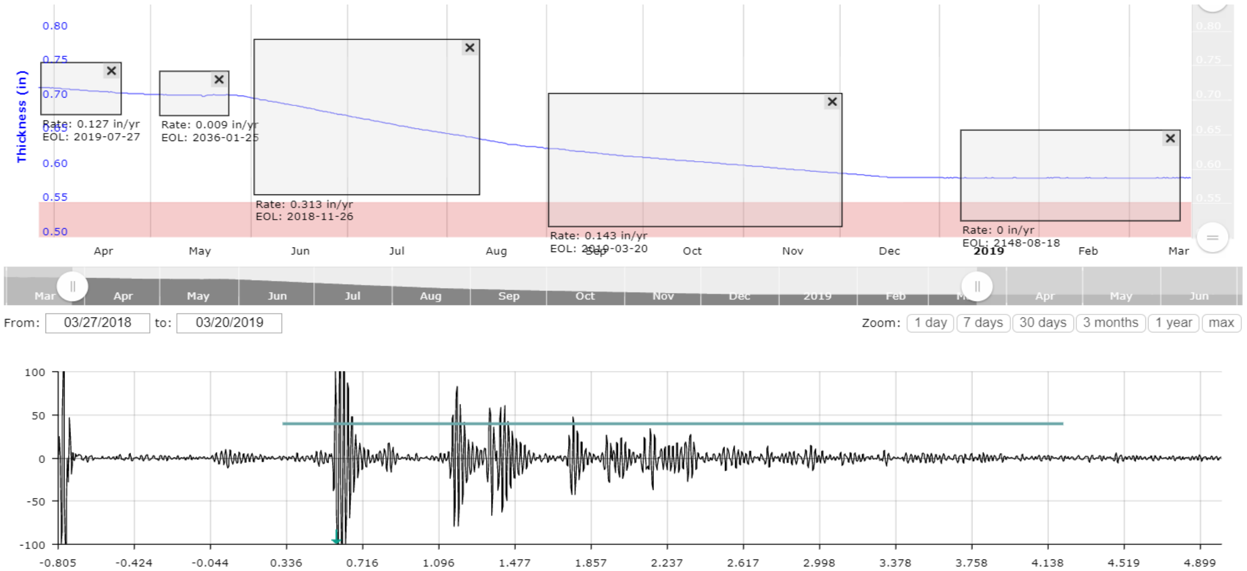

Figure 3: Upper graph: Thickness data (Y-axis) collected over twelve months (x-axis). Lower graph shows Ultrasonic wave form for to make precise (+/1 .001") thickness readings from sensor

The Outcome: Using the monitoring approach via installing wireless UT sensors, the asset owner was able to quickly (about one month) and accurately (to within .001") trend the corrosion rate at each point where the sensor was located. Further, with the help of the operations and corrosion teams, the asset owner was able to tweak process parameters to remediate or reduce the corrosion at this location of the unit. See below in figure 4, a picture of one of the wireless UT sensors.

Figure 4: Wireless UT

Financial Impact: Since the unit was built, there have been 6+ unplanned outages over a 15-year period which have been traced back to this issue at an estimated $12M in maintenance cost and $200M in down time. The ability to trend, and in this case, remediate the corrosion rate for the tail gas unit allowed the asset owner to safely operate the unit for an estimated 4.62 additional years saving maintenance activities for this unit an estimated $4.8M. A $40K investment in a microPIMS starter kit yielded an ROI of 98% and payback period of <3 months. The rest of the site can also now benefit from the long range wireless infrastructure investment and place sensors across the entire facility to monitor other critical assets. By scaling this strategy across their facility, this refiner expects to expand their digital asset integrity and monitoring program to identify many locations with the potential of safely extending the life of their assets with the goal to save millions of maintenance dollars annually.