

COUNTERING CORROSION

John B. Sabey, ProSep, USA, discusses how injection mixers can be optimised to target the root causes of overhead corrosion.



Enduring market demand for fuels and other distillate products continues to influence refinery unit operations, product selection, pricing and margins. The ever-increasing demand for low sulfur products pressures refineries to maximise distillate production in their atmospheric and vacuum distillation units. Maximising the production of these fuels causes refinery operations teams to continually evaluate their process system for mechanical and process integrity to ensure reliable production of those distillate products. To maximise product draws from the distillate sections of their columns, refiners often reduce the temperature at the top of the tower. However, the lower temperatures create the conditions in which salt fouling and corrosion mechanisms occur.

The primary cause of the corrosion in the crude unit overhead system is acid attack at the initial water condensation point. The secondary corrosion mechanisms are due to under-deposit corrosion resulting from amine-chloride salt deposition in the tower top and overhead lines. Often, neutralisers are used to control the pH of the condensing waters to minimise corrosion rates and salt deposition caused by the neutralisation reaction with the acidic species. The temperature at which the first neutralisation salts form from the vapour phase is known as the salt point. These salts tend to be very corrosive themselves and contribute to under-deposit corrosion as well. To combat the deposition and corrosivity of these salts, a water wash is often employed to both dilute and wash



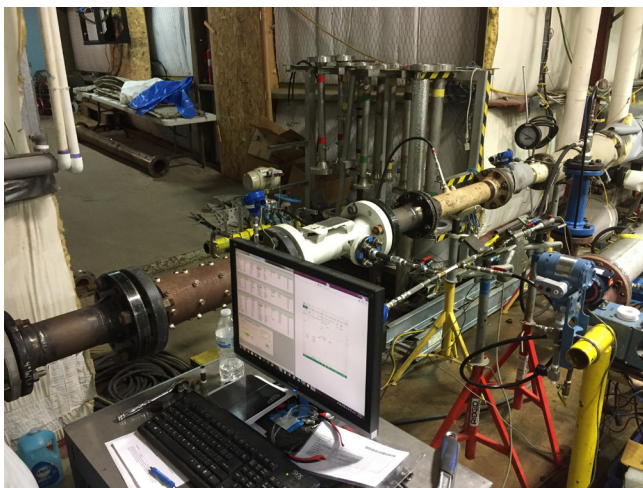


Figure 1. CEESI hot gas flow loop test set-up.

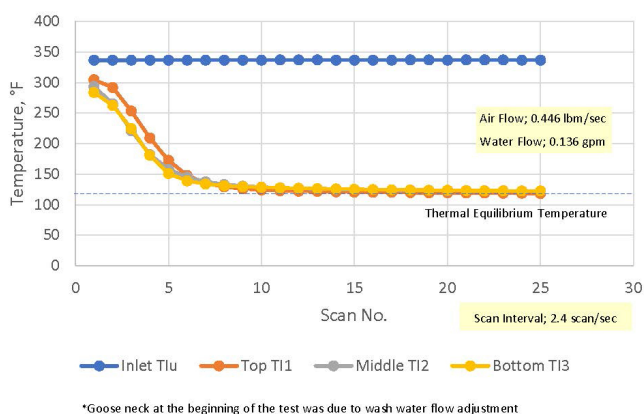


Figure 2. Temperature vs time plot showing uniform temperature and thermal equilibrium condition.

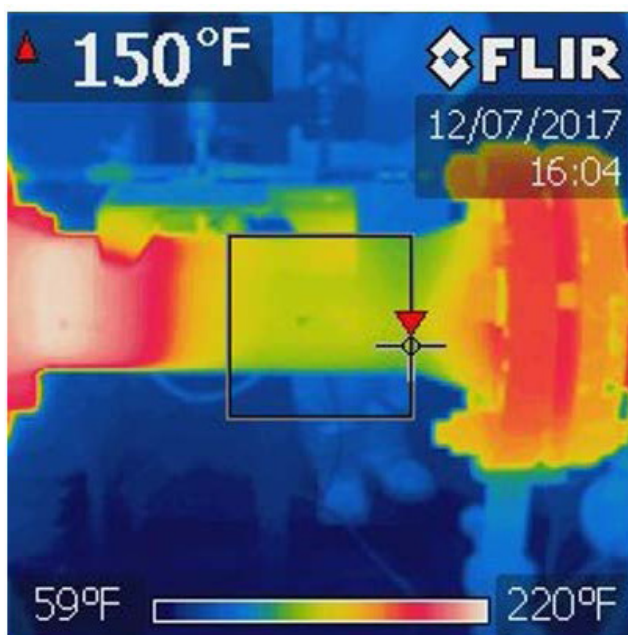


Figure 3. Thermal image of ECLIPSE illustrating the sharp thermal transition at the injection point.

these salts from the overhead line. However, these water wash systems have been found wanting because of poor distribution and resultantly poor collection of ionic species.

