Water-Fired Chiller/Chiller-Heater

WFC-S Series: 5, 10, 20, 30 and 50 RT Cooling

We Are Friendly to the Earth
Yazaki Water-Fired SINGLE-EFFECT chillers have cooling capacities of 5, 10, 20, 30, and 50 tons of refrigeration. Chiller-heaters have cooling capacities of 10, 20, and 30 tons of refrigeration. Both produce chilled water for cooling and chiller-heaters also provide hot water for heating in comfort air conditioning applications. The absorption cycle is energized by a heat medium (hot water) ranging from 158°F (70°C) to 203°F (95°C) from an industrial process, cogeneration system, solar energy, or other heat source. The condenser circuit is water cooled through a cooling tower or ground loop.

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 non-toxic 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 (68°C), the solution pump forces dilute lithium bromide solution into the generator. The solution boils on the surface of the generator tubing bundle, releasing refrigerant vapor. The vapor rises up and flows over into the condenser. The solution becomes more concentrated as a result and the concentrated solution drops into the generator sump where it drains down through a heat exchanger before entering the absorber section.

**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 or ground loop. Refrigerant liquid accumulates in the condenser sump 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 into vapor and removes an amount of heat from the chilled water circuit equivalent to the latent heat of the refrigerant. The recirculating chilled water is cooled to the selected set point 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 for 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. The heat of condensation and dilution is removed by the cooling water and rejected to a cooling tower. The resulting dilute solution is preheated in a heat exchanger and returned to the generator where the cycle is repeated.
GENERATOR
When the heat medium inlet temperature exceeds 154.4°F (68°C), the solution pump forces dilute lithium bromide solution into the generator tubing bundle. The solution boils on the surface of the generator, releasing refrigerant vapor. The vapor rises up and flows over into the condenser. The solution becomes more concentrated as a result and the concentrated solution drops into the generator sump where it drains down through a heat exchanger before entering the absorber section.

EVAPORATOR
Hot refrigerant vapor condenses on the surface of the evaporator coil and an amount of heat equivalent to the latent heat of the refrigerant is transferred into the hot water circuit. The recirculating water is heated to the selected set point. Refrigerant liquid mixes with concentrated lithium bromide solution and the resulting dilute solution returns to the generator where the cycle is repeats.

Control Characteristics

[Graph showing cooling and heating capacity versus outlet temperature]

Importantly, cooling water MUST NOT FLOW during Heating Mode!
Features and Benefits

- Ideal for use in a two-pipe system with properly-sized water coils. (WFC-SH models only.)
- Mode and enable/disable condition can be selected remotely.
- Only a 30-minute changeover delay between cooling and heating modes. (WFC-SH models only.)
- The absorption cycle is energized by hot water. Hot water can be from any source such cogeneration, solar, or any waste heat sources as long as it can be provided to the chiller or chiller-heater at a temperature between 158°F (70°C) to 203°F (95°C).
- Extended capacities available when supplied with cooling water colder than design standard of 87.8°F (31°C) and/or heat medium warmer than design standard of 190.4°F (88°C).
- Faster cold start-up time (as quick as 90 seconds) than similar chillers with flooded generators.
- Working fluids of lithium bromide and water operate under a vacuum at all times and are safe, odorless, and non-toxic.
- Only one rotating part — the hermetically sealed solution pump.
- UL Listed as a unit for USA and Canada.
- Vacuum vessel fully hermetically sealed at the factory for a level of vacuum integrity that is unmatched in the industry. No field welding necessary.
- Helps to prevent crystallization by utilizing a solution pump and gravity drain-back design.
- Chilled and hot water outlet temperatures controlled by a built-in microprocessor with outputs to control a 3-way heat medium bypass valve, all relevant pumps, and can even control the cooling tower fan if so desired. (Valves and pumps are field-supplied.)
- Built-in logic will shut down the unit under abnormally high heat medium and/or cooling water temperatures to help prevent crystallization and other service-related issues.
- Proprietary solution and inhibitor blends ELIMINATE the need for regular chemical analysis, resulting in much simpler regular maintenance when compared with most other manufacturers.
- All chillers and chiller-heaters are supplied with UL50E Type 3R cabinets that are suitable for indoor or outdoor installation without modification.
- Factory charged and run tested. Solution balancing done at the factory so that it does not need to be done in the field at startup.

