Oil Refineries Utilize GE Cooling Water Cleaning Technology

Challenge

Despite excellent overall cooling water treatment performance, Refineries can have difficulties with individual cooling water exchanger's for a number of reasons. The performance of these exchangers is compromised for a variety of reasons. Some of the most common exchanger performance issues include:

- High cooling water outlet temperatures (>160°F [71.1°C]) caused by very hot process side conditions and/or cooling water pinched valves.
- Debris, such as wood and plastic, causing low water flow. The low water flow sets up deposition conditions that essentially cements the debris in place.
- Low water pressure at the exchanger inlet causing low water flow. A significant contributor is pressure drop caused by long term scale accumulation in the supply headers and small diameter supply piping.

In today's business environment, the challenge for the refiner is to regain performance from the affected exchangers while incurring the least amount of down time. Mechanical cleaning of an exchanger can mean a unit shutdown or at least a rate reduction. Alternatives to mechanical cleaning include backwashing and/or air rumbling, but if the problem is not resolved by these measures the refiner is left with looking for other alternatives to mechanical cleaning.

Solution

GE Water & Process Technologies online chemical cleaning solutions have successfully cleaned cooling water exchangers and kept them clean.

Although every situation is different, GE has a number of technologies and the experience to provide the refiner with alternatives that could help alleviate the immediate problem. Some situations might not have a chemical cleaning solution, but many do. GE can develop the best solutions for the individual situation and needs of the refiner and cooling system.

This case study describes three different cleaning strategies GE has implemented in Refineries. Each strategy required a team approach between the refiner and the GE representative to identify the problem and come up with an appropriate cleaning strategy. These three strategies provide only a sampling of the many different chemical-cleaning solutions GE has to offer.

Online cleaning does have the risk of generating and moving "chip scale" leading to the blocking of exchanger tubes and scaling and corrosion issues. Experience is the key to providing and managing a cleaning program designed to minimize these kinds of risks. The goal is to provide a cleaning program that is far superior, in terms of risk and efficacy compared to the traditional chemical acid clean.

Case History 1

A US West Coast refinery was experiencing an increase in their vacuum tower overhead temperatures, which resulted in overhead gas flow issues. These issues caused a production bottleneck for the refinery. A complete flow survey of the cooling system identified a system water flow rate shortfall. Portable flow meter measurements of the water flow to the condensers determined that the second stage condenser, due to its location and elevation, had chronic low water flow.

Find a contact near you by visiting gewater.com or e-mailing custhelp@ge.com.

Global Headquarters
Trevose, PA
+1-215-355-3300

Americas
Watertown, MA
+1-617-926-2500

Europe/Middle East/Africa
Heverlee, Belgium
+32-16-40-20-00

Asia/Pacific
Shanghai, China
+86 (0) 411-8366-6489

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This exchanger would perform well immediately after a mechanical cleaning, but the low water flow along with record high operating rates caused deposition. Based on the cooling water chemistry and conditions, a deposit composition was theorized and a chemical cleaning strategy was developed.

GE designed a program where the chemical was injected upstream of the condenser. Testing was conducted throughout the cooling water system to control both the chemical feed rate and chemical feed duration. The chemical cleaning duration would be shutdown based on predetermined chemistry limits. This allowed the system to recover before the cleaning resumed.

Over a number cleaning treatments conducted over a number of days, the benefit to the refiner was that the vacuum tower overhead temperature decreased by 10°F to 12°F (-12°C to -11°C. The cleaning procedure was stopped when there was an insignificant change in chemistry across the exchanger. The successful cleaning allowed the refiner to continue to operate at the record high rates until the planned refinery turnaround. During the turnaround, the cooling water recirculation pumps were scheduled for overhauling to improve flow to the condenser.

Case History 2

A set of critical condensing exchangers in a Sulfuric Acid Alkylation plant and Butamer plant in a US West Coast Refinery was negatively impacting production. The exchangers had been prone to fouling for years with wood chips because of the work performed on the tower and the flow conditions within the equipment.

Previous turnarounds showed that the exchangers were fouled with wood from the cooling tower as seen in this shutdown photo (Figure 1).

This heavy fouling causes over a 50% reduction in cooling water flow over the course of 18 months that is much less than the planned turnaround cycle. Also, the loss of exchanger cooling capacity was causing a reduction in refinery product recovery from the Alky Unit.

