GE
Water & Process Technologies

Case Study

Continuum* AEC Cooling Program Performs Under Severe Upset Conditions

Background

A Gulf Coast refinery was operating with an alkaline phosphate cooling water treatment with acid feed for pH control and gaseous chlorine for microbiological protection (Figure 1). The cooling water treatment program utilized boiler blowdown and blowdown from another cooling tower as sources of inorganic phosphate in combination with:

- Phosphonate for scale control
- Copolymer for calcium phosphate precipitation/deposition control
- Azole for brass corrosion control

Cooling tower makeup water is a combination of clarified river water, boiler blowdown and blowdown from another cooling tower. Boiler blowdown contributes 0.5 to 1 ppm (mg/L) orthophosphate to the cooling tower makeup requirements and cooling tower blowdown provides an additional 0.1 to 0.5 ppm (mg/L). The system has mild steel, brass, and stainless steel heat exchangers with both tube-side and low velocity shell-side cooling.

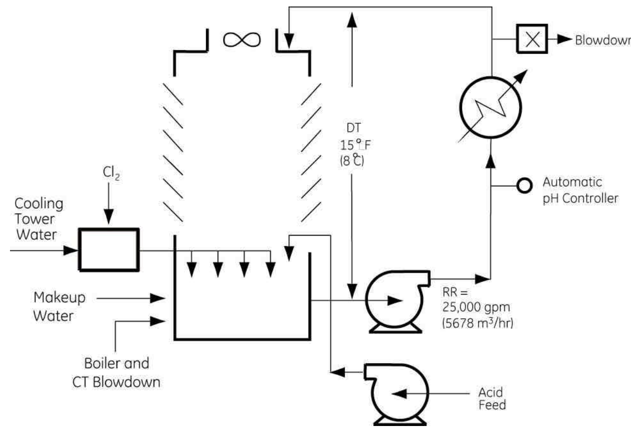

Figure 1: Cooling System Flow Diagram

Challenge

Corrosion rates averaged 0.5 mpy (0.013 mmpy) for mild steel and 0.2 mpy (0.005 mmpy) for brass; however, loss of heat transfer was experienced in hot process equipment because of calcium phosphate and phosphonate fouling.

Control of chlorine feed was a constant problem. High free chlorine residuals (>1 ppm [mg/L]) caused degradation of the phosphonate to orthophosphate, which increased the calcium phosphate fouling potential. Degraded phosphonate had to be replenished to prevent calcium carbonate fouling. This often caused overfeed of the phosphonate which led to calcium phosphonate deposition in hot exchanger bundles.

Occasionally acid feed was lost, resulting in a pH increase to dangerously high values. Because calcium carbonate supersaturation increases with pH and alkalinity, the phosphonate dosage had to be increased to prevent calcium carbonate scaling; however, fouling occurred.

Treatment rates had to be constantly adjusted depending on the upsets.

Solution: Continuum AEC

A Continuum AEC program was recommended as a replacement for the alkaline treatment program. The program is composed of:

- Patented alkyl epoxy carboxylate (AEC) chemistry, which is effective for calcium carbonate scale control and steel corrosion inhibition
- Copolymer for calcium phosphate deposition control
- Halogen Resistant Azole for yellow metal corrosion protection

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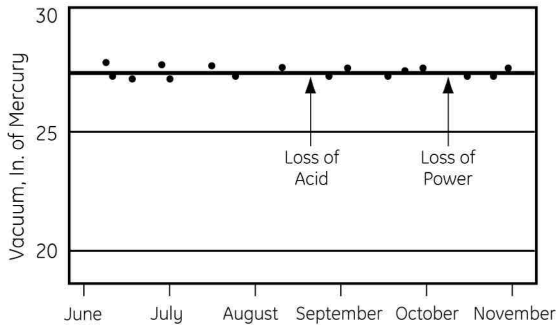

Figure 2: Continuum AEC program maintains heat transfer efficiency of process surface condenser that receives second-pass water from another unit.

A two-product treatment feed is used to maintain performance under upset conditions. All components are calcium tolerant; therefore, treatment dosages can be increased when needed without fouling heat transfer surfaces.

Results

- Fouling has been minimized without sacrificing corrosion control.
- Corrosion rates are consistantly 1 mpy (0.025 mmpy) or less for mild steel and 0.2 mpy (0.005 mmpy) or less for brass.
- High chlorine residuals have no effect on treatment performance.
- Clean heat transfer surfaces are maintained despite system upsets.

The Continuum AEC program demonstrates an unparalleled ability to respond to severe upsets that would cause fouling with traditional phosphonate-based alkaline programs. Results were excellent, even during prolonged periods without acid feed. Process equipment did not experience any loss of heat transfer efficiency after 10 days of operation at high pH (8.8 to 9.0).

Scaling was also successfully avoided on two occasions when electrical power to the tower fans and acid feed pumps was lost. The cooling tower supply water increased to over 110°F (43°C), exchanger exit water temperatures as high as 150°F (66°C) were recorded, and the pH increased to 8.9. Extremely high calcium carbonate and calcium phosphate supersaturation were encountered at these conditions without scaling, as shown in Figure 2.