Pacificorp Naughton improves condenser performance, reduces costs by $900,000

OMNI™
Condenser Performance

NALCO Water
An Ecolab Company

CASE STUDY - POWER
CH-1342

BACKGROUND

Coal-fired power plants operate in a highly competitive market. Electricity demand is growing slowly and that trend is predicted to continue for several years. Natural gas prices are low compared to coal. Labor costs in a coal plant are higher than those in most gas plants. From a regulatory standpoint, coal-fired plants operate in a much more restrictive environment than do other power plants. All of these challenges mean operators of coal-fired power plants need to be mindful of costs and look for any potential opportunities for efficiency gains.

SITUATION

At PacifiCorp's Naughton station – a 707 MW coal-fired plant near Kemmerer, WY – make-up water quality varies with the seasons. Make-up water silt and sediment concentrations rise with the spring run-off. Seasonal degradation of condenser performance is an annual event.

After the spring turn-around in 2011, the degradation seemed more severe than in past years, as evidenced by increasing condenser back pressure and falling condenser cleanliness factor.[1] Rather than continue to operate under sub-optimal conditions, the plant brought Unit #3 down in August. The unit was offline for 38.5 hours while operators

Customer Impact	eROI℠	Economic Results
Prevented microbiologically-induced corrosion, protecting the condenser and ensuring high plant availability.	ASSETS	Avoidance of unplanned outages and unnecessary derates translates into millions of dollars in generating revenues.
Clean condenser surfaces during peak generating periods maximizes plant capacity.	ENERGY	$900,000 in reduced operating costs, including maintenance and fuel.

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

[1] Condenser back pressure was 4.6" Hg and Condenser Cleanliness Factor was 55%.

cleaned out silt and debris and ran brushes through the condenser tubes. The cleaning worked. Condenser back pressure dropped to 3.4" Hg and Condenser Cleanliness Factor was restored to 95%.[2]

Over the next month, performance metrics started to trend down again. Taking the unit offline again was out of the question. Its generating capacity was needed and, when a unit is offline, it makes no money. Another option was needed.

CONDENSER FOULING

Fouling is predominantly a physical process involving the settling of suspended particles. As deposits grow, water flow rate decreases and pumping back pressure increases. Deposits reduce heat transfer because deposits have lower thermal conductivity than metal heat exchange surfaces. In short, deposition increases operating costs and decreases profitability.

Fouling is distinguished from scaling in that fouling deposits are formed from material suspended in water. Fouling is the aggregation of insoluble material – suspended solids, organic contaminants, corrosion products and microbial growth – through physical processes. The fouling mechanism is difficult to inhibit because it is heavily influenced by non-chemical factors like water velocity, materials of construction and the roughness of the heat transfer surface.

The presence of microbial slime exacerbates the fouling tendency in a system. Microbial growth binds corrosion products and suspended solids together, forming sticky, thermally insulating deposits.

THE COST OF CONDENSER FOULING

Design engineers often assume a certain amount of efficiency loss when designing power plant condensers. Building a slightly larger-than-needed condenser costs much less than derating the power plant or living with reduced capacity, availability or efficiency later on.

There is a drawback to this approach. Problems are often not noticed until they become acute. Excess cooling capacity can mask the impact of a relatively small amount of fouling, particularly during cooler months. These problems come to light during the hot summer months, when the sediment loading and incoming water temperatures increase.

Fouling does not affect only the condenser. Microbial fouling in a condenser provides a breeding ground for bacteria which find their ways to the cooling towers. Not only does a reduction in condenser efficiency result from fouling, the cooling towers also become less efficient.

- Left unaddressed, a fouled cooling tower can lose 5°F in approach to ambient wet-bulb temperature within as little as 18 months.
- For every 2°F increase in ambient wet-bulb temperature, the cooling water temperature increases 1°F.
- A tower water temperature increase of 1°F increases energy use by 2%
- A loss of 5°F in approach to wet-bulb temperature reduces the capacity of a cooling tower by 10% to 15%.

[1] Condenser back pressure was 4.6" Hg and Condenser Cleanliness Factor was 55%.
[2] Design Condenser Cleanliness Factor is 85%.
[1] Condenser back pressure was 4.6" Hg and Condenser Cleanliness Factor was 55%.

