# Steam supply heat pump for distillation process at Hokkaido Bioethanol

**Figure 1: Steam supply heat pumps**

## Summary of demonstration case

Bioethanol is a renewable and alternative fuel made by fermenting and distilling biological resources such as wheat, corn, sugar beet and rice. Hokkaido bioethanol CO., Ltd. was established in 2007 as a pilot project by the Ministry of Agriculture, Forestry and Fisheries for model community using biofuel. It manufactures dehydrated ethanol with a concentration higher than 99.5% from the raw materials such as beet syrup or non-standard wheat and rice by grinding, liquefying, fermenting, distilling and dehydrating. During the bioethanol production, a lot of steam is used for heating. Steam consumption of distillation process accounts for about 60% in the total processes. Hence it is important to improve the energy efficiency of the distillation process.

In the distillation process, steam is used to heat the ethanol aqueous solution (10% ethanol and 90% water) and to separate the ethanol and water through evaporation. Evaporated ethanol is cooled and liquified in the distillate cooler. The liquid (95% ethanol and 5% water) is taken to the dehydration process with zeolite membrane, and then pure ethanol (more than 99.5%) is produced.

In the conventional system of the distillation process, steam for heating was supplied by heavy oil-fired boiler, and condensation heat from ethanol was wasted through cooling tower. For the purpose of heat recovery from the condenser and steam supply to the distillation column, steam supply heat pump (SGH120 by KOBELCO) was installed in 2013.

In the new system, the waste heat is recovered as a heat source water of heat pump. The heat pump lifts the heat at 65°C and produces steam at 110–120°C. With 5 units of the heat pump unit integrated for 1 flash tank, usually 4 units of them operate (1 unit is stopped as a spare), and steam of 2 ton/h is supplied to the distillation column, This amount accounts for 70% of the total steam demand. The remained 30% is covered with the existing boiler.

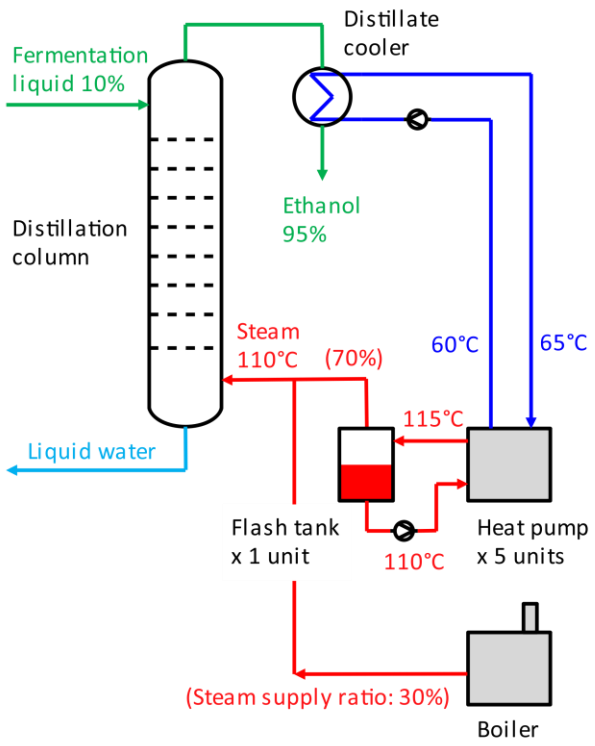


**Figure 2: System configuration**

## FACTS ABOUT THE CASE

**Intallation year:** 2012

**Working fluid used:** R245fa

**Compressor technology:** Twin-screw

**System manufacturer:** KOBELCO

**Performance in design point:**

- **Heat source:** 65°C → 60°C (water)
- **Heat sink:** 20°C (water) → 120°C (steam)
- **Heat supply capacity:** 370 kW/unit
- **$COP_{Heating}$:** 3.5

**Link to webpage:**
https://www.jeh-center.org/asset/00032/monodukurinidenki/vol4_hokkaidobaioetanoru.pdf.pdf

## Operating experiences

The heat pump can operate at the COP of more than 4 thanks to the lower steam supply temperature than designed. Compared to the conventional system, $CO_2$ emissions and energy cost can be decreased by 43% and 54%, respectively. It was confirmed that the investment cost of the heat pump equipment can be recovered in about 3 years.

## Special learnings

The end-user was concerned about the reliability of this heat pump before the operation because this was the first case this heat pump was installed in an actual plant. However, the heat pump operates without problems, and he is pleased with the good performance as planned.

“The distillation process requires stable temperature control. Obviously, this was the suitable process for a waste heat recovery and steam supply system using heat pump, because waste heat is stably obtained,” says the end-user.

## Contact information

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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.