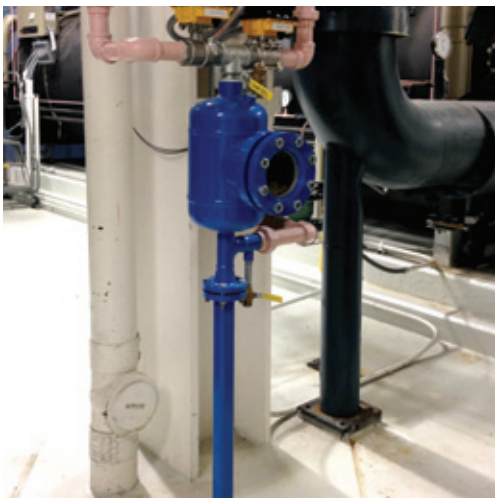
AN INNOVAS TECHNOLOGIES® CASE STUDY

University of Wisconsin–Madison



"We have found real value in maintaining clean condenser and evaporator tube continuously. We save energy, sure, but we also provide better cooling and at the same time, reduce the maintenance requirements of our chillers."

TRAVIS THOENY – POWER PLANT MANAGER

INTRODUCTION

The facilities team at the University of Wisconsin–Madison places a premium on improving the efficiency and productivity of their central cooling plants. After attending a technical presentation by the University of Virginia at the 2018 Big Ten and Friends Conference, Jeff Pollei, P.E., Director of Utilities & Energy Management and Travis Thoeny, Power Plant Manager saw an opportunity through Innovas Technologies' Helios Tube Cleaning System® (Helios TCS) to eliminate heat exchanger tube fouling in the university's Central Utility Plant chillers. At UW–Madison, when an innovative concept is discovered the team evaluates the innovation through the lens of all their facilities' functional areas: engineering, operations, maintenance, and training to evaluate the potential to improve plant efficiency. In this instance, the cross-functional team evaluated the fouling mitigation capability of the Helios TCS and its financial payback potential. This evaluation process included review of chiller operations, cooling water quality, Helios TCS operating principles, and installation considerations.

Innovas Technologies worked with UW–Madison to analyze historical chiller operations data to evaluate and estimate chiller efficiency losses due to tube fouling. This analysis found tube fouling-related efficiency loss in Central Utility Plant chillers amounted to approximately 6-8% efficiency degradation. Satisfied with the potential payback of the Helios TCS, UW–Madison initiated a plan to test a chiller equipped with a Helios TCS side-by-side with an identical, non-Helios-equipped chiller for the 2018 cooling season.

CHALLENGE

Risk Management of Innovation

The UW–Madison team is fully invested in finding innovative ways to improve operations, but they also consider process stability and reliable delivery of cooling to the university critical. Subsequently, UW–Madison's priority is finding innovations offering expanded value while ensuring any change will not cause interruptions to their mission. Any change, including integration of the Helios TCS, cannot cause unplanned cooling interruptions.

Through collaborative meetings, Innovas and UW–Madison created a plan to install a Helios TCS for a cooling season, and measure and validate results compared to an identical chiller operating under the same conditions but without a Helios TCS. Key to the plan was that Innovas would guarantee the risk, if the Helios TCS results weren't as expected, Innovas would take it back.

TRIAL DETAILS

The strategy for the trial was to run two identical chillers side-by-side under the same conditions and equal run-hours—one chiller (Chiller 2) retrofitted with Helios TCS systems and the other (Chiller 1) without. The chillers share common chilled water and condenser water piping and were monitored throughout the trial period for the data listed below. It was important for the trial to leverage multiple sources of comparative data in order to fully validate the Helios Tube Cleaning System® effectiveness. To supplement the analysis and results from the side-by-side comparison, Chiller 2 operational data from 2017 (pre-Helios TCS) was compared to 2018 (post-Helios TCS) to demonstrate the change in efficiency after the Helios TCS installation.

Trial Background

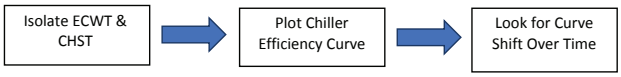
1. UW–Madison Charter Street Heating & Cooling Plant – Chillers 1 & 2
2. Twin Field-Erected Steam Turbine Chillers, Capacity 4,000 Tons Each
3. Condenser: 3,100 Tubes, 2 Pass, 24" Piping
4. Evaporator: 3,101 Tubes, 3 Pass, 18" Piping
5. Shared Chilled Water & Condenser Water Piping

Trial Set-Up & Test Plan

1. Install Helios Tube Cleaning System® on Chiller 2 evaporator and condenser
2. Record chiller operations data for 2017 and 2018
3. Conduct pre-Helios TCS & post-Helios TCS evaluation of Chiller 2 efficiency
4. Conduct side-by-side efficiency evaluation of Chiller 2 equipped with Helios TCS vs. Chiller 1 without Helios TCS.

