

OMNI Heat Exchanger Reliability Helps Define Strategy to Avoid Downtime in a Texas VCM Plant



BACKGROUND

Vinyl chloride monomer (VCM) is the key chemical precursor to polyvinyl chloride (PVC). PVC is used in a wide range of commercially available products. VCM is produced commercially by reacting ethylene with elemental chlorine to create ethylene dichloride (EDC). The EDC is cracked to form VCM and several by-products (impurities). Critical in VCM production is the VCM purification process required to remove the impurities created during EDC cracking. Certain impurities are removed from the VCM stream through a low temperature process. In this process, propylene is used as a refrigerant to indirectly contact the VCM vapor and selectively condense impurities, which allows the impurities to be removed. The propylene refrigerant must be condensed as part of the refrigeration cycle.

SITUATION

The ability to prevent and proactively identify issues with critical heat exchangers is critical to achieving a reliable and profitable operation.

This customer produces more than 4 million pounds per day of VCM. The process is frequently affected by a critical condenser in the cooling water system: the propylene refrigerant condenser. This shell-and-tube heat exchanger is critical for maximizing process efficiency as it condenses the

CUSTOMER IMPACT



ECONOMIC RESULTS

Reduced unscheduled downtime due to cleanings and recover production during summer



Avoid production loss due to cleaning: \$818,182 per year

Recovered 10% nominal production: \$3,618,817 per year

Reduced maintenance cost by decreasing cleaning frequency from once every 1.5 years to an expected once every three years

\$50,000 per year

Increased asset life

\$25,000 per year

Reduced power consumption by using VFD in one circulating pump



Potential savings of \$528,023 per year

propylene in the refrigeration cycle. Once condensed, the propylene is flashed to create the temperatures required to remove impurities from the VCM product stream. If the propylene is not efficiently condensed, impurities are not removed effectively, and production slows or shutdowns result.

Indications of inefficient propylene condenser performance occur frequently. During the previous summer, the condenser forced unscheduled site downtime for cleaning (tube sheet trash and debris) after spending more than 90 days operating at a load reduction, about 10% of nominal capacity of the plant. Production loss was quantified about U\$3.6MM during that period of time.

The cleaning cost \$75K. More significantly, two days of site production were lost. According to site personnel, process variables such as propylene compressor discharge pressure and power consumption data are used as predictive tools for determining condenser performance. Other predictive tools, such as manual measurement of cooling water flow and cooling water and process temperatures are also used. However, due to the nature of the fouling, these indicators are not able to anticipate the problem as proactively as desired. A solution for early, proactive detection of propylene condenser fouling was desired.

SOLUTION

Nalco Water incorporated OMNI Heat Exchanger Reliability as part of the solution to proactively predict required corrective action.

OMNI Heat Exchanger Reliability is an innovative program which avoids production losses, enhances the reliability of the cooling water system, and increases the life cycle of critical customer assets. This is achieved by creating a stress profile of critical heat exchangers. Then, using non-invasive sensors and proprietary diagnostic tools, key performance indicators are continuously monitored, and treatment chemistry and mechanical conditions are optimized. Combining the performance data with our 3D TRASAR™ technology, performance reliability is guaranteed through our Microsoft-powered predictive analytics platform.

Once installed, OMNI calculated the water velocity and heat transfer coefficient (U value) on a continuous basis. During the first four months of operations, OMNI data identified a consistent cooling water flow decrease with no measurable impact on heat transfer efficiency (see figure 1).



Figure1. Variations of U value and Water velocity inside the Heat exchanger

Based on the historical issues at this site, it was anticipated that the cooling water inlet tube sheet likely had accumulated debris restricting the cooling water flow. This accumulation of debris was confirmed during the turnaround. See photographs of EA2281B Tube sheet, (see Figure 2.)



Figure 2. Debris in the inlet of critical heat exchanger.

The ability to “visualize” the condition of a heat exchanger allows production personnel to implement proactive corrective actions at times most convenient to site operations. During the inspection, no significant scale or deposition was observed, and the tubes and tube sheet were in a favorable condition. Nalco Water and the customer had discussed installing strainers to minimize the debris issue. Strainers were installed in 2017 and now provide an improved solution to the debris fouling.

OMNI™ data also discovered that this heat exchanger was using approximately 25% greater-than-design cooling water flow. The OMNI-calculated U-Value trends didn't show any significant decrease in heat transfer. Therefore, it was decided by Nalco Water and the customer to manually reduce the cooling water flow to the propylene condenser and redirect the excess flow to other heat exchangers in need. In addition, OMNI identified potential savings that could be realized by installing variable frequency pump drives, if the customer decided to reduce the circulating water on the system. Variable frequency (flow) pumps allow the most efficient use of pump motor energy consumption, considering the excess of water used on this heat exchanger.

CONCLUSION

OMNI identified and analyzed valuable information that the enabled the customer to make critical decisions about how the propylene condenser must be operated in the cooling water system in order to achieve maximum efficiency and highest reliable performance. Total potentials savings were \$5,157,901 per year.

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