Accessories

Supplied with Chiller/Chiller-Heater:

- ACT-3 Maintenance Checker (1)
- Installation Instructions (1)
- L-Anchor Plates {with WFC-SC50 only}
- Leveling Shims (6) {except on WFC-SC50}
- Lifting Lugs / eyebolts (4)
- Operating Instructions (1)
- Warranty Registration Card (1)
- Wiring Schematic (1)

Factory-Installed Options:

- FS2 Cooling Water Flow Switch
- Higher Pressure Fluid Circuits on Certain Models {except for Heat Medium circuit}
- WTI Inlet Chilled/Hot Water Sensor

Optional Field-Installed Accessories:

- Building Management System Interface Adapter (LON-compatible)
- FS2 Cooling Water Flow Switch
- Heat Medium Bypass Valve Kits
- WFC-S Service Manual
- WTI Inlet Chilled/Hot Water Sensor
## Specifications - Imperial Units

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<th>SC/SH10</th>
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<th>SC50</th>
</tr>
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<tr>
<td><strong>Cooling Capacity</strong> Mbtuh</td>
<td>60.0</td>
<td>120.0</td>
<td>240.0</td>
<td>360.0</td>
<td>498.9</td>
<td>600.0</td>
</tr>
<tr>
<td><strong>Heating Capacity</strong> (WFC-SH Only) Mbtuh</td>
<td>---</td>
<td>166.3</td>
<td>332.6</td>
<td>498.9</td>
<td>---</td>
<td>---</td>
</tr>
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</table>

### Chilled/Hot Water
- **Cooling Temperature**: °F
- **Heating Temperature**: °F
- **Evaporator Pressure Loss**: PSI
- **Max Operating Pressure**: PSI
- **Rated Water Flow**: GPM
- **Allowable Water Flow**: % of Rated
- **Water Retention Volume**: Gal

### Cooling Water
- **Heat Rejection**: Mbtuh
- **Temperature**: °F
- **Absorber Pressure Loss**: PSI
- **Condenser Pressure Loss**: PSI (Included in Absorber)
- **Max Operating Pressure**: PSI
- **Rated Water Flow**: GPM
- **Allowable Water Flow**: % of Rated
- **Water Retention Volume**: Gal

### Heat Medium
- **Heat Input**: Mbtuh
- **Temperature**: °F
- **Generator Pressure Loss**: PSI
- **Max Operating Pressure**: PSI (No High Pressure Option on Any Size)
- **Rated Water Flow**: GPM
- **Allowable Water Flow**: % of Rated
- **Water Retention Volume**: Gal

### Electrical
- **Power Supply**: 115 / 60 / 1 208 volts AC / 60 Hz / 3-Phase
- **Minimum Circuit Amps**: Amps
- **MOCP**: Amps

### Capacity Control
- **Dimensions**: Width Inches: 23.4, 29.9, 41.9, 54.3, 70.3
- **Depth**: Inches: 29.3, 38.2, 51.2, 60.8, 77.2
- **Height**: Inches: 69.1, 74.8, 79.1, 80.5, 82.1
- **Weight**: Dry lbs: 805, 1100, 2050, 3200, 4740
- **Operating lbs**: 926, 1329, 2548, 3975, 5955

### Piping
- **Chilled/Hot Water**: 1-1/4 NPT, 1-1/2 NPT, 2 NPT
- **Cooling Water**: 1-1/2 NPT, 2 NPT, 2-1/2 NPT
- **Heat Medium**: 1-1/2 NPT, 2 NPT, 2-1/2 NPT

1. Minimum cooling water flow is 100%.
2. Power consumption does not include external pumps or motors.
3. Height does not include removable lifting lugs but does include level bolts. Width/Depth does not include the junction box or mounting plates.
4. All specifications are based on water in all circuits and a fouling factor of 0.0005 ft²hr°F/BTU.
5. If heat medium temperature exceeds 204.8°F (96°C), the chiller or chiller/heater will shut down and require manual reset.
6. Do not exceed 85.3 PSI (588 kPa) in any operating circuit unless the high pressure option is chosen. High pressure option allows 113.9 PSI (785 kPa) in the Chilled/Hot Water and Cooling Water circuits only. There is no high pressure option for the Heat Medium circuit.
7. Noise level is measured in a free field at points 1m away from the cabinet and 1.5m above ground level.
Performance Characteristics at 44.6°F (7°C)

NOTES:

1. Bold blue lines indicate rated design conditions. Where these lines cross designate the Standard Rating Point.

2. All curves are based on water in all circuits flowing at rated design condition flow rates.

3. Heating Efficiency = 97%

4. Performance may be interpolated but must not be extrapolated.

5. 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.

