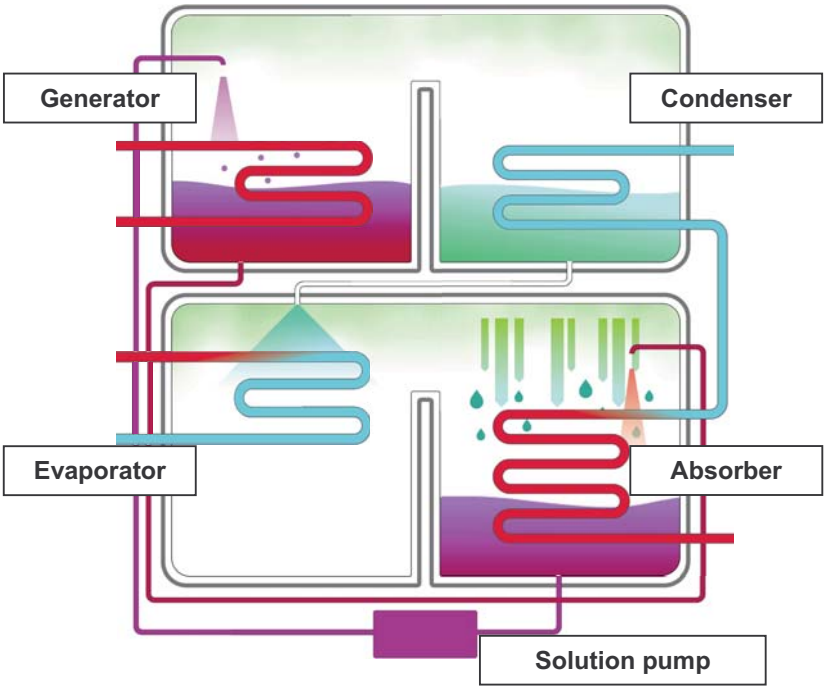
Solar Cooling:
Yazaki Aroace Absorption Chillers Generating Cooling from Solar Thermal

1. How Absorption Cooling works



The energy source heats a dilute lithium bromide solution in the generator. This boiling process generates the refrigerant vapor and thereby concentrates the lithium bromide solution. The refrigerant vapor then flows to the condenser.

In the condenser, refrigerant vapor from the generator is condensed on the surface of the cooling coil and condensation heat is removed by the cooling water. Refrigerant liquid accumulates in the condenser and then passes through a narrow channel into the evaporator.

Pressure in the evaporator is close to a vacuum, forcing the refrigerant liquid to flow from the condenser into the evaporator. Here it easily boils on the surface of the chilled water coil. At this point the evaporative latent heat of the refrigerant is removed from the chilled water, decreasing it from 12°C to 7°C. The refrigerant vapor flows to the absorber.

A low pressure in the absorber is maintained by the affinity of the concentrated lithium bromide solution from the generator with the refrigerant vapor formed in the evaporator. The refrigerant vapor is absorbed by the concentrated lithium bromide solution as it flows across the surface of the absorber coil. Heat from condensation and dilution is removed by the cooling water.

The solution pump conveys the dilute lithium bromide solution from the absorber back to the generator.

2. Solar Cooling

Solar cooling has recently become one of the most discussed applications in absorption cooling. Solar cooling takes the majority of driving energy from solar radiation at no cost. Since the cooling demands of buildings usually behave according to the course of the sun, solar cooling uses this heat as the driving energy with which to generate comfortable room conditions.

