Question 82: Have any of your FCC units observed extensive corrosion in carbon steel piping operating below500°F, particularly in the slurry circuit? What are your typical corrosion mechanisms? What metallurgies would you deem acceptable for high-temperature, high-sulfur streams?

WELLS (LyondellBasell Industries, Houston Refinery)

We have not seen any issues with piping below 500°F. Sulfidic corrosion is the typical mechanism about which to worry with regard to hot streams containing sulfur, such as FCCU feed and slurry. API Recommended Practice 939C should be referenced for sulfidic corrosion. There, you will also find the modified McConomy curves that will show you the expected corrosion rates for different metallurgies versus operating temperature and sulfur concentration.

THRAEN (Flint Hills Resources, LP)

For an FCC processing hydrotreated feed, corrosion rates less than 10 mpy (mils per year, i.e., thousandths of an inch per year) should be expected in carbon steel operating below 550°F in the heavy oil circuits. However, there is a concern for any carbon steel piping components that may contain low silicon in these hot oil circuits. Below 0.1 wt % Si content, sulfidic corrosion behavior of the carbon steel is highly variable and can be four to 10 times higher. At higher temperatures, chrome piping is typically selected. Generally, 9 Cr is specified, although there are some older piping systems that are 5 Cr (Note: Many refiners now shy away from 5 Cr because it has also been found to have varying corrosion resistance in these services). For FCC product piping, the corrosion mechanism is generally sulfidic with erosion corrosion as a potential concern at high velocities. Sulfidic corrosion is also the primary corrosion mechanism for the FCC feed circuit, with the additional concern for naphthenic acid corrosion if processing non-hydrotreated feed. Different alloys can be used depending on the temperature and contaminant levels. For hot piping with significant TAN, the piping will generally need to be solid nickel alloy (e.g., Alloy 825) or clad/weld overlaid with a molybdenum containing stainless steel (e.g., 316 or 317). With weld overlay systems, special care must be taken to ensure rigorous QA/QC, especially at small bore piping connections and other pipe fittings. Solid 300 series stainless piping has the added risk of chloride and polythionic stress corrosion cracking, so care must be taken to properly mitigate at shutdowns/startups.

Chlorides

Mechanical

Process

Reliability

Year

2016