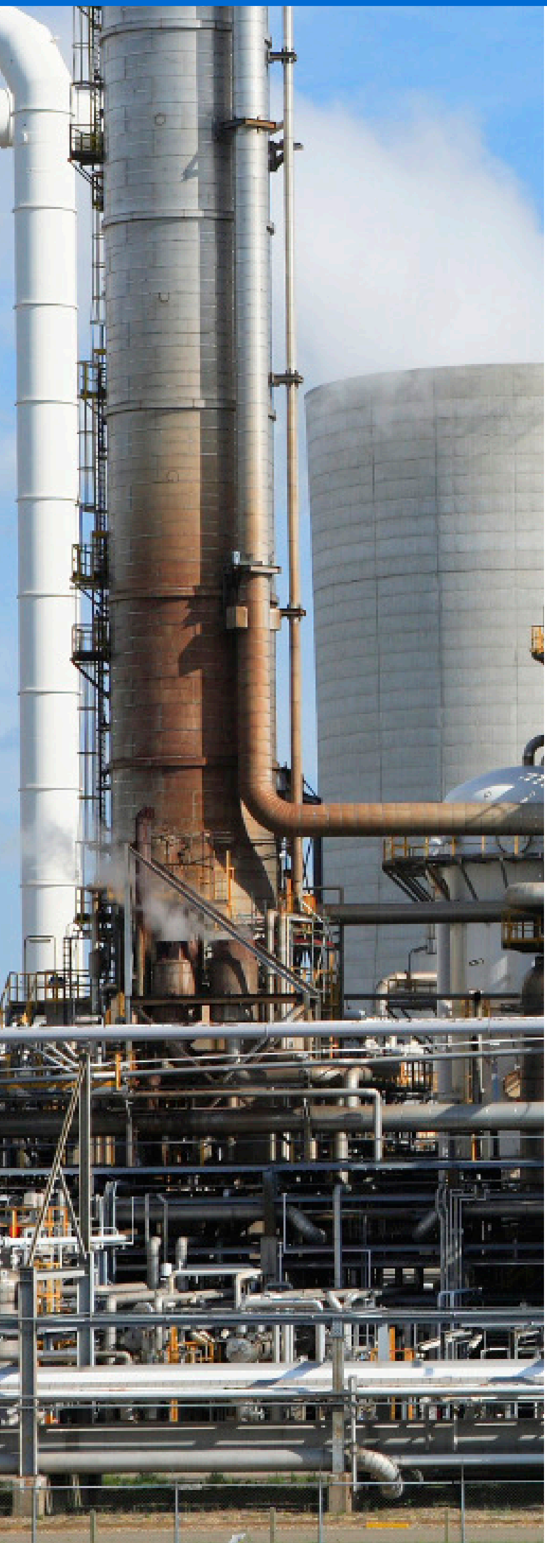
Ecolab®
Heat Exchanger **IQ**™

Ecolab® Heat Exchanger IQ™ monitoring optimizes reliability, asset protection, and total operating costs in ammonia and fertilizer production facilities

NALCO Water
An Ecolab Company

CASE STUDY – CHEMICAL INDUSTRY

CH-2038



SITUATION

Under design conditions, heat exchangers should provide reliable duty and a long service life with little or no maintenance. However, plants rarely run at design production rates, and cooling systems come with numerous mechanical, operational, and chemical (MOC) challenges.

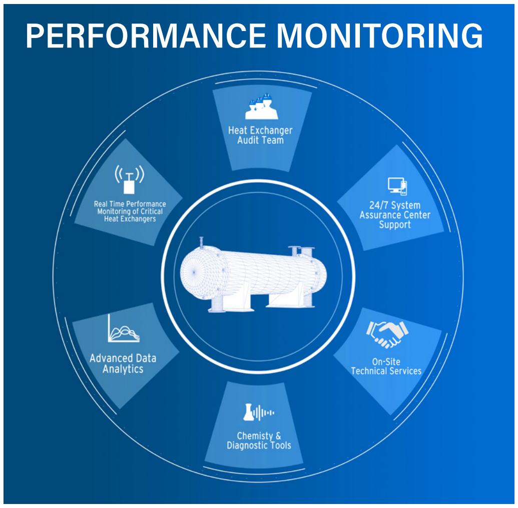
Corrosion, whether velocity-induced or under-deposit pitting, shortens asset life or, worst case, can lead to failure resulting in unexpected loss of production. Biofouling creates an insulating layer, resulting in a loss of heat transfer efficiency. The loss of heat transfer efficiency means that somewhere else in the system, additional energy is required to make up for the short fall.

In many cases, facilities do not have adequate insight into heat exchanger performance issues, whether compared to design expectations, or as affected, by stressed operating conditions. Lacking exchanger performance data can hinder troubleshooting and identification of root causes that may impact plant reliability and/or efficiency.

Ammonia and fertilizer production facilities often face challenging cooling water conditions associated with process contamination and other factors, such as high heat flux, low water velocity, and high exchanger tube skin temperatures. These high stress conditions may result in the problems described above, and are usually cumulative in nature. If undetected, they will often persist beyond the point where corrective actions can achieve a recovery in exchanger performance.

SOLUTION

There are many root causes of heat exchanger problems and most are preventable, particularly corrosion, scale, and fouling. Ecolab Heat Exchanger IQ is a comprehensive, data-driven, performance management program for critical heat exchangers that provides the information and response required to optimize reliability, asset protection, and total operating costs.



