Environmental and Economic Impacts of Automatic Tube Cleaning System

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Defining the Problem

- Chillers represent >15% of building’s energy use during warm months
- Studies show >95% of shell & tube heat exchangers suffer tube fouling
  
  (Muller-Steinhagen, 2011; Steinhagen et al., 1992; Garrett-Price et al., 1985)

Scale  Particulate  Biofilm

- >$1.5 Billion wasted every year in USA due to chiller inefficiency
Before ATCS: George Mason University: Chiller #9

The Status Quo: Linear Chiller Fouling
-The Solution-
How Auto Tube Cleaning Systems (ATCS) Work
How Auto Tube Cleaning Systems (ATCS) Work
What It Does

• Constant cleaning of the tubes:
  • No suspended solids can collect
  • No biological colonies can form
  • No seed particles form for scale growth
  • No Fouling in your tubes........
Automatic Tube Cleaning Systems (ATCS): Multiple Value Dimensions

- Avg. chiller efficiency improves 5-15%
- Increase chiller cooling output up to 10%
- Reduce or eliminate manual tube brushing & chemical cleaning
- Improves chiller plant availability
- Reduce GHG emissions and environmental impact
- Reduces labor churn freeing team for higher value tasks
Clear Visual Evidence of Fouling
Condenser Tubes With ATCS

Clear Visual Evidence of Cleanliness as a Result of ATCS

Clean.........Perfectly.......
BACKGROUND INFORMATION:
- CENTRAL COOLING PLANT CHILLERS 9 & 10
- 1,470 NOMINAL TONS EACH
- SHARED CHILLED & CONDENSER H2O HEADERS
2017: ATCS Maintains Chiller 10 Constant Approach Temp

No ATCS

With ATCS
2017-18: Chiller 9 Approach Temp Flatlines
After ATCS

GMU Chiller 9 Condenser Approach Temperature Comparison
Before & After ATCS Installation

No ATCS

With ATCS
2017-18: Chiller 10 w/ ATCS Continues Flatline Approach

Consistent Results
With ATCS
GMU Savings Summary

- Energy Savings
- Maintenance Savings
- Green Cleaning

Total Team Adoption
EPA Greenhouse Gas Equivalency

https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

• 910 Tons of Carbon per year
• Equivalent of:
  • 210 Cars or 2,420,566 car-miles
  • 111,400 gallons of gas
  • 1,082,306 pounds of coal burned
  • 173 homes yearly electrical use
  • 345 tons of waste recycled versus landfilled
• This environmental offset also has an economic benefit of roughly $89,000 per year to GMU
Recap: George Mason University

<table>
<thead>
<tr>
<th>George Mason University Case Study Summary Results</th>
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<tbody>
<tr>
<td>Average Chiller Efficiency Gain:</td>
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<tr>
<td>Chiller Capacity Increase:</td>
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<tr>
<td>Annual Energy Savings:</td>
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<td>Project Lifetime CO2 Emission Reductions:</td>
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<td>Project Lifetime Savings (15 Yrs):</td>
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### University of Wisconsin Case Study Summary Results

<table>
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<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Average Chiller Efficiency Gain:</td>
<td>12%</td>
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<tr>
<td>Chiller Capacity Increase:</td>
<td>Up to 400 tons</td>
</tr>
<tr>
<td>Annual Energy Savings:</td>
<td>10,370 MMBtu</td>
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<tr>
<td>Annual Energy Cost Savings:</td>
<td>$40,000</td>
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<tr>
<td>Project Lifetime CO2 Emission Reductions:</td>
<td>9,200 tons</td>
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<tr>
<td>Project Lifetime Savings (15 Yrs):</td>
<td>$850,000</td>
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- Consistent Performance Elsewhere -

**Xcel Energy Case Study Results**

**Xcel Energy Case Study Summary Results**

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<th>Metric</th>
<th>Result</th>
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<tbody>
<tr>
<td>Average Chiller Efficiency Gain:</td>
<td>4%</td>
</tr>
<tr>
<td>Chiller Capacity Increase:</td>
<td>Up to 200 tons</td>
</tr>
<tr>
<td>Annual Energy Savings:</td>
<td>180,000 kW-hrs</td>
</tr>
<tr>
<td>Annual Cost Savings:</td>
<td>$20,000</td>
</tr>
<tr>
<td>Project Lifetime CO2 Emission Reductions:</td>
<td>2,200 Tons</td>
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<tr>
<td>Project Lifetime Savings (15 Yrs):</td>
<td>$410,000</td>
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</table>
XCEL Energy: Chiller 4 Efficiency Curves Before & After ATCS & Increased Capacity

Downward curve shift indicates efficiency gain from ATCS.

Average Efficiency Gain After ATCS: 12%

Up to 400 Tons Extra Capacity

Average Efficiency Gain After ATCS: 9%

Up to 400 Tons Extra Capacity
Summary: If Our True Goal is to Optimize Chiller Efficiency... Then The Status Quo Has To Be Changed

Chemical Treatment Alone Is NOT “Best In Class” Efficiency

Water Treatment + Continuous Tube Cleaning = True Optimized Efficiency