HPC INDUSTRIAL POWERED BY CLEAN HARBORS

Case Study ULTRASONIC CHEMICAL CLEANING

Foulants Reduce Effective Heat Transfer – and Cost Money

A hydrocracker is a specialized unit in some refineries that takes low-quality, heavy-gas oils and converts them to high-quality, clean-burning fuels through a series of catalytic reactions. Our client was using a set of stainless steel, twisted-type, shell-and-tube heat exchangers in the unit, which they had been unable to clean since their installation 15 years prior. On the tube side, the reactor effluent resulted in a layer of inorganic pyrophoric iron sulfide scale, posing significant danger when exposed to air. On the shell side, the reactor feed resulted in the formation of a polymeric organic olefin fouling, which ranged in consistency from sticky and gummy on the lower temperature units to a hard crystalline foulant on the higher temperature units. Both foulant types are insulating materials, and the inability to clean them was significantly compromising the heat transfer efficiencies on this unit.

Prior attempts to clean this unit focused on the use of traditional hydroblasting techniques or chemical cleaning. During a 2015 outage, the client decided to combine these techniques to try and regain some efficiencies. They used solvent-based degreaser to chemical clean and decontaminate the unit. They circulated the solvent for 48 hours – with no observable results from the flush – before pulling the exchangers, disassembling them and moving to the hydroblast stage for the remainder of the outage. For the remaining 14 days of the turnaround, hydroblasting techniques were applied to the exchangers with little success. The net result was unsatisfactory, as the heat exchangers were returned to service incompletely clean.

Additional Benefits of Ultrasonic Cleaning: Post-Project Observations

- **Due to increased efficiency in heat transfer, engineers throttled back the furnace by 50%, saving on fuel gas.**
- **An impressive savings of $110M in fuel gas consumption throughout the run was estimated, based on current fuel prices and a reduction of 38.5M gallons of fuel gas during the 3.5 year run between the 2020 and 2024 outages.**
- **The reduction in fuel gas consumption equates to a reduction in greenhouse gas emissions of approximately 733 million pounds, of which the primary contributor is CO2.**
- **During previous runs, it was vital that a mid-run maintenance flush be conducted to maintain volume throughput and gain some heat transfer capacity. However, post ultrasonic cleaning, this mid-run outage was unnecessary and resulted in extended run-time for the hydrocracker unit.**
- **The customer estimated the extended run-time saved approximately $6 million in lost profit by eliminating the mid-run maintenance flush.**

Our Solution: Ultrasonic Cleaning

Ultrasonic Immersion Technology greatly enhances the cleaning results on heat exchangers and other industrial equipment; it combines both chemical and mechanical cleaning methods to remove stuck-on fouling while reaching all interstitial parts of the equipment simultaneously.

Our Clean Harbors proprietary chemical line, Paratene®, was tested against samples of the foulant material and a custom solution was developed for this client that assisted in the removal of both foulant types: inorganic scale and organic deposits. This custom chemical solution was a combination of our base degreasing blend and some low-volume additives to boost dispersion and wettability and prevent the formation of hydrogen sulfide (H2S).

For each of the four twisted-type exchangers cleaned during this project, an ultrasonic treatment of 12 hours was applied to the bundles, followed by 10,000 psi hydroblasting for two hours on the tube side and four hours on the shell side. Faster return to service allowed for less downtime and elimination of the bottleneck around this critical path item. But best of all, the bundles were returned to service in a better than 95% clean state, bringing the exchangers back to peak performance and improving heat transfer efficiencies.

Before

After

Before

After