Analysis Method

1. Simultaneously consider multiple factors impacting chiller efficiency
   a. Chiller Load (L)
   b. Chilled Water Supply Temperature (CHST)
   c. Entering Condenser Water Temperature (ECWT)
   d. Chiller Tube Fouling



2. UW–Madison Conditions
   a. Chilled Water Supply Temperature Constant 40F
   b. Plots at 4 Entering Condenser Water Temperatures 65F,70F,75F & 80F

RESULTS

After careful analysis of the data it was clear that the Helios TCS had delivered a very significant efficiency improvement for Chiller 2 when compared head to head with Chiller 1. Additionally, the measured efficiency improvement was further substantiated via comparison of Chiller 2 performance from 2017 (pre-Helios TCS) to 2018 (post-Helios TCS). Interestingly, Chiller 2 also provided much greater capacity after Helios TCS installation—producing up to 400 additional tons of cooling due to its clean-tube performance.

FIGURE 1 compares Chiller 2 efficiency curves from 2017 (before Helios TCS) and 2018 (after Helios TCS) at a CHST of 40F and ECWT of 65F, and indicates a 14% efficiency improvement after Helios TCS installation. When all four operating conditions (ECWT of 65F, 75F, 80F, 85F) are considered the average year-over-year efficiency gain is 11%, a substantial efficiency improvement attributed to the Helios TCS.

The side-by-side analysis required juxtaposition of Chiller 1 and Chiller 2 operating data from the complete 2018 cooling season. During the season, the operating hours on the chillers were balanced across the full operation range. **FIGURE 2** highlights the substantial improvement in efficiency between Chiller 1 (without Helios) and Chiller 2 (with Helios) at an ECWT of 65 Degrees F. The result is a 14% efficiency improvement for the Helios chiller over the non-Helios chiller. When the efficiency data for all four measured ECWT is averaged, the total improvement for Chiller 2 over Chiller 1 is 13%.

The data show an additional Helios TCS benefit for chiller productivity. The Helios TCS kept the chiller tubes clean and optimized heat transfer efficiency. The result is increased chiller capacity and cooling output. **FIGURE 3** highlights the increased capacity of Chiller 2 over Chiller 1—directly attributed to the Helios TCS—when the ECWT was 75 degrees F. At identical operating conditions, Chiller 2 generated up to 400 tons more cooling than Chiller 1 even while consuming less energy than Chiller 1.

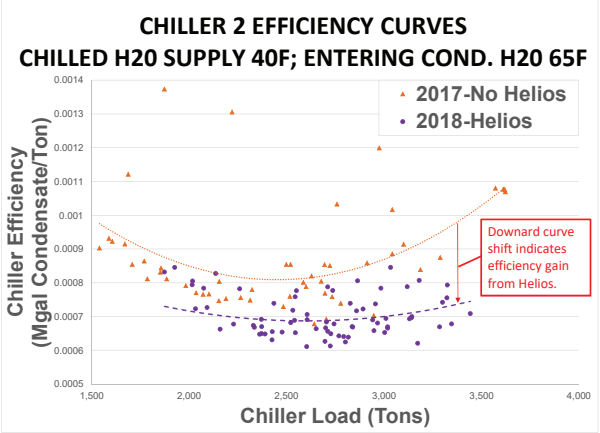


FIGURE 1 Chiller 2 Efficiency Comparison from 2017 (Pre-Helios) to 2018 (Post-Helios) at 65 Degree F Entering Condenser Water Temperature.

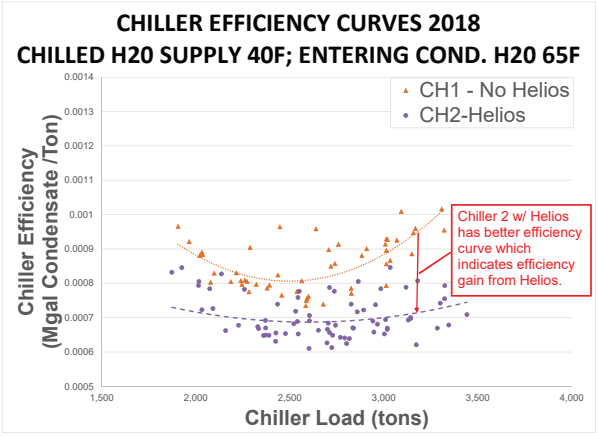


FIGURE 2 Side by Side Comparison of Chiller 1 (Without Helios) and Chiller 2 (With Helios) For Complete 2018 Cooling Season With 65 Degree F Entering Condenser Water

