Highly Efficient, Low Carbon and Low Cost Energy Using Functional Surfaces

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DOE Project Title: Advanced Anti-Fouling Coatings to Improve Coal-Fired Condenser Efficiency
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Abstract

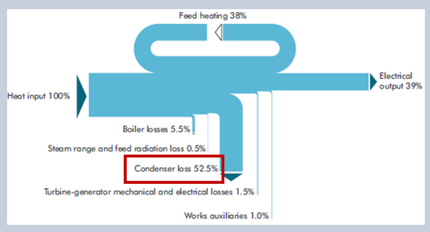
Efficiency improvements in coal power plants can lead to significant savings over time. One area which experiences significant efficiency losses but has not been an area of significant research interest is the condenser. Heat losses due to fouling, corrosion, and film-wise condensation can cause significant heat losses during energy production.

One potential solution to increase condenser efficiency is the application of a surface treatment in order to protect the heat exchange surfaces from fouling, as well as promote dropwise condensation to increase heat transfer.

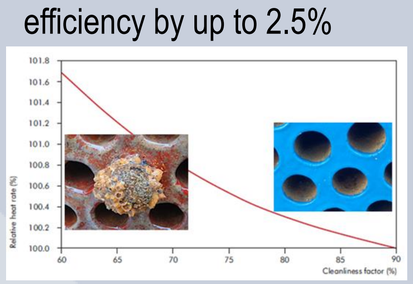
Oceanit proposes the application of HeatX™, a low surface energy treatment developed for heat exchanger applications to improve condenser efficiency, as well as decrease maintenance frequency.

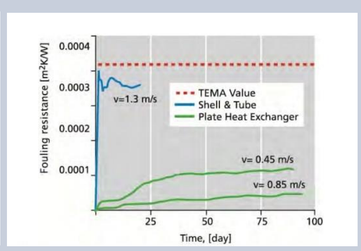
Problem Statement

Up to 50% of conversion losses during the steam boiling power generation cycle occurs during condenser processes.



Fouling of heat transfer surfaces is especially challenging, with sea-water fed exchangers generally showing fouling within 30-45 days, increasing heat transfer resistance by up to 30%, and overall system efficiency by up to 2.5%





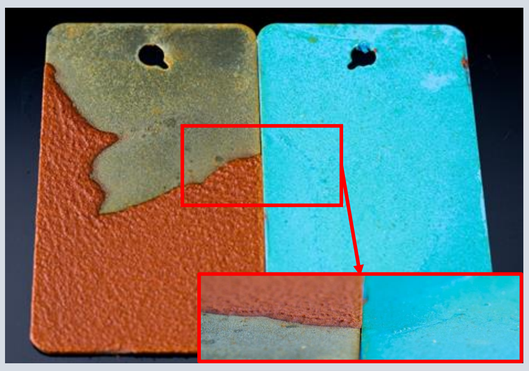
Coatings are one way to significantly decrease such fouling, however, they have not been widely adopted, because:

- Coating materials must be applied extremely thick (20+ mil), introducing heat transfer resistance equal to or greater than fouling.
- Coatings must be applied to factory-new surfaces, and thus, represent significant capital expenses with long payback periods.

Approach

HeatX™ is a novel surface treatment specifically optimized for application on complex geometry heat transfer surfaces. HeatX™ imparts extremely low surface energy, enabling it to actively repel both water- and oil-based contaminants. Additionally, it is designed to be applied in-situ to existing, previously fouled surfaces with a minimum of surface preparation.

HeatX™ also significantly reduces the surface roughness, increasing flow speed and reducing available surface area on a micron scale level, preventing the adhesion and spreading of biofilms on a bacterial and cellular level.