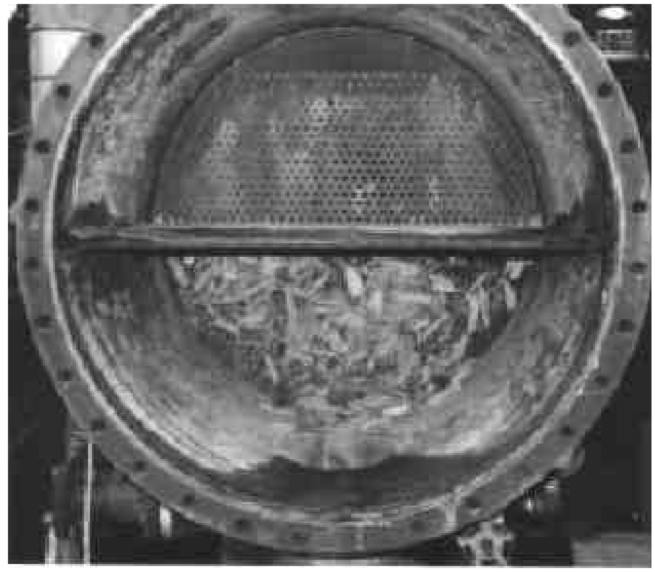

Figure 1: Exchanger Opening from Shutdown

During the most recent run in 2005, the cooling water flow to this exchanger was once again in decline and back flushing alone was not improving the flow. It was theorized by GE that the fouling was becoming cemented in place because the fouling led to low flow conditions leading to deposition.

GE Representatives developed an online chemical cleaning technology that could be incorporated into the back flush procedures. The application of this cleaning technology resulted the cooling water flow increasing a net of 525 gpm (2 m^3/hr), from 730 to 1,255 gpm (3 to 5 m^3/hr), over the course of 2 days. This successful unique cleaning solution resulted in the refiner being able to restore normal product recoveries for the units.

Case History 3

A US West coast refinery has been operating for approximately 50 years with the same cooling headers and piping system. During that time, it had accumulated a significant amount of scale and deposits in the system. This was causing system pressure drop impeding flow throughout the system. The flow through small pipe services such as pump gland coolers was the most affected, but also some large critical exchangers were suffering from reduced flow.

GE recommended an on-line chemical clean up of the entire system utilizing new slow acting cleaning technology. The slow cleaning technology was proposed to minimize the risk of developing large chip scale from the supply headers that might directly

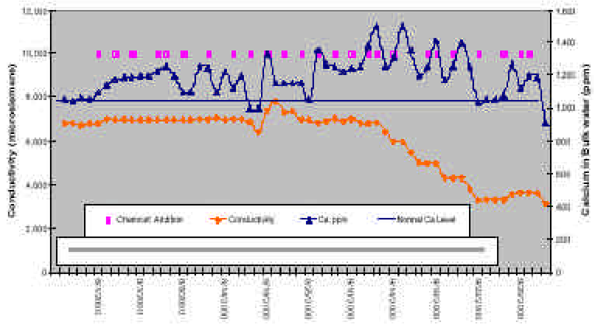

Figure 2: Refinery System Cleaning

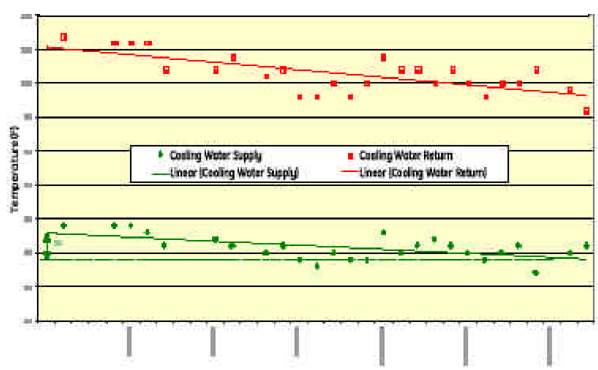

Figure 3: CW Temperatures

foul downstream exchangers while protecting the system during the cleaning process. The cleaning program would be implemented over about a month's period of time.

The GE representative managed the cleaning program, adjusting chemical feed frequency and cooling water chemistry to keep system parameters within preset guidelines. One of the more reassuring aspects of this program was that, as the cleaning chemical was added the appearance of the Cooling water became clearer as opposed to more turbid, even at increased cooling water dissolved solids levels. In fact the cooling water became so much clearer than normal that the bottom of the cooling tower basin could be seen. The water clarity provided further evidence that the procedure was minimizing the risk of large amounts of scale sloughing off and causing exchanger plugging. The chemistry and exchanger operating conditions where monitored during and after the cleaning to confirm cleanliness.

Figure 2 shows the calcium in the bulk cooling water increased with the addition of the chemical. Management of the cleaning program limited the calcium level and conductivity of the cooling system. Over the course of the cleaning, the increase in calcium averaged 156 ppm (mg/L). Over the 60 days of cleaning applications, the calcium removed from the system was estimated to exceed 11,000 lbs (4.989.5 kg).

Assuming the calcium was approximately 25% of a typical cooling water deposit, it was estimated that over 30,000 lbs (13.608 kg) of deposits were blown down from the system during the clean.

During the turnaround that followed the cleaning, heat exchanger openings revealed that minimal to no high-pressure water wash cleanings were required. Also, maintenance workers observed that the pump-bearing cooling systems and small-bore piping were much cleaner.

Another benefit of the cleaning was that the cooling tower became cooler and more efficient as seen in Figure 3. The system wide cleaning also resulted in a cleaner tower deck and fill area. The benefit of the more efficient tower was an improvement in cooling water supply temperature of 4°F (-15.6°C).