West Coast CCGT uses Nalco Water's OMNI Condenser Performance program to evaluate cooling system performance

OMNI™
Condenser Performance

NALCO Water
An Ecolab Company

CASE STUDY – POWER
CH-1071

BACKGROUND

For a merchant combined cycle power plant, high efficiency and lower operating costs mean high profits. Plant management, operations and maintenance staffs continually evaluate changes for potential savings. With respect to changes to the cooling water treatment program, evaluating those changes presents real challenges. Operating conditions rarely remain constant enough to accurately compare one time period, under one treatment program, to another.

SITUATION

That was the challenge faced by a west coast combined cycle gas turbine (CCGT) plant. The operators made changes to their cooling water treatment program and were unsure about the results they'd obtained. The type of sophisticated analysis needed to really understand the implications of the changes were not in the budget, but the implications of a bad decision — or the possible gain associated with making a better decision — merited investigation.

Volumes have been written about power plant performance monitoring. The tools available range from simply measuring condenser backpressures to comprehensive plant heat balances. Whatever the method, they all share the same goal: establishing performance benchmarks against which current performance can be measured.

The plant chose the Nalco Water OMNI Condenser Performance program to evaluate condenser performance before and after changes, and evaluate which program performed better. Data was pulled from the plant's PI system. The dataset contained about 3,600 data points over the eight-week trial period. The evaluation period was divided into two stages.

- Stage 1: June 24 through July 19
- Stage 2: July 20 through August 24

ENVIRONMENTAL RESULTS	eROI℠	ECONOMIC RESULTS
0.5% increased turbine efficiency resulting in 8,750 MWh/yr incremental asset utilization	ASSETS	$875,000/yr in incremental profit

eROI is our exponential value: the combined outcomes of improved performance, operational efficiency and sustainable impact delivered through our services and programs.

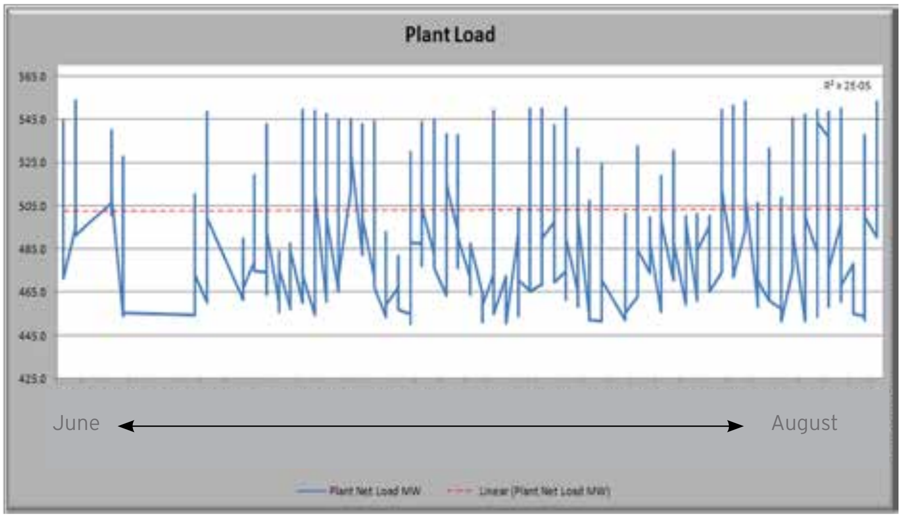

Figure 1 – *Steam Load and Generation were constant through the trial period.*

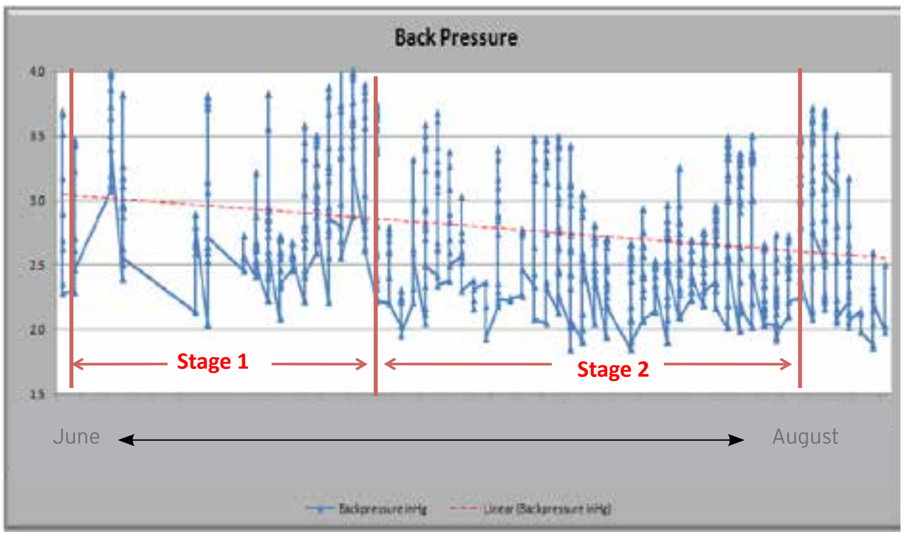

Figure 2 – *Condenser Backpressure appeared to drop over the trial period, but its cause was not clear.*