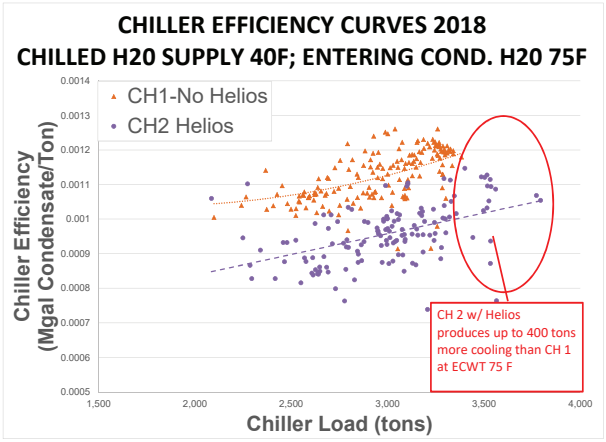


FIGURE 3 Increased Chiller 2 Capacity Vs Chiller 1 Due to Clean Tubes at Entering Condenser Water Temperature at 75 Degrees F.

SUMMARY

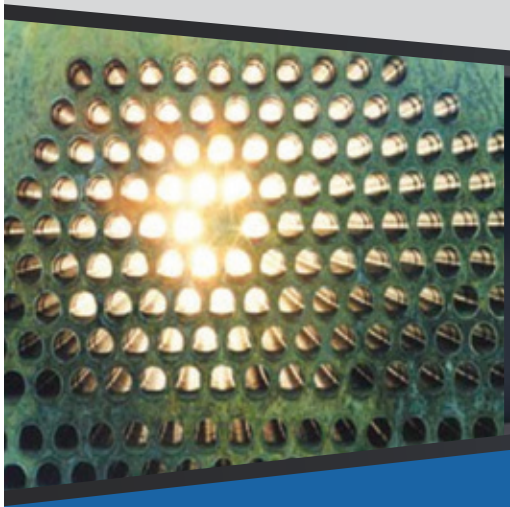
The Helios Tube Cleaning System® provided exceptional efficiency gains for the University of Wisconsin–Madison as demonstrated by the 2017-2018 comparative chiller analyses results. UW–Madison addressed the fouling-related chiller inefficiency problem and adopted an innovative but proven solution to substantially improve chiller plant productivity.

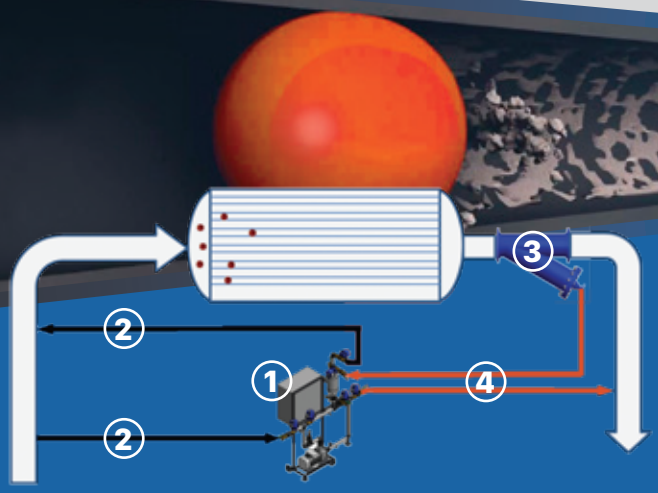
University of Wisconsin–Madison Summary Results	
Avg. Chiller Efficiency Gain:	12%
Chiller Capacity Increase:	Up to 400 tons
Annual Energy Savings:	10,370 MMBtu
Annual Energy Cost Savings:	$40,000
Project Life-time CO2 Emission Reductions:	9,200 Tons
Project Life-time Cost Savings (15 Yrs):	$850,000

FIGURE 4 UW–Madison Summarized Efficiency Effects of Helios TCS

The Helios Tube Cleaning System® from Innovas improves the energy efficiency of cooling systems

- **Prevents scale**, fouling, biological life and corrosion in heat exchanger tubes
- **Reduces maintenance** and downtime costs by eliminating manual or chemical tube cleaning
- **Extends the service life** of heat transfer equipment





The Helios Cleaning Cycle

The Helios cycle is fully automatic and controlled by a programmable controller.

1. Between cycles, the sponge balls are stored in the Collector and all valves are closed.
2. At programmed intervals, the Controller commands the injection valves to open and pump to start, and the balls are injected into the heat exchanger inlet line.
3. Normal cooling water flow transports the balls through the heat exchanger tubes and into the Ball Trap.
4. The Controller then prompts the collection valves to open and pump to start, and the balls are returned to the Collector, where they are held until the next injection/collection cycle starts.

View the Helios TCS Operation in action at innovastechnologies.com

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