6. Performance data based upon standard fouling factor of 0.0005 ft²hr°F/BTU in all circuits.
**WFC-SC/SH30**

Heat Medium Flow Rate Correction Chart

**WFC-SC50**

Heat Medium Flow Rate Correction Chart

**WFC-SC5**

Heat Medium Flow Rate Correction Chart

**WFC-SC/SH10, 20, 30**

Heat Medium Flow Rate Correction Chart

**LEGEND**

Cooling Water Temperatures
- **80.6°F (27°C)**
- **85.1°F (29.5°C)**
- **87.8°F (31°C)**
- Heating Capacity No Cooling Water

Allowable Flow Rates:
- Chilled/Hot Water: 80 - 120%
- Cooling water: 100 - 120%
- Heat Medium: 30 - 120%
ABSORPTION CHILLER HEAT BALANCE

HEAT IN = HEAT OUT

Qg + Qe = Qc

Where:
Qg = Actual Heat Input to Generator
Qe = Actual Cooling Capacity
Qc = Actual Heat Rejected to Tower

COOLING CAPACITY

Qe = CCF x HMFCF x RCC

Where:
Qe = Actual Cooling Capacity
CCF = Cooling Capacity Factor
HMFCF = Flow Correction Factor
RCC = Rated Cooling Capacity

HEAT INPUT (COOLING)

Qg = HIF x HMFCF x RHI

Where:
Qg = Actual Heat Input to Generator
HIF = Heat Input Factor
HMFCF = Flow Correction Factor
RHI = Rated Heat Input

HEATING CAPACITY

Qh = HCF x HMFCF x RHC

Where:
Qh = Actual Heating Capacity
HCF = Heating Capacity Factor
HMFCF = Flow Correction Factor
RHC = Rated Heating Capacity

HEAT INPUT (HEATING)

Qg = Qh / 0.97

Where:
Qg = Actual Heat Input to Generator
Qh = Actual Heating Capacity

TEMPERATURE DIFFERENCE

ΔT = Qx in Mbtuh / (0.5 x Qa)

Where:
ΔT = Temperature Difference
Qx = Actual BTUH Transferred
Qa = Actual Flow Rate in GPM

PRESSURE DROP FOR NONSTANDARD FLOW RATES (PSI)

ΔPa = ΔPr x (Qa / Qr)²

Where:
ΔPa = Actual Pressure Drop
ΔPr = Rated Design Pressure Drop
Qa = Actual Flow Rate in GPM
Qr = Rated Design Flow Rate GPM

EXAMPLE 1

Given:
- Heat Medium Inlet Temp: 195°F
- Heat Medium Flow: 114.1 GPM
- Cooling Water Inlet Temp: 85.1°F
- Cooling Water Flow: 242.5 GPM
- Chilled Water Outlet Temp: 44.6°F
- Hot Water Outlet Temp: 131°F
- Chilled/Hot Water Flow: 72.6 GPM
- Chiller-Heater Model: WFC-SH30

Refer to Performance Charts for Curves (Page 7) and Specifications (Page 5) for Rated Design Information on the Model WFC-SC/S30.

1. AVAILABLE COOLING CAPACITY:

CCF at 195°F Heat Medium = 1.12
Heat Medium Flow = 114.1 / 114.1 = 100%
HMFCF for 100% Flow Rate = 1.0
Rated Cooling Capacity = 360.0 Mbtuh

Qe = 1.12 x 1.0 x 360.0 = 403.2 Mbtuh
Chilled Water ΔT = 10.1 * (72.6 / 72.6)² = 10.1°F

2. HEAT INPUT (COOLING):

HIF at 195°F Heat Medium = 1.17
HMFCF for 100% Flow Rate = 1.0
Rated Heat Input = 514.2 Mbtuh

Qg = 1.17 x 1.0 x 514.2 = 601.6 Mbtuh
Heat Input

Heat Medium ΔT = 601.6 / (0.5 x 114.1) = 10.5°F
Heat Medium ΔP = 8.8 * (114.1 / 114.1)² = 8.8 PSI

3. HEAT REJECTED TO COOLING TOWER:

Qc = Qg + Qe

Qc = 601.6 + 403.2 = 1004.8 Mbtuh
Required minimum flow rate = 242.5 GPM

The cooling tower selected must be capable of rejecting a minimum of 1004.8 Mbtuh at a minimum flow rate of 242.5 GPM.

Cooling Water ΔT = 1004.8 / (0.5 x 242.5) = 8.3°F
Cooling Water ΔP = 6.7 * (242.5 / 242.5)² = 6.7 PSI

4. AVAILABLE HEATING CAPACITY:

HCF at 195°F Heat Medium = 1.12
HMFCF for 100% Flow Rate = 1.0
Rated Heating Capacity = 498.9 Mbtuh

Qh = 1.12 x 1.0 x 498.9 = 558.8 Mbtuh
Hot Water ΔT = 558.8 / (0.5 x 72.6) = 15.4°F
Hot Water ΔP = 10.1 * (72.6 / 72.6)² = 10.1 PSI