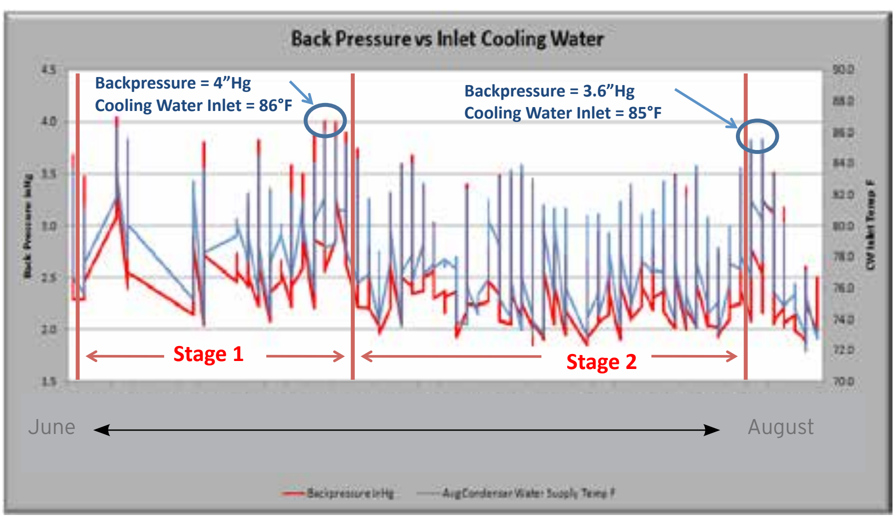

Figure 3 – *Lower condenser backpressures under similar weather conditions indicated a real effect of the change in treatment program.*

SOLUTION

During Stage 1, it was hypothesized that oxidizing biocide could serve as the foundation of the cooling water treatment program. A small amount of dispersant – the application of which was controlled with a Deposit Accumulation Testing System (DATS) from Bridger Scientific – and a small amount of polyphosphate-based corrosion inhibitor – applied based on the signal from a corrator – would deliver good results. During Stage 2, a different hypothesis was evaluated: dispersant, plus biocide, would keep the condenser cleaner.

Results appeared good during the initial period of Stage 1. On Day 28, the DATS monitor recorded some fouling. Dispersant concentrations were increased, but signs of fouling continued. Corrosion measurements remained low throughout the trial.

Nalco Water used its 3D TRASAR® Cooling Water technology to control and monitor the chemical program during Stage 2. Employing an inert fluorescent material not tied to the dispersant polymer along with a second fluorescent material chemically tagged to it, the real-time polymer consumption can be measured and dispersant applied in response to actual system demand. During the first five days of Stage 2, polymer consumption was very high. Then, as demand subsided, less dispersant was needed. This was another indication that something more than random variation or weather was impacting system performance.

Biocide application showed similar trends. Early in the trial, more biocide was needed to achieve the desired wet chemistry results. As the trial progressed, demand leveled off. Non-oxidizing biocides supplemented the oxidizing biocide program during Stage 2.

CONDENSER PERFORMANCE MONITORING

A number of parameters indicate condenser performance:

- Cleanliness Factor (CF)
- Terminal Temperature Difference (TDD)[1]
- Inlet Water Temperature
- Condenser Back Pressure
- Cooling water temperature rise across the condenser (ΔT)
- Log Mean Temperature Difference (LMTD)
- U Coefficient

Back pressure is the most common and easily measured parameter, but Cleanliness Factor and U Coefficients are more revealing.[2]

$$CF\% = \frac{U_{Actual}}{U_{Design}}$$

A change in U_{Actual} or U_{Design} changes CF %.

$$U_{Actual} = \frac{\text{Heat Duty (lb/hr)}}{\text{Area (ft}^2\text{) * LMTD (°F)}}$$

Of the variables affecting U_{Actual}, only the LMTD reveals condenser performance, given a constant steam load. Barring a change in steam side performance, such as air in-leakage, the inlet water temperature reveals the performance of the condenser. Any cooling tower performance changes affect the performance of the condenser.

