Application Note

Corrosion Monitoring in Crude Unit Distillation Tower Overhead Systems

Gone are the days of sweet crude and simple solutions for overhead corrosion control. With declining crude quality and the high profit potential of using opportunity crudes, refiners now face a difficult balancing act of determining the optimum combination of crude blends, unit operations, corrosion control programs and unit maintenance to achieve the highest return on investment (ROI).

Crude Distillation Unit (CDU) Overhead Corrosion Issues

[1]Crude oil contains varying amounts of chloride salts (i.e. mainly $CaCl_2$, $MgCl_2$, NaCl) that forms HCl due to hydrolysis during heating in the CDU preheat train and associated furnaces. Because presence of a liquid water phase is required, hydrochloric acid corrosion is usually confined to the CDU distillation tower overhead equipment where water is condensed. The most corrosive conditions occur at the initial aqueous dew point, where the majority of the HCl readily enters the first water phase that forms.

Other acid gases like H_2S, light organic acids, CO_2, SO_X-based acids are also present in overhead systems. H_2S can accelerate hydrochloric acid corrosion in unneutralized or low pH conditions. Carbonic acid (H_2CO_3) is formed when CO_2 dissolves in water. Rough surfaces are usually characteristic of wet CO_2 corrosion when compared to the relatively uniform, smooth appearance associated with corrosion by stronger acids such as hydrochloric acid. SO_X-based acids, including sulfurous acid (H_2SO_3) and sulfuric acids (H2SO4) are strong and similar to hydrochloric acid in their corrosiveness; consequently, their control or elimination is usually desirable.

Other types of salts formed in the process are NH_4Cl and Amine hydrochloride salts in CDU distillation tower overhead systems. These salts are hygroscopic and their

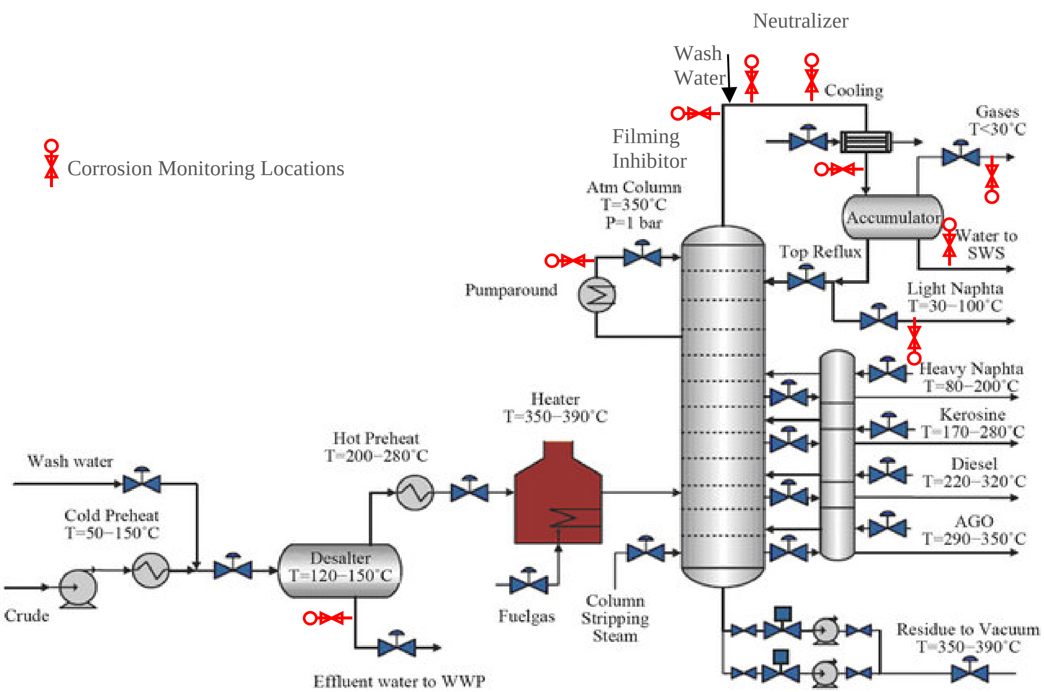

Figure 1. Typical Corrosion Monitoring Locations in Crude Distillation Tower Overhead System

deposition and corrosion often occur in the top of the CDU distillation tower, as well as in the tower overhead systems including the overhead piping, overhead condensers, overhead drums, and reflux piping.

Since various corrosive species cause corrosion in different sections of the crude distillation tower overhead system, a successful CDU tower overhead system corrosion monitoring program typically incorporates inspection, online corrosion monitoring, modeling and process stream analysis.

Online Corrosion Monitoring Scheme in Crude Distillation Tower Overhead System

The subject of online corrosion monitoring of CDU distillation tower overhead systems has been discussed in numerous publications for over twenty years[2]. Online corrosion monitoring is generally considered complementary to process stream analysis and also normally used to assess the success of corrosion mitigation methods, including crude oil desalting and blending, neutralization and inhibition, and water washing of deposits. With the use of online corrosion monitoring systems, corrosion rate data from remote probes can now be sent to an existing process control system (e.g. DCS, PLC) for process correlated analysis to identify the root cause of critical corrosion events.

Online corrosion monitoring of CDU distillation tower overhead systems is complex primarily because of the difficulty of predicting the location of aqueous condensation or deposition of salts. Online corrosion monitoring at locations exposed to the accumulated condensed water can be informative; however, there conditions typically do not represent those in the overhead piping systems, particularly those at the aqueous dew point locations where first condensation and mixing with acidic vapors occurs. At the aqueous dew point, pH and the presence of acidic vapors and salt films can produce significantly higher corrosion rates and pitting activities than in the accumulated condensate.

The most comprehensive approach to online corrosion monitoring is to use multiple locations in the condensing overhead streams (as shown in Figure 1). With the use of multiple locations the majority of the overhead system can be covered, the changes in corrosion rate at these locations can be monitored, and a corrosion mitigation strategy can be implemented.

Traditionally, corrosion coupons were used to monitor corrosion in crude unit overhead systems. Coupons can provide additional data from visual inspection, but since its assessment period is typically in months they cannot provide the necessary corrosion rate data in real time that are required for immediate actions. Advancements in online corrosion monitoring technologies (specifically High Resolution ER - **Metal Samples' ultra-high resolution CorrVelox system -** and electrochemical technology) now enable corrosion rates to be measured at various important locations in an online, near real-time manner. Also, with the integration of corrosion rate data to plant process control system (DCS), process correlated analysis with other operating parameters helps unit operators and corrosion engineers to find the root cause of corrosion problems.

Traditional MS2500E/MS3500E ER corrosion monitoring systems and the advanced ultra-high resolution CorrVelox system are the most suitable techniques for corrosion monitoring in crude unit overhead systems since they operate in hydrocarbon gas or liquid applications. MS2500L/MS3500L electrochemical corrosion monitoring systems can be used in SWS service applications in overhead separator bottoms.

The primary advantage of implementing CorrVelox ultra-high resolution ER systems and MS3500L LPR corrosion monitoring systems at various locations in CDU tower overhead systems is that they provide regular and preferably continuous information of the change in corrosion rate to the plant operators in a timely manner to enable control of inhibitor additions and assist in plant optimization.

References:

1. NACE 34109 (2009 Edition), Crude Distillation Unit—Distillation Tower Overhead System Corrosion
2. H.U.Schutt and R.J.Horvath, "Crude Column Overhead Corrosion Problem Caused by Oxidized Sulfur Species,: CORROSION/87, paper no. 198 (Houston, TX: NACE, 1987)

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