HeatX Increases Heat Exchanger Performance While Inhibiting Corrosion and Biofouling

Heat exchangers in power generation plants (Figure 1) often use ground or sea water to cool operational fluids exiting the power-generating turbines. The use of unprocessed water in heat exchangers and chillers creates significant problems such as scaling, fouling, and eventually corrosion of the metal exchanger components.

Fouling can reduce heat transfer efficiency of steam power plants by anywhere from 2-10%, increasing pumping power and fuel consumption to compensate for inefficiency, creating a constant cycle for maintenance, and increasing costs from exchanger downtimes.

Oceanit has developed HeatX, a nanocomposite surface treatment for heat exchanger efficiency which mitigates the need for frequent shutdowns and maintenance required for exchangers and other components which can suffer from fouling. HeatX has been shown to inhibit biofouling and prevent corrosion while improving exchanger efficiency.

This case study describes an Oceanit collaboration with Hawaiian Electrical Company (HECO), a major utility company in the state of Hawaii. Several HECO power plants use unprocessed sea water as a primary source for cooling hot water exiting the power generation turbines. HECO utilizes ‘shell and tube’ heat exchangers in many of their power plants. Using sea water for cooling poses several challenges for the operation of HX units, namely:

- Fouling & rapid growth of barnacles or other biological organisms
- Abrasion caused from sand carried by sea water
- Erosion from scale particles breaking loose and impinging on other surfaces

Coatings for Heat Exchangers

After HECO uses sea water for cooling operations, the water is then released back in to the sea. Hence, the exchanger coating and type of material used are heavily regulated under EPA and state laws. Coatings may not leach any harmful biocidal or toxic materials that could pose a threat to the marine life.
As such, heat exchangers within HECO typically have no coating to prevent fouling inside the tubular. A thick layer (30 mil) of erosion-resistant epoxy coating protects the tube sheet from sand erosion at the entrance of the heat exchanger. The epoxy coating, however, does not provide any fouling resistance (see Figure 3).

**Oceanit Solution: HeatX**

In order to effectively minimize the growth of barnacle and biofouling on the surface of the exchanger tubes without the use of any biocides or chemicals, a highly inert treatment that resists growth or deposit is required.

Oceanit’s HeatX meets those conditions and demonstrates low adhesion, high pressure stability, high temperature stability, and omniphobic (oil and water resistant) properties well-suited for the release of barnacle and biofouling growth on the tubes.

HeatX is a water-based formulation (75%) that can even be applied to unprepared, already-corroded surfaces to achieve the full benefits. In addition, HeatX is effective at an overall thickness of less than 4mil and is non-insular (does not affect the overall heat transfer).

Due to the extreme low surface energy of the HeatX, the treated surface becomes extremely slippery. This prevents formation of biofilms and minimizes barnacle’s ability to bind on the surface and grow. HeatX does not contain any harmful biocidal compounds that are commonly found in antifouling coatings (Figure 4).

**Field Trial & Evaluation:**

In this effort, Oceanit collaborated with HECO to apply HeatX to one of HECO’s shell and tube heat exchangers (~1000 tubes 3/4” dia, 20’ length). HeatX was applied to a seawater operated exchanger (chiller) at the Kahe Generation Plant, Oahu, in December 2016. Currently, the HeatX-treated chiller has completed 18 months of service with no interruption.

During the initial six-month period after treatment, HECO monitored the seawater, auxiliary chiller water inlet & outlet temperature, and the overall power generation from the turbine associated with HeatX versus an untreated chiller.

The six-month inspection (Figure 5) showed a negligibly thin layer of biofilm, sand, and debris but no signs of blockage or barnacle build up.
Due to the unplanned shut down of an unprotected chiller run in a parallel system, the HeatX-treated chiller was activated to cool down two turbines, instead of just one. During this period of three months, HeatX handled 2X the regular load with no signs of performance degradation. Combining the visual inspection and overall power generation performance, HeatX significantly minimized the need for frequent clean up and improved the overall operational capability of the chiller.

Based on performance data from this trial, HECO decided that downtime for heat exchanger maintenance could be reduced from 20 days/year to just 2 days/year for HeatX-treated units. In addition, the HeatX-treated chiller was able to absorb all costs for replacement power generation when the non-treated chiller went down – saving $15,000 per day by handling a load from two turbines at once by avoiding the need for replacement power generation.

Economic Impact of HeatX:
HeatX surface treatment addresses two major issues: (i) reduces exchanger downtime & maintenance costs and (ii) mitigates the cost of replacement power generation during downtime.

Based on the performance data and analyzing the cost associated with maintenance and replacement power generation, HECO estimates that HeatX will save nearly $72,000 on maintenance by reducing the days for downtime and maintenance annually. Taking these factors into account, HECO estimates savings of $1.5 million+ on replacement generation cost over a period of five years – per heat exchanger.

HECO Summary:
• After six months of service, HeatX-treated chiller showed:
  • No signs of barnacle growth
  • No blockage in the tubulars
  • Consistent performance & efficiency of the exchanger
  • HeatX-treated chiller handled 2X the load upon breakdown of an untreated chiller

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Figure 5: Photograph of unprotected chiller and a HeatX-treated chiller after 6-month service