

Nalco Water's Bio Detergent Program helps a major steel manufacturer from India restore and maintain their condenser performance with savings of \$219 K USD per annum.

BACKGROUND

A major steel manufacturer from India is among the top 10 global steel companies with an annual crude steel capacity of over 28 million tons per annum (MTPA). It is now one of the world's most geographically diversified steel producers, with operations in 26 countries and a commercial presence in over 50 countries.



SITUATION:

At the customer site in India, there are three main captive power generation plants with an installed capacity of 135 MW. This Power House has two turbo generators with a power generating capacity of 30 MW each.

In 2014, there was a steady drop in the condenser vacuum which increased the fuel rate and ultimately affected the generation output. To restore the condenser performance, the plant performed flushing of the unit assuming fouling in the condenser tubes. However, there wasn't significant improvement in the performance of the of the condensor.

SOLUTION:

Puzzled by the situation, the plant consulted the Nalco Water team and asked them to study the conditions and help restore the plant performance. Nalco Water's expert team visited the site to conduct a detailed audit of the plant's Mechanical, Operational and Chemical (MOC) conditions. The team discovered a slight increase in the DP (differential pressure) across the condenser. This minimal increase coupled with a major decrease in the rate of heat transfer could be caused by the bio fouling. Further, the prevailing temperature conditions in the cooling system also suggest the growth of slime formers. The team also found that the existing bio - management program doesn't

ENVIRONMENTAL INDICATORS	eROI™	ECONOMIC RESULTS
Increased power output by 3325 MW/year, which ought have been substituted by the power from the grid		Saving of US\$219,733 per year
Reduced 2293 metric tons of CO2 emissions		Carbon sequestered by 58,795 tree seedlings grown for 10 years

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include any bio dispersant, which further adds to the possibility of the slime growth.

Based on the above observations, the team concluded that the significant drop in the vacuum / reduced heat is due to the formation of the bio films. Nalco Water suggested the plant carry out a bio flushing of the entire cooling system with their proprietary bio detergent, Nalco N 73550, to restore the system performance and then include it as a part of the regular bio management program to avoid the recurrence of any such issue.

BIO FILM & BIO DETERGENT:

Organisms do not live in the water system individually, but together form an ecosystem, which is called biofilm.

Bio Film is an aggregation of microbial cells and their associated extra-cellular polymeric substances, actively attached to, growing and multiplying on a surface.

Typically, 99% of the bacteria within a cooling system, comprising both aerobic and anaerobic species, live within the bio film.

There are four phases of biofilm formation:

1. Adsorption of organic film onto clean surfaces
2. Microorganisms attach themselves by the production of exopolymers
3. Microorganisms multiply, and trap silt, corrosion byproducts and scale organisms
4. Shear forces cause biofilm to spread over additional surfaces

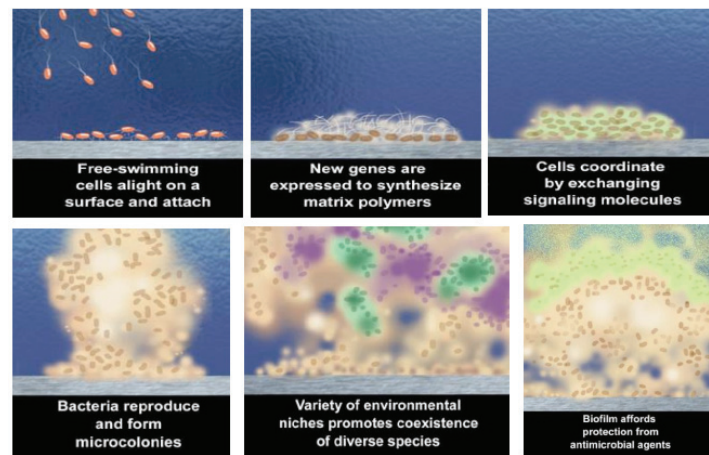


Figure 1: Different stages of biofilm formation

Biofilms are more insulating than the commonly found mineral scales and retard the rate of heat transfer in a big way. The thermal conductivity of biofilm is significantly (about 4 times) lower than that of the mineral scale. In other words, one millimeter thick bio film is equivalent to a four millimeter thick calcium carbonate scale.

Scale	Thermal Conductivity (W/mK)
Calcium Carbonate	2.26 - 2.93
Calcium Sulfate	2.31
Calcium Phosphate	2.60
Magnesium Phosphate	2.16
Magnetic Iron Oxide	2.88
Biofilm	0.63

Figure 2: Thermal conductivity of various mineral scales & biofilm
Source: N. Zelver et al., CTI Paper No. TP239A

As the biofilms grow, the bacteria thrive underneath them and cause under deposit corrosion or initiate scale formation. The micro-biocides (Oxidizer & Non oxidizers) on their own will not be able to penetrate the biofilms and manage it effectively. Therefore, we need effective bio dispersants to penetrate through the slime-forming bacteria and eliminate the microbial population.

BIO DETERGENT 73550 PROGRAM

Biodetergent 73550 is a nonionic biodetergent for removing and dispersing microbiological-based slime and silt deposits within cooling tower fill. As a detergent, Biodetergent 73550 disrupts biofilm integrity, removing surface deposits and facilitating biocide penetration into the slime. As a dispersant, it disperses dislodged biofilm aggregates into the bulk water preventing re-deposition.

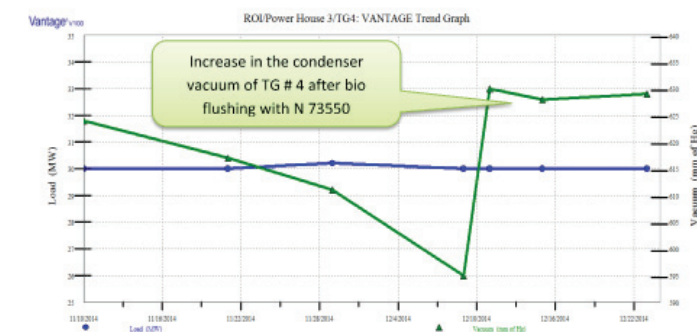


Figure 3: Trend showing the Load vs Condenser vacuum for TG # 4

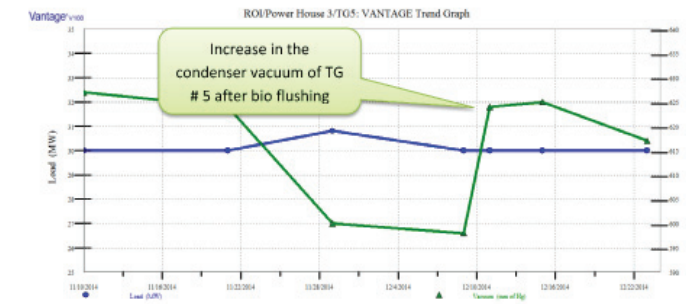


Figure 4: Trend showing the Load vs Condenser vacuum for TG # 5

RESULTS:

Based on the recommendations by the experts, the Nalco Water team in conjunction with the customers operating team has carried out the bio flushing with the Bio Detergent N 73550. The product was slug fed @ 5 ppm based on the holdup volume, followed by slug feeding of the oxidizing biocide. The system circulated for 24 hours under the close supervision of Nalco Water. There was a sharp increase in the turbidity due to the removal of slime & other deposits from the cooling system.

Soon after the bio flushing there was a marked improvement in the condenser vacuum. The back pressure has decreased by 9.8 mm Hg for both the turbines (refer to figures 3 and 4). With this improvement in the vacuum, the plant could generate an additional power of 3325 MW/yr from both the turbines for the same fuel consumption.