Heat Exchanger IQ combines in-depth system audits, 24/7 monitoring, unique diagnostic tools, and consultative service that optimizes heat transfer and guarantees reliability. Heat Exchanger IQ provides new insight into process performance and delivers a step change in reliability and profitability.

RESULTS

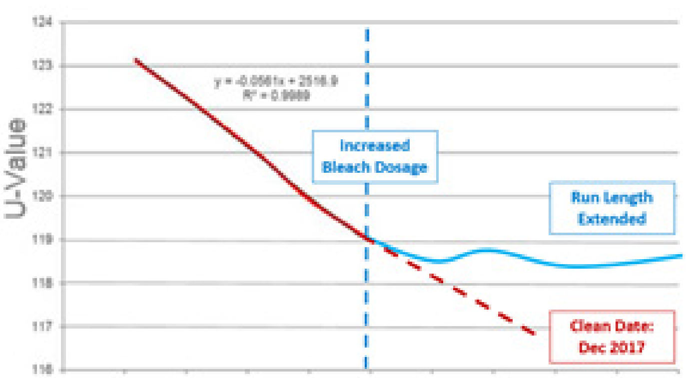
The following case studies illustrate how Ecolab Heat Exchanger IQ provides bottom-line savings by early detection and pro-active response to declining heat transfer performance.

Case Study 1 – Midwestern Ammonia Plant

Real-time heat exchanger KPI monitoring showed a steady decline in U-Value, a loss in heat transfer efficiency. The root cause investigation started with examining factors contributing to biofilm development. Biofilms are much more heat insulating than typical mineral scales. In fact, biofilms can be four times more heat insulating than a calcium carbonate scale of similar thickness. The reason biofilms reduce heat transfer so much is that microorganisms and the extracellular products they secrete are largely made up of water, which has a very high heat capacity.

Testing found very low chlorine residuals in the cooling water return and a rise in microbiological counts. This signaled that the amount of bleach being added was not meeting system demand. After consulting with the customer, it was agreed to slowly increase the bleach dosage (by increasing the ORP set point) to improve microbiological control and eliminate biofilm layer in the heat exchanger.

As shown in the chart below, the impact of effective microbiological treatment was clearly demonstrated as U-Values quickly improved. By restoring and maintaining U-Value performance, the plant avoided a projected cleaning date and will be able to extend their production run until the scheduled maintenance turnaround.

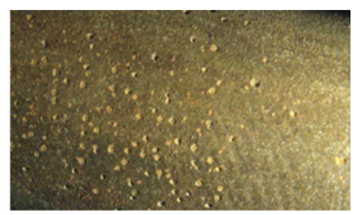


The avoided cost of an unexpected 5-day outage to clean this critical heat exchanger is $2.4 million ($1.5 million in energy and maintenance, $0.9 million in gross margin production opportunity).

Case Study 2 – Eastern Canada Ammonia Plant

A key component of Heat Exchanger IQ is the Sentinel™ test heat exchanger that replicates cooling water performance at the skin temperature and velocity of the most critical exchangers in the plant. Sentinel provides several methods of monitoring and assessing fouling, scale, and corrosion. The clear polyacrylic shell allows for visual observation of the annular exchangers at any time. The annular exchanger tubes can also be pulled for laboratory analysis. Pre-weighing of the heat transfer tube allows for determination of scale accumulation as well as actual metal loss due to corrosion at the end of the exposure period. Metallographic and deposit analysis further defines the type of mineral scale as well as whether corrosion is velocity-induced or a result of under-deposit pitting.

In this case, a rapid build-up of scale and corrosion was observed on the Sentinel exchanger tubes during a 46-day exposure period. Standard corrosion coupon results on the cooling water supply and exchanger outlet were 1.32 mpy and 1.9 mpy, respectively. The corrosion rate for the Sentinel exchanger tubes were 1.93 mpy for Exchanger #1 and 3.88 mpy for Exchanger #2. The Sentinel data points were not unusual since corrosion rates are more aggressive under heat exchanger conditions. (Corrosion rates typically double with every 18 °F increase in metal temperature). However, further examination of the exchanger tubes revealed localized corrosion with pit depths > 20 mils. Photomicroscopy (below) and deposit analysis showed a build-up of mineral scale, primarily composed of iron phosphate, which resulted in under-deposit corrosion.

Based on this new understanding of the nature of the scale and the performance under actual heat flux conditions, the cooling water treatment program was adjusted. This included an overlay of pyrophosphate to sequester iron and minimize deposition. After these program changes, only slight corrosion was observed and pit depths were 0.1 mpy, a 99% improvement and a quantum change in asset protection.

Assuring the designed asset life of a stainless steel tube bundle can save an average of $75K per year for each exchanger (based on bundle replacement cost of $450K and 20 year life cycle).

CONCLUSION

This case history highlights two key components of the Ecolab Heat Exchanger monitoring program. In addition to the Real-Time Monitoring and Sentinel, Heat Exchanger IQ also provides the following services in order to achieve complete, comprehensive heat exchanger monitoring:

- A bi-annual survey of all plant heat exchangers to compare operating conditions with design, performed by Nalco Water's dedicated audit team
- Periodic compilation of Data Analytics for review with plant management
- Correlation of Water Treatment Data with heat exchanger performance

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