130°C Hot water supply heat pump for drying process at Takaoka Toko

Figure 1: Hot water supply heat pump

Summary of demonstration case

Oyama factory of Takaoka Toko produces mainly electric transformers for distribution at 6 kV. 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. If the drying is not sufficient, the paper and the copper wire do not adhere well. Hence the drying process is one of important processes affecting the product quality.

Conventionally, boiler steam was used in the drying process of the transformer coil. Despite the purpose of removing water from the coil, the iron core was also heated at the same time. This increased the drying time. It was a significant problem that a lot of time and heat were consumed.

A diagnostic survey of energy usage in the drying process was started in 2008 to realize both of saving time and reducing energy consumption. As the result, the following measures were taken:

- Reviewed the manufacturing process and changed the drying process for the coil alone
- Introduced a heat recovery high-temperature heat pump alternative for existing steam boiler

In the previous system, steam boiler was used for producing hot air. And the exhaust gas from the dryer had relatively high temperature, but not recovered. Likewise, in another process (annealing process), there was waste heat.

In the new system, a heat pump (ETW-S by MHI Thermal Systems) 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.

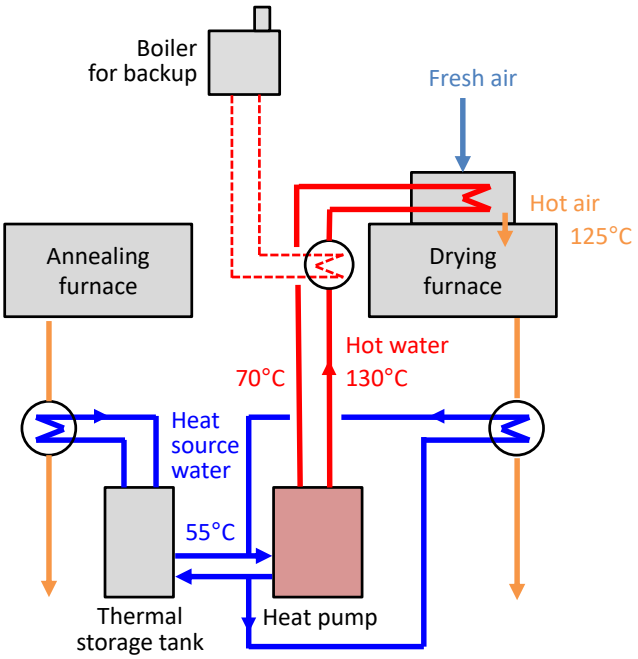

Figure 2: System configuration

FACTS ABOUT THE CASE

Intallation year: 2012

Working fluid used: R134a

Compressor technology: Centrifugal

System manufacturer: MHI Thermal Systems

Performance in design point:

- **Heat source:** 55°C → 50°C (water)
- **Heat sink:** 70°C → 130°C (pressurized water)
- **Heat supply capacity:** 627 kW
- **$COP_{Heating}$:** 3.0

Link to webpage:
https://www.jeh-center.org/asset/00032/monodukurinidenki/vol3_toukoutakaoka_oyama.pdf

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.

Operating experiences

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. In addition, by changing the drying process for the coil alone, the drying time has been significantly reduced, and the production lead time has been reduced from 5 days to 2 days.

Special learnings

Preliminary detailed analysis of the heat demand and waste heat before the installation of the heat pump was the key to success. Especially, the exhaust gas properties and its effect on the heat exchanger were analyzed as well as measuring the amount of heat from the exhaust gas.

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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.