5. HEAT INPUT (HEATING):

Qg = Qh / 0.97 = 558.8 / 0.97 = 576.1 Mbtuh
Heat Input

Hot Water ΔT = 576.1 / (0.5 x 114.1) = 10.1°F
Hot Water ΔP = 8.8 * (114.1 / 114.1)² = 8.8 PSI

EXAMPLE 2

Given:
- Heat Medium Inlet Temp: 203°F
- Heat Medium Flow: 57.0 GPM
- Cooling Water Inlet Temp: 85.1°F
- Cooling Water Flow: 242.5 GPM
- Chilled Water Outlet Temp: 44.6°F
- Hot Water Outlet Temp: 131°F
- Chilled/Hot Water Flow: 72.6 GPM
- Chiller-Heater Model: WFC-SH30

Refer to Performance Charts for Curves (Page 7) and Specifications (Page 5) for Rated Design Information on the Model WFC-SC/S30.

1. AVAILABLE COOLING CAPACITY:

CCF at 203°F Heat Medium = 1.22
Heat Medium Flow = 57.0 / 114.1 = 50%
HMFCF for 50% Flow Rate = 0.86

Qe = 1.22 x 0.86 x 360.0 = 377.7 Mbtuh (31.5 T)
Chilled Water ΔT = 377.7 / (0.5 x 72.6) = 10.4°F
Chilled Water ΔP = 10.1 * (72.6 / 72.6)² = 10.1 PSI

2. HEAT INPUT (COOLING):

HIF at 203°F Heat Medium = 1.35
HMFCF for 50% Flow Rate = 0.86
Rated Heat Input = 514.2 Mbtuh

Qg = 1.35 x 0.86 x 514.2 = 597.0 Mbtuh
Heat Input

Heat Medium ΔT = 597.0 / (0.5 x 75.0) = 20.9°F
Heat Medium ΔP = 8.8 * (75.0 / 114.1)² = 2.2 PSI

3. HEAT REJECTED TO COOLING TOWER:

Qc = Qg + Qe

Qc = 597.0 + 377.7 = 974.7 Mbtuh
Required minimum flow rate = 242.5 GPM

The cooling tower selected must be capable of rejecting a minimum of 974.7 Mbtuh at a minimum flow rate of 242.5 GPM.

Cooling Water ΔT = 974.7 / (0.5 x 242.5) = 8.0°F
Cooling Water ΔP = 6.7 * (242.5 / 242.5)² = 6.7 PSI

4. AVAILABLE HEATING CAPACITY:

HCF at 203°F Heat Medium = 1.33
HMFCF for 50% Flow Rate = 0.86
Rated Heating Capacity = 498.9 Mbtuh

Qh = 1.33 x 0.86 x 498.9 = 570.6 Mbtuh
Hot Water ΔT = 570.6 / (0.5 x 72.6) = 15.7°F
Hot Water ΔP = 10.1 * (72.6 / 72.6)² = 10.1 PSI

5. HEAT INPUT (HEATING):

Qg = Qh / 0.97 = 570.6 / 0.97 = 588.2 Mbtuh
Heat Input

Heat Medium ΔT = 588.2 / (0.5 x 57.0) = 20.6°F
Heat Medium ΔP = 8.8 x (57.0 / 114.1)² = 2.2 PSI
The condenser and absorber of the WFC-SC/SH Series are connected in parallel by cooling water crossover piping that is field-fabricated with field-supplied parts and installed by others at the jobsite. The only exception is the WFC-SC/SH10 model which only has one inlet and one outlet for cooling water.

The cooling water crossover piping should be installed per these recommendations to ensure balanced and controllable flow through the condenser and absorber.

Due to differing flow characteristics of copper and steel tubing, the sizes of the pipe required to field-fabricate the cooling water crossover may differ. The chart here presents the minimum size of pipe for the model indicated.

Dimension A is also referred to as the Common side. This is where the cooling tower typically connects to the crossover piping.

Dimension B is also referred to as Branch Piping and connects directly to the unit. If the size indicated by the chart is larger than the size of the connection at the unit, make the reduction as close to the unit as possible.

### Connection Options:
1. Remote Heat/Cool Mode Selection
2. Remote Enable/Disable Selection
3. Mode Status Feedback
4. Heat Source Control
5. Alarm Indication
6. Cooling Water Flow Switch
7. Freeze Protection
EQUIPMENT DIMENSIONS

Drawings are not to scale. Piping shown is all Field-Supplied.

WFC-SC5

WFC-SC/SH10

WFC-SC/SH20
EQUIPMENT DIMENSIONS
Drawings are not to scale. Piping shown is all Field-Supplied.

WFC-SC/SH30

WFC-SC50

Cooling Water
Crossover Piping
(Field-Supplied)
All sizes and lengths are minimums.
For information concerning sales, operation, application, or for technical assistance, please contact your Yazaki Sales Representative, Distributor, or the following:

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