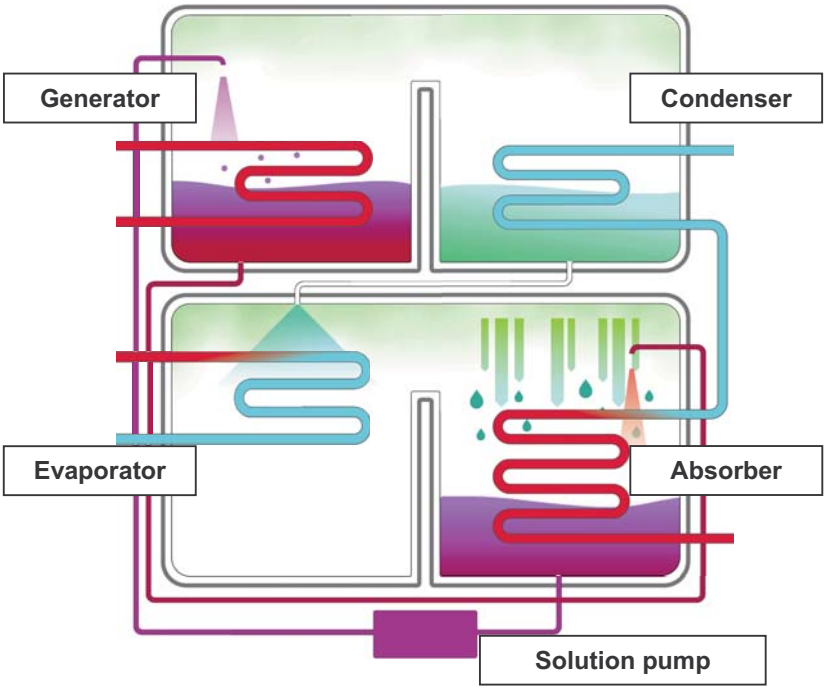
Combined Cooling, Heating and Power (CCHP): Yazaki Aroace Absorption Chillers Using Waste Heat from CCHP-Plants

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. Co-Generation system

Co-generation is a common and increasingly promoted method of optimising energy efficiency in power production. The waste heat from power production can easily be converted into useful energy, used for heating in winter and most notably for cooling applications in summer (Combined Cooling, Heating and Power generation or trigeneration).

Characteristics of trigeneration applications:

- Driving energy is provided as waste heat from incineration processes in electricity production
- Achievement of longer operating times in heat-driven cogeneration plants through the use of exhaust heat for cooling during summer months
- Additional utilization of heat with electrically driven cogeneration plants, making it possible to achieve annual utilization rates that may be required by national subsidy schemes
- Greater latitude in the usage options for the electricity produced from gas generators by reducing electrical power consumption for cooling through the use of absorption chillers

Points to consider:

The most important point of trigeneration system is how to continuously utilize the waste heat from Co-gen unit and achieve a high efficiency of the plant.
Drastic temperature fluctuations caused by ON/OFF of the WFC etc. must also be considered (which impact it has on Co-gen unit efficiency).

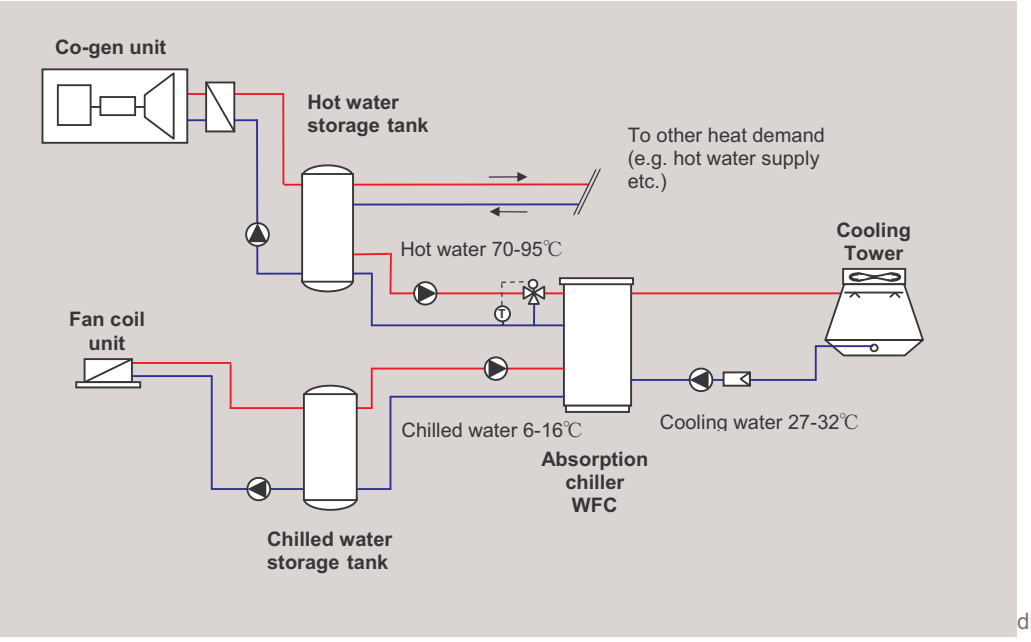
Hot water storage tank and Heat demand:

If the WFC does not extract enough heat from the Co-gen unit (e.g. when the WFC is turned off etc.) please consider to install a hot water storage tank and an additional application for waste heat (e.g. hot water supply etc.) to make the Co-gen unit operate continuously.

Proportional 3 way valve:

If the WFC uses too much heat from the Co-gen unit, the efficiency of the Co-gen unit will decrease. The solution to this is a 3 way valve which automatically redirects the flow to bypass in order to avoid a large temperature drop of the Co-gen unit or to buffer the temperature drop by a hot water storage tank.

Typical system diagram



3. CCHP in Practice:

Yazaki Aroace Absorption Chillers in a CCHP Plant in a Pharmaceutical Factory in Neumarkt (Germany)

Branch: Industry and trade
Bionorica AG, Neumarkt in der Oberpfalz, Germany

Project
In the course of constructing its new company headquarters in Neumarkt, the client made a short-term decision to integrate the previously existing decentralised, building-related heating and cooling generation system in a centralised power centre. As in the case of the new administration building, high ecological standards were set in constructing the centralised power centre.

Task
The challenge was to centrally integrate the heating and cooling system in a combined system consisting of tri-generation (vegetable-oil cogeneration) and a biomass boiler (pellets) to serve both the administration and the production buildings. Power generation and cooling were to be set up redundantly (server rooms for worldwide Bionorica data network).

Solution
Power centre consisting of
- 1 vegetable oil-cogeneration system (100 kWel/140 kWth) including emergency power facility (for server rooms and periphery)
- 1 pellet boiler 450 kW
- 1 pellet boiler 545 kW
- Process steam as redundancy
- 4 absorption chillers, YAZAKI, WFC-SC 30

Technical data of the installed YAZAKI absorption chillers
Type WFC-SC 30
105 kW cooling output (max. 140 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