Water Fired Chiller/Chiller-Heater

WFC-S Series: 10, 20 and 30 RT Cooling
Yazaki water fired SINGLE-EFFECT chillers or chiller-heaters have cooling capacities of 10, 20 and 30 tons of refrigeration and produce chilled water for cooling or hot water for heating in comfort air conditioning applications. The absorption cycle is energized by a heat medium (hot water) at 158°F to 203°F from an industrial process, cogeneration system, solar energy or other heat source and the condenser is water cooled through a cooling tower.

Absorption Principle

The Yazaki absorption chiller or chiller-heater uses a solution of lithium bromide and water, under a vacuum, as the working fluid. Water is the refrigerant and lithium bromide, a nontoxic salt, is the absorbent. Refrigerant, liberated by heat from the solution, produces a refrigerating effect in the evaporator when cooling water is circulated through the condenser and absorber.

Cooling Cycle

Generator

When the heat medium inlet temperature exceeds 154.4°F, the solution pump forces dilute lithium bromide solution into the generator. The solution boils vigorously under a vacuum and droplets of concentrated solution are carried with refrigerant vapor to the primary separator. After separation, refrigerant vapor flows to the condenser and concentrated solution is precooled in the heat exchanger before flowing to the absorber.

Condenser

In the condenser, refrigerant vapor is condensed on the surface of the cooling coil and latent heat, removed by the cooling water, is rejected to a cooling tower. Refrigerant liquid accumulates in the condenser and then passes through an orifice into the evaporator.
Evaporator
In the evaporator, the refrigerant liquid is exposed to a substantially deeper vacuum than in the condenser due to the influence of the absorber. As refrigerant liquid flows over the surface of the evaporator coil it boils and removes heat, equivalent to the latent heat of the refrigerant, from the chilled water circuit. The recirculating chilled water is cooled to 44.6°F and the refrigerant vapor is attracted to the absorber.

Absorber
A deep vacuum in the absorber is maintained by the affinity of the concentrated solution from the generator with the refrigerant vapor formed in the evaporator. The refrigerant vapor is absorbed by the concentrated lithium bromide solution flowing across the surface of the absorber coil. Heat of condensation and dilution are removed by the cooling water and rejected to a cooling tower. The resulting dilute solution is preheated in a heat exchanger before returning to the generator where the cycle is repeated.

Generator
When the heat medium inlet temperature exceeds 154.4°F, the solution pump forces dilute lithium bromide solution into the generator. The solution boils vigorously under a vacuum to generate refrigerant vapor and droplets of concentrated solution. Since the changeover valve is open during heating operation, the mixture of refrigerant vapor and concentrated solution flows directly into the evaporator. Some refrigerant vapor flows through the condenser before reaching the evaporator.

Evaporator
Hot refrigerant vapor condenses on the surface of the evaporator coil and heat, equivalent to the latent heat of the refrigerant, is transferred to the hot water circuit. The recirculating water is heated to 131°F. Refrigerant liquid mixes with concentrated lithium bromide solution and the resulting dilute solution returns to the generator where the cycle is repeated.
Features

- Absorption cycle energized by hot water at 158°F to 203°F from process, cogeneration, solar or other waste heat sources.
- Safe, odorless, non-toxic working fluids of lithium bromide and water operate under a vacuum at all times.
- Supplied as a chiller only or a chiller-heater for applications that require separation of heating water and heat medium circuits due to glycol, operating pressure, flow or piping limitations.
- Crystallization prevented in the generator by utilizing a solution pump and gravity drain-back system.
- Single hermetic pump controls solution flow.
- Faster cold start-up time than similar chillers with flooded generators.
- Chilled water and hot water outlet temperatures controlled by a built-in microprocessor with outputs to control a 3-way valve and/or heat medium pump (supplied by others).
- All chillers and chiller-heaters supplied with a standard weatherproof cabinet suitable for outdoor installation.
- Built-in shutdown controls for high heat medium temperature and abnormal cooling water conditions.
- Cooling capacities increased at 85°F cooling water and when energized by 203°F heat medium.
- Ideal for a two pipe hydronic system in which chilled or hot water is circulated to a central airhandling unit or multiple fan-coil units.
- Cooling or heating operation on chiller-heaters can be selected from a remote or built-in switch.
- Only 30 minute delay required for operation changeover.
- Transportation and lifting are simplified because of modular construction.
- Factory charged and performance tested.
- UL Listed for USA and Canada.