BIODISPERSANTS

Unlike biocides, biodispersants — also known as biopenetrants — do not kill bacteria. They dislodge biofilms and deposits from metal surfaces and allow biocides to contact the bacteria.

By breaking up biofilms and releasing them into the bulk water, biodispersants increase the effectiveness of all biocides. Oxidizing biocides, the most commonly-used biocides in the power industry, kill only what they contact. Non-oxidizing biocides, which are used to a lesser extend in the power industry, are absorbed through the bacterial cell walls, poisoning the organisms. Microbial slime produces an impenetrable barrier, preventing both oxidizing and non-oxidizing biocides from reaching most of the bacteria. Also, anaerobic bacteria — which often produce corrosive hydrogen sulfide gas as a product of their metabolisms and drive microbial-influenced corrosion (MIC) — thrive in the oxygen-free environment beneath biofilms. Biofilms protect these destructive bacteria from all biocides. Biodispersants, simply by breaking up biofilms and aerating their environment, eliminate the anaerobic conditions necessary for these organisms to thrive.

CONDENSER CLEANING PROGRAM

The results of the mechanical cleaning and the impact of the bio-dispersant are shown in Figures 2, 3 and 4. In the month following the condenser cleaning, condenser cleanliness factor and backpressure degraded almost to the point it was prior to the mechanical cleaning. The engineering staff evaluated a number of options for bringing the unit back up to its design efficiency, including taking the unit offline again. The chosen option: increase cooling tower blowdown, slightly reduce pH and apply a biodispersant.[3]

Within one day of applying the biodispersant, improvement was noted in condenser backpressure and condenser cleanliness factor. Within two weeks, performance had improved almost to the point seen after the mechanical cleaning. Performance continues to improve and there has been no loss of efficiency, like that seen after the mechanical cleaning.[4] A continuous use of the biodispersant is expected to maintain the condenser at its current, high efficiency.[5]

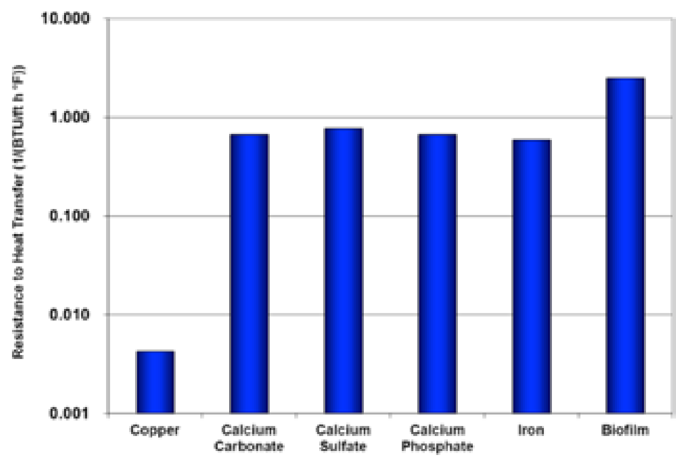

Figure 1 – *Biofilm has a higher resistance to heat transfer than other deposits. Note also the impact of deposition on heat transfer when compared to other deposits and copper, the material of construction of many heat exchangers.*

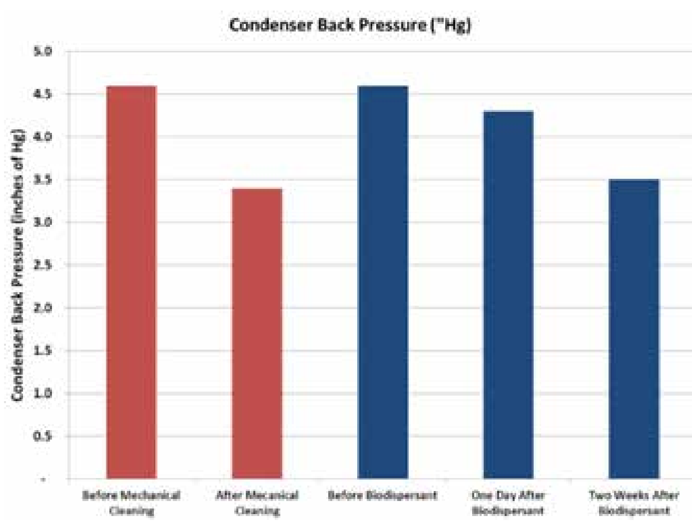

Figure 2 – *Mechanical cleaning reduced condenser backpressure, but required an outage of 38.5 hours. Nearly the same result was achieved, without the outage, through the application of a biodispersant.*