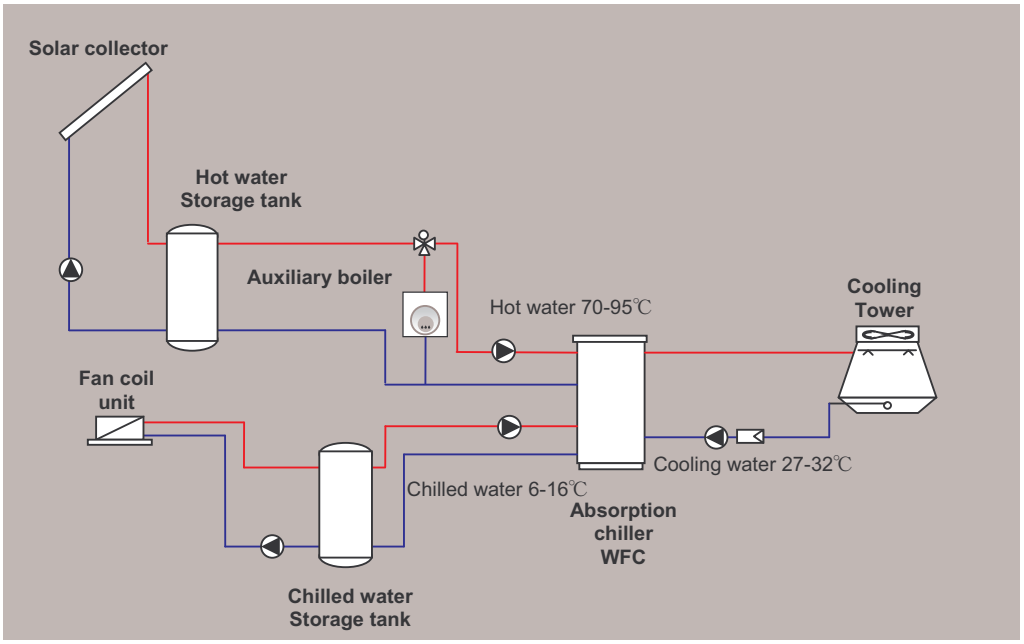
YAZAKI WFC series is especially suitable for solar cooling as it requires the lowest driving energy temperature (70°C) in absorption technology.

Characteristics of solar cooling applications:

- Driving energy is taken from solar energy (solar thermal collectors).
- The energy efficiency of a building is significantly increased with a high solar fraction (solar fraction = solar contribution divided by gross energy consumption).

Points to consider:
Solar cooling has several design parameters such as solar radiation quantity, solar radiation time, cooling demand time etc. It is essential to design it considering the entire system.
Storage tank:
The hot and chilled water storage tank serves for leveling fluctuation of the solar radiation and the cooling demand. Due to the heat storage, cooling is possible even when the solar collection is inadequate.
Auxiliary boiler:
If the storage tank can not satisfy the full cooling demand, back-up equipment is necessary.
If you consider an auxiliary boiler, please design the boiler control carefully so that it does not operate when you have plenty of solar heat.
Auxiliary chiller:
An auxiliary chiller is another back-up solution. Please adjust a higher turn off setting of the chilled water temperature than for the WFC. It will serve as the solar cooling base load operation.

Typical system diagram



3. Solar Cooling in Practice:
Yazaki Absorption Chillers in one of Europe's biggest Solar Cooling Plants of a Private Bank in Geneva (Switzerland)

Private bank Pictet & Cie. in Geneva Switzerland

Project
The private bank Pictet & Cie. wishes to reduce its CO2 emissions. An important factor in this process is a continuous reduction in the use of fossil fuels to heat and cool the buildings. The solar cooling and heating system is a clear commitment on the part of the bank to do something for the environment on a sustained basis. It can reduce its consumption of heating oil and can consequently cut its CO2 emissions.

Task
The project required the installation of 364 solar vacuum tube collectors to function together with the three YAZAKI WFC systems. The YAZAKI water-fired chillers employ the water heated by solar thermal energy to drive the simple absorption cooling, using an environmentally friendly solution of water and lithium bromide as a fluid. This makes it possible to cool the closed circuit water to 9°C in order to air-condition the bank building.

Solution
Solar cooling facility consist of
- 364 solar collector installed over an area of 600 square meters
- 3 absorption chillers, YAZAKI WFC-SC 20

Technical data of the installed YAZAKI absorption chillers
Type WFC-SC 20
70 kW cooling output (max. 85 kW)
Hot water: 88 to 83 °C (inflow min. 70 °C / max. 95 °C)
Hot water volume flow rate varying between 30 and 100 %
Cold water: 12.5 to 7 °C (outflow min. 6 °C)
Cooling water: 31 to 35 °C (inflow min. 24 °C / max. 34.5 °C)
COP: 0.7