Control Characteristics

- COOLING

- HEATING

- Standard Rating Point

- Standard Control Settings
**Application** (Water Fired Cooling & Heating System - Cooling Operation)

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**Specifications**

<table>
<thead>
<tr>
<th>Model</th>
<th>WFC</th>
<th>SC10</th>
<th>SH10</th>
<th>SC20</th>
<th>SH20</th>
<th>SC30</th>
<th>SH30</th>
</tr>
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<tbody>
<tr>
<td><strong>Cooling</strong></td>
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<tr>
<td>Capacity (Btu/hr x 1000)</td>
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<td><strong>Heating</strong></td>
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<tr>
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<td>Hot Water Temp. (°F)</td>
<td>131.0 Outlet, 117.3 Inlet</td>
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<td>Rated Water Flow (gpm)</td>
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<td>Evap. Press Drop (psi)</td>
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<td>Heat Rejection (Btu/hr x 1000)</td>
<td>291.4</td>
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<td>Inlet Temperature (°F)</td>
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<td><em>Rated Water Flow (gpm)</em></td>
<td>80.8</td>
<td>161.7</td>
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<td>Cond./Abs. Press. Drop (psi)</td>
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<td>Input (Btu/hr x 1000)</td>
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<td>Inlet Temperature (°F)</td>
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<td>76.1</td>
<td>114.1</td>
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<td>Generator Press. Drop (psi)</td>
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<td>Power Supply</td>
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<td>260</td>
<td>310</td>
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<td><em>On - Off</em></td>
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<td><strong>Noise Level</strong></td>
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<td>Sound Pressure dB(A)</td>
<td>49</td>
<td>49</td>
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<td><strong>Piping</strong></td>
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<tr>
<td>Chilled/Hot Water (in)</td>
<td>1-1/2 NPT</td>
<td>2 NPT</td>
<td>2 NPT</td>
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<td>Cooling Water (in)</td>
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<td>2 NPT</td>
<td>2-1/2 NPT</td>
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<td>Heat Medium (in)</td>
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<td>2 NPT</td>
<td>2-1/2 NPT</td>
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<tr>
<td><strong>Weight</strong></td>
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<td>Dry (lb)</td>
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<td>2,050</td>
<td>3,200</td>
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<tr>
<td>Operating (lb)</td>
<td>1,329</td>
<td>2,548</td>
<td>3,975</td>
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</tr>
</tbody>
</table>

* Minimum cooling water flow

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**NOTES:**

1. Specifications are based on water in all circuits and fouling factor of 0.0005 ft/hr°F/Btu.
2. Do not exceed 85.3 psi operating pressure in any water circuit.
3. If heat medium inlet temperature exceeds 203°F the chiller/chiller-heater will shutdown and require manual reset.
5. Sound pressure noise level measured in a free field at a point 79 in. behind the chiller/chiller-heater and 59 in. above the ground.
Performance Characteristics

**WFC-SC10/SH10**
(44.6°F CHILLED WATER)

<table>
<thead>
<tr>
<th>Heat Medium Inlet Temperature (°F)</th>
<th>Cooling Capacity Factor</th>
<th>Heat Input Factor</th>
<th>Heating Capacity Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>80°F</td>
<td>1.3</td>
<td>1.0</td>
<td>0.8</td>
</tr>
<tr>
<td>85°F</td>
<td>1.2</td>
<td>1.0</td>
<td>0.7</td>
</tr>
<tr>
<td>87.8°F</td>
<td>1.1</td>
<td>1.0</td>
<td>0.6</td>
</tr>
<tr>
<td>158°F (MIN)</td>
<td>1.0</td>
<td>1.0</td>
<td>0.4</td>
</tr>
<tr>
<td>203°F (MAX)</td>
<td>0.7</td>
<td>1.0</td>
<td>0.2</td>
</tr>
</tbody>
</table>

**WFC-SC20/SH20**
(44.6°F CHILLED WATER)

<table>
<thead>
<tr>
<th>Heat Medium Inlet Temperature (°F)</th>
<th>Cooling Capacity Factor</th>
<th>Heat Input Factor</th>
<th>Heating Capacity Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>80°F</td>
<td>1.6</td>
<td>1.4</td>
<td>1.2</td>
</tr>
<tr>
<td>85°F</td>
<td>1.5</td>
<td>1.4</td>
<td>1.1</td>
</tr>
<tr>
<td>87.8°F</td>
<td>1.4</td>
<td>1.4</td>
<td>1.0</td>
</tr>
<tr>
<td>158°F (MIN)</td>
<td>1.3</td>
<td>1.4</td>
<td>0.8</td>
</tr>
<tr>
<td>203°F (MAX)</td>
<td>1.2</td>
<td>1.4</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Cooling Water Inlet Temp. 85°F
Hot Water Outlet Temp. 131°F
NOTES:

1. Designates Standard Rating Point.

2. Capacity and Heat Input curves based on standard water flow rates in all circuits.

3. Heat Medium Flow Correction curve only applicable for heat medium inlet temperatures of 176°F to 203°F.

4. Heating Efficiency = 97%.

5. Performance based on standard fouling factor of 0.0005 ft²hr°F/Btu in all circuits.

6. Performance data may be interpolated but must not be extrapolated.

7. Expanded performance curves are provided for reference only. Contact Yazaki Energy Systems, Inc. to obtain certified performance ratings from the factory or to determine performance at other conditions outside the scope of this publication.
ABSORPTION CHILLER HEAT BALANCE
HEAT IN = HEAT OUT

Qg + Qe = Qc
Where, Qg = Heat input to generator
Qe = Cooling capacity
Qc = Heat rejected to cooling tower

COOLING CAPACITY
Qe = CLG. CAP. x HM FLOW x STD. CLG. FACTOR CORRECTION x CAPACITY

HEAT INPUT (COOLING)
Qg = HEAT INPUT x HM FLOW x STD. HEAT FACTOR CORRECTION INPUT

HEATING CAPACITY
Qh = HTG. CAP. x HM FLOW x STD. HTG. FACTOR CORRECTION x CAPACITY
Where, Qh = Heating Capacity

HEAT INPUT (HEATING)
Qg = HEATING CAPACITY = Qh

TEMPERATURE DIFFERENCE (°F)
ΔT = ADJUSTED CAPACITY OR HEAT INPUT (MBH) / 0.5 x FLOW (gpm)

PRESS. DROP FOR NONSTANDARD FLOW (psi)
ΔP = STANDARD x NONSTANDARD FLOW / STANDARD FLOW

EXAMPLE 1.

Given design conditions:
Heat medium inlet temperature .....................195°F
Heat medium flow ......................................114.1 gpm
Cooling water inlet temperature .......................85°F
Cooling water flow .....................................242.5 gpm
Chilled water outlet temperature .....................44.6°F
Hot water outlet temperature ........................131°F
Chilled/hot water flow ................................72.6 gpm

Refer to Capacity Factor curves and Specifications for model WFC-SC30/SH30. Since 114.1 gpm is standard, the Heat Medium (HM) Flow Correction is 1.0.

1. AVAILABLE COOLING CAPACITY:
   Cooling Capacity Factor = 1.12
   Heat Medium Flow Correction = 1.0
   Standard Cooling Capacity = 360.0 MBH
   Qe = 1.12 x 1.0 x 360.0 = 403.2 MBH (33.6 tons)
   Chilled Water ΔT = 403.2 / 0.5 x 72.6 = 11.1°F
   Chilled Water ΔP = 10.1 psi (Standard)

2. HEAT INPUT (COOLING):
   Heat Input Factor = 1.17
   Heat Medium Flow Correction = 1.0
   Standard Heat Input = 514.2 MBH
   Qg = 1.17 x 1.0 x 514.2 = 601.6 MBH
   Heat Medium ΔT = 601.6 / 0.5 x 114.1 = 10.5°F
   Heat Medium ΔP = 8.8 psi (Standard)

3. HEAT REJECTED TO COOLING TOWER:
   Qc = Qg + Qe = 601.6 + 403.2 = 1004.8 MBH
   Cooling Water ΔT = 1004.8 / 0.5 x 242.5 = 8.3°F
   Cooling Water ΔP = 6.7 psi (Standard)

4. AVAILABLE HEATING CAPACITY:
   Heating Capacity Factor = 1.12
   Heat Medium Flow Correction = 1.0
   Standard Heating Capacity = 498.9 MBH
   Qh = 1.12 x 1.0 x 498.9 = 558.8 MBH
   Hot Water ΔT = 558.8 / 0.5 x 72.6 = 15.4°F
   Hot Water ΔP = 10.1 psi (Standard)

5. HEAT INPUT (HEATING):
   Qg = Qh = 558.8 / 0.97 = 576.1 MBH
   Heat Medium ΔT = 576.1 / 0.5 x 114.1 = 10.1°F
   Heat Medium ΔP = 8.8 psi (Standard)

EXAMPLE 2.

Given design conditions:
Heat medium inlet temperature .....................203°F
Heat medium flow .....................................57.0 gpm
Cooling water inlet temperature .......................85°F
Cooling water flow ....................................242.5 gpm
Chilled water outlet temperature .....................44.6°F
Hot water outlet temperature ........................131°F
Chilled/hot water flow ................................72.6 gpm

Refer to Capacity Factor curves and Specifications for model WFC-SC30/SH30. Since 57.0 gpm is 50% of standard, the Heat Medium (HM) Flow Correction is 0.86.

