Improving Chiller Efficiency & Sustainability Via Tube Fouling Prevention

Presented by:
Michael Crocker – Innovas Technologies

December 2018
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)

- >$1.5 Billion wasted every year in USA due to chiller inefficiency
If Our True Goal is to Optimize Chiller Efficiency…

**Chemical Treatment Alone**

Is NOT

“Best In Class” Efficiency

Water Treatment + Continuous Tube Cleaning =

True Optimized Efficiency
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
How Auto Tube Cleaning Systems (ATCS) Work
Since 2012, ATCS Installed on 18 Chillers (26,000 Tons) & Counting!
University of Wisconsin Case Study

BACKGROUND INFORMATION:

- CENTRAL PLANT - CHILLERS 1 & 2
- TWIN 4,000 TON STEAM CHILLERS
- SHARED CHILLED & CONDENSER H2O HEADERS
- ATCS INSTALLED ON CHILLER 2 CONDENSER & EVAPORATOR
ATCS Increased Chiller Cooling Capacity!

CH 2 w/ ATCS produces up to 350 tons more cooling than CH 1 at ECWT 80F.
Chiller 2 Efficiency Curve Before & After ATCS

Average Efficiency Gain After Helios: 11%

Downward curve shift indicates efficiency gain from ATCS.
Chiller Efficiency Curves Side by Side Comparison

Chiller Efficiency Curves 2018
Chilled Water Supply 40F, Entering Condenser Water 75F

Chiller 2 w/ ATCS has lower efficiency curve which indicates efficiency gain from ATCS.

Average Efficiency Advantage With Helios: 15%
### University of Wisconsin Case Study Summary Results

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

BACKGROUND INFORMATION:

• XCEL ENERGY DISTRICT COOLING PLANT – CHILLER 4
• 2,500 NOMINAL TONS
• DENVER DOWNTOWN DISTRICT COOLING
Chiller 4 Efficiency Curves Before & After ATCS

Average Efficiency Gain After ATCS: 12%

Average Efficiency Gain After ATCS: 9%

Downward curve shift indicates efficiency gain from ATCS.
## Xcel Energy Case Study Summary Results

<table>
<thead>
<tr>
<th>Description</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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</tbody>
</table>
George Mason University Case Study

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
2017-18: Chiller 9 Approach Temp Flatlines After ATCS
2017-18: Chiller 10 w/ ATCS Continues Flatline Approach
### George Mason University Case Study Summary Results

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<td>Average Chiller Efficiency Gain:</td>
<td>10%</td>
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<tr>
<td>Chiller Capacity Increase:</td>
<td>Up to 200 tons</td>
</tr>
<tr>
<td>Annual Energy Savings:</td>
<td>550,000 kW-hrs</td>
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<td>Annual Cost Savings:</td>
<td>$45,000</td>
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<tr>
<td>Project Lifetime CO2 Emission Reductions:</td>
<td>6,500 Tons</td>
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<td>Project Lifetime Savings (15 Yrs):</td>
<td>$900,000</td>
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</table>

**BACKGROUND INFORMATION:**
- CENTRAL COOLING PLANT CHILLERS 9 & 10
- 1,470 NOMINAL TONS EACH
- SHARED CHILLED & CONDENSER H2O HEADERS

**George Mason University Case Study**
Key ATCS Technology Application Concepts

- Supplements water treatment
- Applies to chiller condenser or evaporator
- Upper temperature limit of 280 F
- Effective coarse straining of inlet cooling water is critical
- For optimum benefit, all tubes in tube bundle need to be the same size
ATCS & Emerging Technologies

Introducing Mobile Micro-sensor Technology to Operating Chillers

• Low Cost
• Condenser flow & temperature measurement
• Predictive failure prevention via vibration analysis
• Future to provide real-time tube NDE.
• Allows optimized condenser operation.
• Industrial IOT: automate a slow manual process

Today: Offline, Manual, Reactive
Tomorrow: Real Time, Automated, Predictive
Questions?

Michael Crocker, Innovas Technologies
mcrocker@innovastechnologies.com
How Auto Tube Cleaning Systems (ATCS) Work