[3]The biodispersant chosen was Nalco Water 73551 applied at 3 ppm.
[4]Three weeks after application, cleanliness factor reached 90%. Design cleanliness factor for this condenser is 85%.
[5]A slight difference in the TDD and backpressure measurements will be noted between Figures 2 and 3 and Figure 4. Figure 4 uses data from a different data source, one used to verify the data collected by the plant Historian which is shown in Figures 2 and 3.

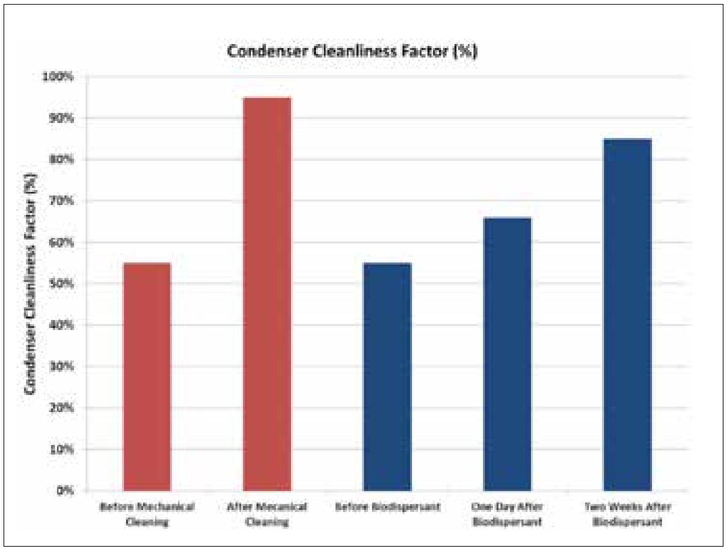

Figure 3 – *Cleanliness Factor showed the same trend as condenser backpressure. Mechanical cleaning and biodispersant delivered almost equivalent results without the availability loss associated with an outage.*

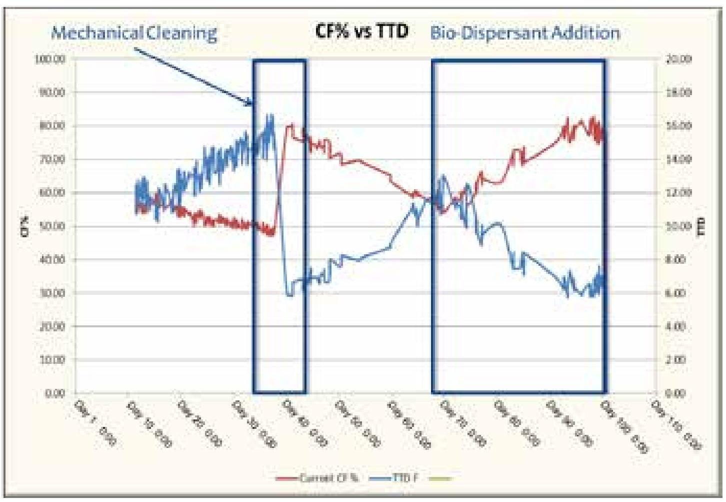

Figure 4 – *The comparative effects of the mechanical cleaning and bio-dispersant application are shown in this graph from the plant's DCS.*

RESULTS

Maintaining high condenser efficiencies directly benefit the power plant. A clean condenser ensures that, during peak demand times, the plant will have capacity available to meet demand. Plant availability is maintained by avoiding expensive and time-consuming outages for cleaning. High efficiencies positively impact heat rate, requiring less fuel per megawatt produced.

Adopting a bio-dispersant program, one of the offerings of the OMNI Condenser Performance program, as a substitute for an offline mechanical cleaning saved PacifiCorp Naughton Station over $900,000 in maintenance, lost production, and fuel costs.

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