130°C Hot Water Supply Heat Pump / ETW-S

Mitsubishi Heavy Industries Thermal Systems

Figure 1: External appearance

Summary of technology

The hot water supply heat pump was commercialized in 2011. This heat pump can supply pressurized water of 130°C and can be applied for heating processes such as drying and sterilization.

This heat pump uses water as both of the heat source and heat sink media (see Figure 2). At the design point, the heat source temperature is 55°C inlet / 50°C outlet, and the heat sink temperature is 70°C inlet / 130°C outlet.

The heat sink temperature glide is large. For higher efficiency, a transcritical heat pump cycle is selected. R134a, which critical temperature and pressure are 101.1°C and 4.06 MPa, is used as the refrigerant.

This heat pump equips a two-stage centrifugal compressor. For higher efficiency, impellers with different sizes are used for the 1st and 2nd stages. Considering thermal expansion due to a large temperature difference between when stopped and when operating, carbon steel, which has a smaller coefficient of linear expansion than aluminum, is selected as the material of the impeller. This can keep the clearance between the impeller and the shroud and prevent deterioration of the compression efficiency. Carbon steel also has a higher strength, which can prevent deformation of the impeller tip. The maximum rotating speed is 42,000 rpm.

The gas cooler is a brazing plate heat exchanger designed for high pressure and temperature specifications more than 5 MPa and 145°C.

By introducing an intercooler, compressor suction vapor is superheated with gas cooler outlet refrigerant. This can reduce compressor discharge pressure, while keeping the high discharge temperature.

The heating COP is 3.0 at the design point (see Table 1). The COP decreases under part-load conditions. When the heating capacity is 250 (40% part-load), the COP is 2. The heating capacity is 627 kW, which is almost equivalent to steam of 1 ton/h.

Project example

The heat pump was installed in an electric transformer production factory for a drying process of the coil. The coil of electric transformer has copper wire and paper coated with a special resin. By heating the coil, the resin melts and the paper and the copper wire adhere.

In the previous system, steam boiler was used for producing hot air. And the exhaust gas from the dryer had

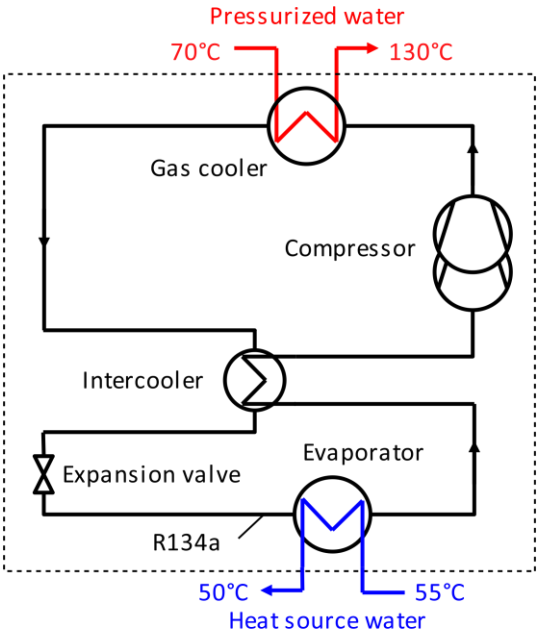

Figure 2: System configuration

Table 1: Performance

$T_{source,in}$ [°C]	$T_{source,out}$ [°C]	$T_{sink,in}$ [°C]	$T_{sink,out}$ [°C]	$COP_{heating}$ [-]
55	50	70	130	3.0

relatively high temperature, but not recovered. Likewise, in another process (annealing process), there was waste heat.

In the new system, the heat pump was installed. The heat pump uses both exhaust heats from drying process and annealing process as the heat source. However, the operation time of the annealing process is not the same at the drying process. Hence a thermal storage tank was also installed for securing the stable heat source of the heat pump. This heat pump supplies 130°C pressurized water, and then produces 125°C hot air with heat exchange. The previous boiler is used for the backup.

The total waste heat of the drying process and the annealing process is about 420 kW at the time average value. It is sufficient for the heat source. The heat pump can supply all the heat needed for the drying without using the backup boiler.

FACTS ABOUT THE TECHNOLOGY

Heat supply capacity: 627 kW

Temperature range: Heat source water 55°C, Pressurized hot water 130°C

Working fluid: R134a

Compressor technology: two-stage centrifugal

Specific investment cost for installed system without integration:

TRL level: TRL 9

Expected lifetime: 15 years

Size: Weight 6,500 kg, Footprint 7.7 m^2

The heat pump can operate at the COP of 3. Compared to the conventional system with natural gas-fired steam boiler, CO_2 emissions and energy cost can be decreased by 60% and 65%, respectively.

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All information were provided by the supplier without third-party validation. The infomation was provided as an indicative basis and may be different in final installations depending on application specific parameters.