1. AVAILABLE COOLING CAPACITY:
   Cooling Capacity Factor = 1.22
   Heat Medium Flow Correction = 0.86
   Standard Cooling Capacity = 360.0 MBH
   Qe = 1.22 x 0.86 x 360.0 = 377.7 MBH (31.5 tons)
   Chilled Water ΔT = 377.7 / 0.5 x 72.6 = 10.4°F
   Chilled Water ΔP = 10.1 psi (Standard)
2. **HEAT INPUT (COOLING):**

   - Heat Input Factor = 1.35
   - Heat Medium Flow Correction = 0.86
   - Standard Heat Input = 514.2 MBH
   - \[ Q_{g} = 1.35 \times 0.86 \times 514.2 = 597.0 \text{ MBH} \]
   - Heat Medium \( \Delta T = \frac{597.0}{0.5 \times 57.0} = 20.9°F \)
   - Heat Medium \( \Delta P = 8.8 \times \left( \frac{57.0}{114.1} \right)^2 = 2.2 \text{ psi} \)

3. **HEAT REJECTED TO COOLING TOWER:**

   - \[ Q_{c} = Q_{g} + Q_{e} = 597.0 + 377.7 = 974.7 \text{ MBH} \]
   - Cooling Water \( \Delta T = \frac{974.7}{0.5 \times 242.5} = 8.0°F \)
   - Cooling Water \( \Delta P = 6.7 \text{ psi (Standard)} \)

4. **AVAILABLE HEATING CAPACITY:**

   - Heat Capacity Factor = 1.33
   - Heat Medium Flow Correction = 0.86
   - Standard Heating Capacity = 498.9 MBH
   - \[ Q_{h} = 1.33 \times 0.86 \times 498.9 = 570.6 \text{ MBH} \]
   - Hot Water \( \Delta T = \frac{570.6}{0.5 \times 72.6} = 15.7°F \)
   - Hot Water \( \Delta P = 10.1 \text{ psi (Standard)} \)

5. **HEAT INPUT (HEATING):**

   - \[ Q_{g} = Q_{h} = 570.6 = 588.2 \text{ MBH} \]
   - Heat Medium \( \Delta T = \frac{588.2}{0.5 \times 57.0} = 20.6°F \)
   - Heat Medium \( \Delta P = 8.8 \times \left( \frac{57.0}{114.1} \right)^2 = 2.2 \text{ psi} \)

**Cooling Water Crossover Piping (Supplied by others)**

The condenser and absorber of chiller/chiller-heater models WFC-SC20/SH20 and WFC-SC30/SH30 are connected in parallel by cooling water crossover piping installed at the jobsite. If this piping is fabricated at the jobsite by others it must be designed in accordance with the following recommendations to ensure balanced flow through the condenser and absorber:

1. Branch piping is 2 in. (WFC-SC20/SH20) or 2-1/2 in. (WFC-SC30/SH30).
2. Common inlet and outlet piping is 3 in.

**NOTES:**

1. All pipe (or tube) sizing is nominal.
2. Install a manual balancing valve in the branch cooling water circuits to the condenser and absorber if flow is unbalanced due to changes in the piping configuration or pipe sizes.
**Typical Piping**

- Cooling tower
- CW control valve
- CT switch
- CW pump
- Absorber
- CW temp. switch
- Flush valve
- Drain
- Water supply
- CW (cooling water) control valve
- CW (cooling water) temp. switch
- Cooling water outlet
- Condenser water inlet
- Heat medium outlet
- Heat medium inlet
- Chilled/hot water outlet
- Chilled/hot water inlet
- Air vent
- FREEZE switch
- Chill/hot water pump
- HM pump
- HM bypass valve
- Limit switch
- Power supply (208V, 60Hz, 3 ph)

**Typical Field Wiring**

- CT (cooling tower) switch
- CW (cooling water) temp. switch
- Cooling water pump
- Chilled/hot water pump
- Limit switch
- HM bypass valve
- Optional methods of controlling heat medium (HM) input to chiller/chiller-heater.

**Optional Junction Box Connections**

- Remote cooling/heating mode selection (Model SH only)
- Remote start/stop selection (All models)
- Cooling tower fan control output (Alternative to CT Switch)
- Heating/cooling mode status
- Heat medium pump
- General shutdown alarm output

**Optional Control Box Connections**

- Heat medium supply shutdown control output
- Auxiliary boiler control output
- Heat available input (Temp. switch supplied by others)
- Cooling water flow input (Flow switch supplied by others)

**Optional I/O Board Connections**

- Shutdown interlock (Additional interlock)
- Freeze protection switch inputs for chilled/hot water and heat medium circuits (Temp. switches supplied by others)
- Chiller-heater standby status
- Operating status
- General fault alarm output
Dimensions

WFC-SC10/SH10

WFC-SC20/SH20

WFC-SC30/SH30

All Dimensions In Inches