Field and flow loop results

Chlorides are the dominant corrosion-contributing constituent of distillation towers in refineries. The principal process unit for controlling the chloride content of crude charge is the refinery's desalter. Use of ProSep's MAX+ (Multiphase Adjustable eXtreme Mixer with AIM injection) desalting mixer has demonstrated significant reduction of dry crude salt content by 20 – 60%. This has led the company to evaluate the application of its injection mixer technologies in other downstream applications. Several mixers have been identified as potential solutions for improving the performance of the wash water systems in atmospheric and vacuum distillation overhead lines as well as hydrotreater process units.

To verify the potential benefits of these injection mixers for distillation overhead water washing, ProSep was contracted by a US refiner to conduct a study of the effectiveness of an ECLIPSE (Enhanced Center Located Injection Pipe Spool Element) injection mixer. The goal of the testing was to demonstrate the effectiveness of the injection mixer in cooling hot gas with water to the theoretical equilibrium temperature of the two phases in less time than the current atomiser and injection quill performance. Utilising a 4 in. mixer with 300°F hot air as the main process stream and 100°F injected water for cooling, the company conducted flow loop testing where the hot air and water injection rates were varied and the resultant steady state temperatures were monitored and compared to theoretical steady state values. The testing was conducted at the Colorado Engineering Equipment Station in Nunn, Colorado, US. The test setup included inlet flowmeters and temperature probes (thermocouples) for both the hot air and wash water stream, the test unit itself, and three downstream thermocouples: one at half the diameter of the pipe (top mount), another at a quarter of the pipe diameter (side mount) and the third at one eighth of the diameter (bottom mount) for determining the temperature profile of the pipe cross section. These thermocouples were mounted in the process piping just downstream of the mixer. Thermal imaging was also used to assess the effect of the wash water. The test setup is illustrated in Figure 1.

The results of the testing confirmed the effectiveness of the injection mixer to thoroughly disperse the wash water to achieve and maintain thermal equilibrium across the full cross section of the pipe within three pipe diameters of the injection point. This was confirmed by the thermocouple values. A typical temperature vs time graph from the testing is illustrated in Figure 2, with the theoretical equilibrium temperature indicated as well. As shown on the graph, the measured temperature reached a steady state

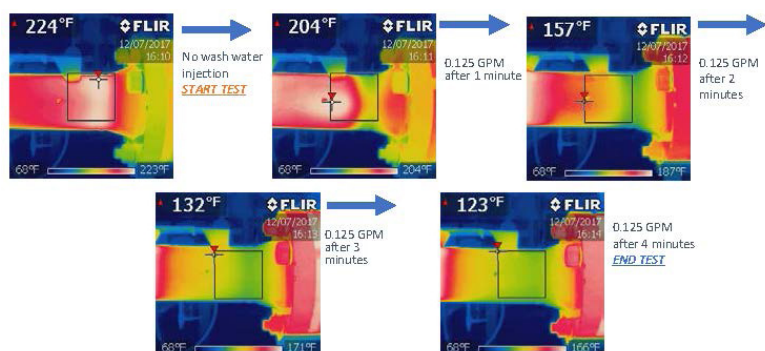


Figure 4. Thermal images illustrating thermal transition with quench water.

temperature lower than the theoretical calculated value.

Thermal imaging of the mixer illustrated a sharp demarcation of temperature across the injection point in Figure 3.


The series of thermal images shown in Figure 4 illustrates the injection mixer's ability to achieve uniform dispersion and mixing of the injected phase. Recording the thermal profile over time, the mixer body reached a thermal equilibrium skin temperature in less than 5 min. after introducing wash water.

The refinery client that sponsored the study commented that the ProSep ECLIPSE injection mixer

has the potential to fundamentally change atmospheric and vacuum distillation column overhead water wash systems as well as hydrotreater water wash operations, because of the performance observed during thermal equilibrium testing. ProSep anticipates installing the first AIM mixer in hydrotreater service later this year.

Conclusion

Naturally occurring salts and acids found in crude oils are detrimental to refinery distillation and hydrotreating operations. A unique injection, dispersion and homogeneous mixing device has been

demonstrated to enhance the effectiveness of wash or quench water in flow loop testing. This article provides an overview of refinery corrosion issues, describes the flow loop testing and presents promising results that may prove beneficial for countering refinery corrosion issues. 

Bibliography

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