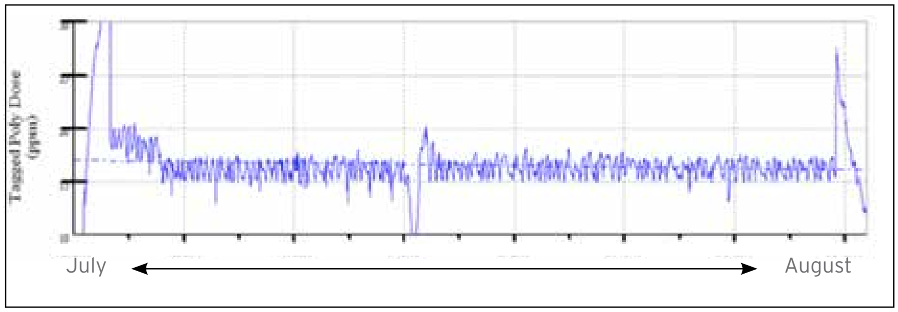

Figure 4 – *Dispersant polymer use was high during the first 5 days of Stage 2 and then leveled off as demand subsided.*

[1]Also known as Approach Temperature
[2]U Coefficient is also known as the Heat Transfer Coefficient

RESULTS

As shown in Figure 5, the condenser Cleanliness Factor in Stage 2 was better than in Stage 1. The change of 0.5% overall, represents roughly a 0.5% efficiency improvement.

Less dispersant was required, over time, as a result of better control, as shown in Figure 6. As deposition was brought under control, less dispersant was required to maintain good performance.

For a 250 MW combined cycle gas turbine plant, a 0.5% efficiency improvement translates to 1.25 MW. Assuming an availability of 80%, that's about 7,000 hours of generation or 8,750 MWh. At a wholesale price of $100/MWh, the economic impact of such an improvement is $875,000.

To obtain the improvement, the plant incurred an incremental chemical cost increase of only $12,000.

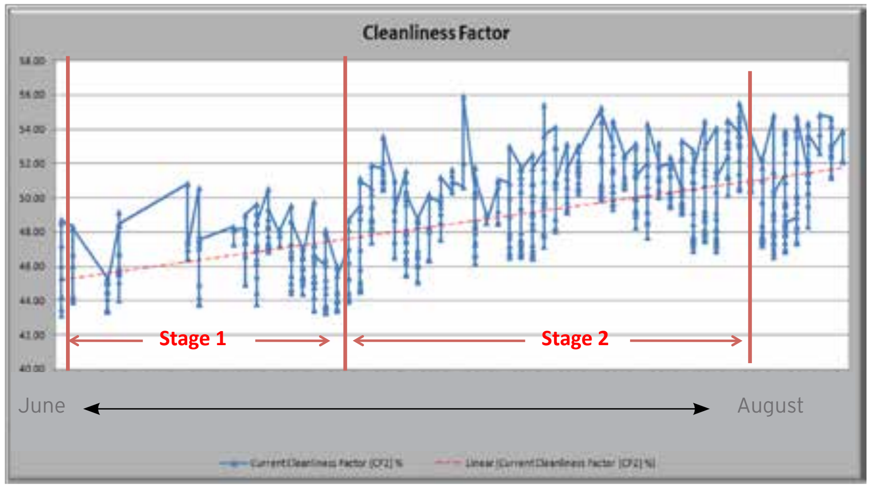

Figure 5 – *Cleanliness Factor across the entire evaluation period*

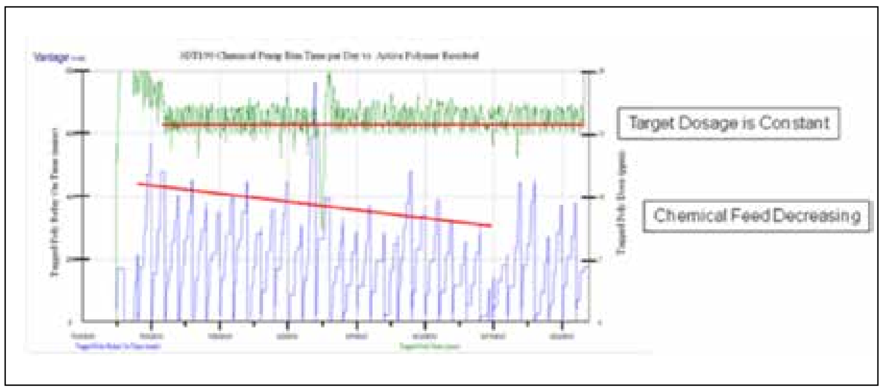

Figure 6 –

$$\text{Return on Investment (ROI)} = \frac{\text{Incremental Savings} - \text{Incremental Investment}}{\text{Incremental Investment}} \times 100$$

$$\text{Return on Investment (ROI)} = \frac{\$875{,}000 - \$12{,}000}{\$12{,}000} \times 100$$

Return on Investment (ROI) = 7200%

Nalco Water reports Environmental Return on Investment (eROI) values to customers to account for contributions in delivering both environmental performance and financial payback.

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