WORKING FOR A BETTER WORLD INSIDE AND OUT

Carrier
“Hybrid Cooling with a Power Twist”

Cooling Combined Heat and Power (CCHP)
Sustainable Design

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Carrier Corporation

Con Edison

Carrier

1011/07
United Technologies Corporation

• Pratt Whitney
• Otis
• Hamilton Standard
• UTC Power
• Sikorsky
• Carrier
Where Does Your Money Go?

Operational Costs

Energy Costs

Repairs & Outside Maintenance Costs
Put Capital Back Into Your Operation Where It Can be Used to Upgrade and Increase Effectiveness

Operational Costs

Energy Costs

Repairs & Outside Maintenance Costs
Overview

• What is a typical hybrid chiller plant?

• Why is this CCHP different?

• What is a Microsteam Turbine Generator?

• Potential Applications/Benefits

• Sample Layout
Typical Hybrid Plant
1200 ton capacity

Kw

Steam

Electric drive (600T)

Absorption (600T)
CCHP Hybrid Plant
1200 ton capacity

- 125 PSIG
- 275 Kw
- 14 PSIG

- Electric drive (500T)
- VFD drive
- Microsteam
- L.P. Absorption (700T)
1200 Ton Cooling Hybrid CHP Plant

- 700 tons: LP Absorption
- 500 tons: VFD Electric

Input Temperature: 56°F
Output Temperature: 44°F

Pressures: 165 PSIG, 12 PSIG
Power: 275 Kw

Microsteam Generator
1200 Ton Cooling Hybrid CHP Plant

700 tons

56F

165 PSIG

12 PSIG

275Kw Microsteam

12 PSIG

VFD Electric

500 tons

LP Absorption

44F

500 tons
CCHP Hybrid Plant
CCHP-1200

- Nom. 700 ton LP absorber @18 #/ton hr = 12,600 #/hr
- Microsteam Power system at 275 Kw = 1,083 #/hr
- Overall steam flow = 13,683 #/hr
- For 1200 tons, nom. system steam rate is = 11.4 #/ton hr
- 500 ton VFD chiller @ .55 Kw/ton = 275 Kw
- Cooling plant capacity = 1200 tons
- Off peak operational flexibility yes
- Scaleable Capacity Range yes
Overview

• What is a typical hybrid chiller plant?

• Why is this CCHP different?

• What is a Microsteam Turbine Generator?

• Potential Applications/Benefits

• Sample Layout
Target Market
Commercial / Institutional

• Web Sites
  – DOE: Energy Tips: “Replace Pressure-Reducing Valves with Backpressure Turbogenerators”

• Journal Articles
  – IDEA’s District Energy: “STGs as PRVs?”

• Reasons
  – Value of Power Savings
  – Electric Peak Load Shedding
  – Sustainable Design
  – Waste Steam Availability
  – Efficiency of Power Production
  – Lack of Utility Grid Capacity
Figure 1 Microsteam Power System
Microsteam® Turbine

- Basic Euler Turbine Design
- Flow Through Nozzles Against Blades
- Opposed Rotation Steam Discharge Through Blade Passages
Microsteam® Turbine

- Shrouded Wheel Design
- Operating Speed: 28,000 RPM
- Titanium Alloy Construction
- Vertical Shaft for Top Mounting
Projected Performance 125-15psig@12,000#/hr

Turbine Performance Predictor

<table>
<thead>
<tr>
<th>Input</th>
<th></th>
</tr>
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<tbody>
<tr>
<td>Supply Pressure</td>
<td>165</td>
</tr>
<tr>
<td>Superheat</td>
<td>0</td>
</tr>
<tr>
<td>Load Pressure</td>
<td>15</td>
</tr>
<tr>
<td>Steam Load Flow</td>
<td>11000</td>
</tr>
<tr>
<td>Electric Power Hz.</td>
<td>60</td>
</tr>
</tbody>
</table>

| Number of Units        | 1     |
| Electric Power Output  | 275   |
| Required Blade Length  | 0.322 |

| Total Flow             | 12083 |
| Equivalent Stm Use for kW Gen | 1083 |

Part Load Operation for single unit:

<table>
<thead>
<tr>
<th>Total Flow</th>
<th>Equivalent Flow</th>
<th>Equivalent Power</th>
<th>Equivalent Stm Use</th>
<th>Equivalent By-Pass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lb/hr</td>
<td>Lb/hr</td>
<td>kW</td>
<td>kW</td>
<td>kW</td>
</tr>
</tbody>
</table>

| 12083      | 11000           | 275               | 1083               | 34                  |
| 10575      | 9919            | 243               | 956                | 0                   |
| 9667       | 8566            | 206               | 811                | 0                   |
| 8458       | 7794            | 161               | 664                | 0                   |
| 7250       | 6731            | 130               | 519                | 0                   |
| 6042       | 5663            | 93                | 378                | 0                   |
| 4033       | 4591            | 50                | 243                | 0                   |
| 3625       | 3516            | 23                | 109                | 0                   |

Nozzle Inlet Temperature 373.3°F
Nozzle Inlet Pressure 165.1 psig
Nozzle Exit Pressure 56.0 psig
Noz. Exit Total Temp. 333.2°F
Noz. Exit Static Temp. 303.2°F
Rotor Inlet Tot. Rel. Temp. 303.2°F
Turbine Exit Total Temp. 298.4°F
Routing of wiring/conduit is shown for schematic purposes only contractor to route these as required.

Notes: Unless otherwise specified.
Microsteam Prototype
Installed in
Rolex World HQ
New York, NY

Design of 150Kw
9/03 Operation
Commercial Release
Microsteam® Turbine

Design of 275 Kw
2/06 release
Carrier Microsteam
Installed in
United Technologies
Research Center
Hartford, CT
Carrier Microsteam
Installed in
7 World Trade Center
New York, NY
Carrier Microsteam for installation at 65 Broadway New York, NY

The MST is part of Carrier’s Combined Heat and Power Plant (CCHP-850) system installed there
Carrier Microsteam
Single Skid Design for Con Edison
New York, NY
Microsteam run test for Princeton University
Potential Applications/Benefits

• Alternative to all electric drive plant
• Series flow coolers – electric chiller can trim
• Cogeneration - make electricity from HP steam
• Alternative to double effect/turbine
• NYSERDA incentive benefits
• CON EDISON incentive benefits
• Potential NYISO incentives
• Environmental aspects
• Operating costs
• Lower maintenance costs
• LEED for new construction and retrofit
• Lower risk to ownership
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ANY QUESTIONS?