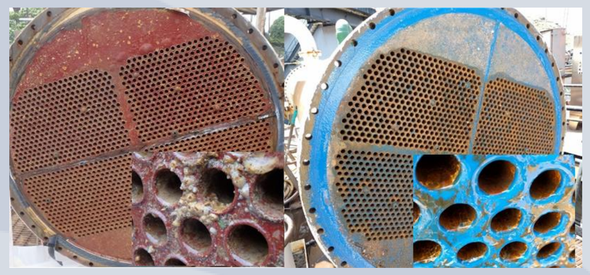
All this is delivered via a treatment which is applied at a recommended thickness of 2 mil or below, which does not affect heat transfer. HeatX™ is operator-friendly, with a water-based, non-toxic formulation that contains no biocides or heavy metals.

Anticipated Benefits

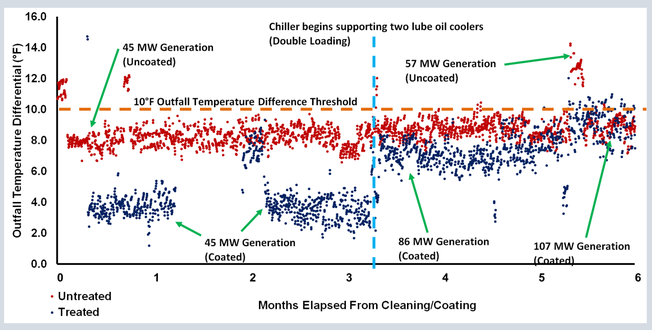
- Decreased fouling on feedwater side by up to 50%, improving heat transfer efficiency.
- Promotes dropwise condensation on vacuum side, due to hydrophobicity, resulting in reduced backpressure and lower temperature outfall.
- Overall increased lifetime for condenser components.
- Reduced need for maintenance and downtime.
- Applicable as refurbishment operation, allowing for fast payback and rapid deployment on existing installed systems.

Field Application

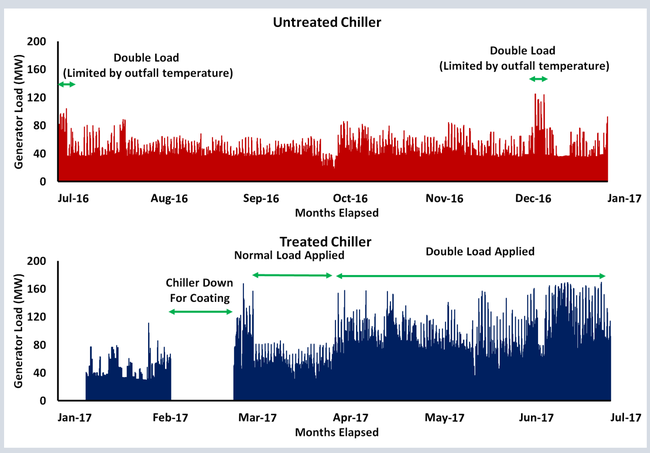
Oceanit previously applied the HeatX™ treatment to a pilot study in Honolulu, HI. A seawater fed, 15 year old shell-and-tube heat exchanger with severe fouling issues had HeatX™ applied to the interior tube surfaces. Results were immediately apparent. By visual inspection alone, biological organism attachment was significantly decreased after **6 months**, with an uncoated chiller typically requiring 2 weeks of sand-blasting, while the coated chiller has shown no signs of growth or fouling impacting performance after **18 months**, with zero maintenance required thus far.



Heat transfer efficiency was greatly improved after HeatX™ application. Seawater outfall temperatures were reduced by nearly 100%, allowing for generator turbines to be run at maximum rated load for extended periods of time, when they were typically capped at 50% due to insufficient cooling to keep up with thermal load requirements.



Overall, a **single treated chiller** has been able to replace and exceed the cooling capacity of **two untreated chillers** susceptible to fouling, allowing for reduced fuel consumption and huge operational savings.



Commercialization Potential

- 2-10% of total CO_2 and greenhouse gas emissions from energy generation companies is directly due to increased fuel consumption due to fouling of heat transfer surfaces.
- Chiller efficiency due to HeatX™ resulted in an estimated yearly savings of **$300,000**. Even a very conservative increase in condenser efficiency of 0.5% due to treatment, would result in a substantially larger cost savings due to significant fuel consumption and much higher maintenance costs.