

8th Conference “Climate protection through waste heat utilization”

Industrial Heat Pumps in Japan

New Energy and Industrial Technology Development
Organization (NEDO)
Energy Conservation Technology Department



Introduction

1. Electrification in Industrial sector is the key for decarbonized society in Japan.
2. Maximum supply temperature of commercially available industrial heat pumps is approx. 130°C but required up to 200°C class heat pump to replace fossil fuel boiler.
3. From 2013 to 2022, NEDO project has been developing high temperature heat pump which can supply 160~200°C with high efficiency.
4. NEDO is participating in IEA HPT TCP Annex58 “High temperature heat pumps.

**R&D Project on Innovative Thermal Management
Materials and Technologies**

**Development of
High Temperature Heat Pump**

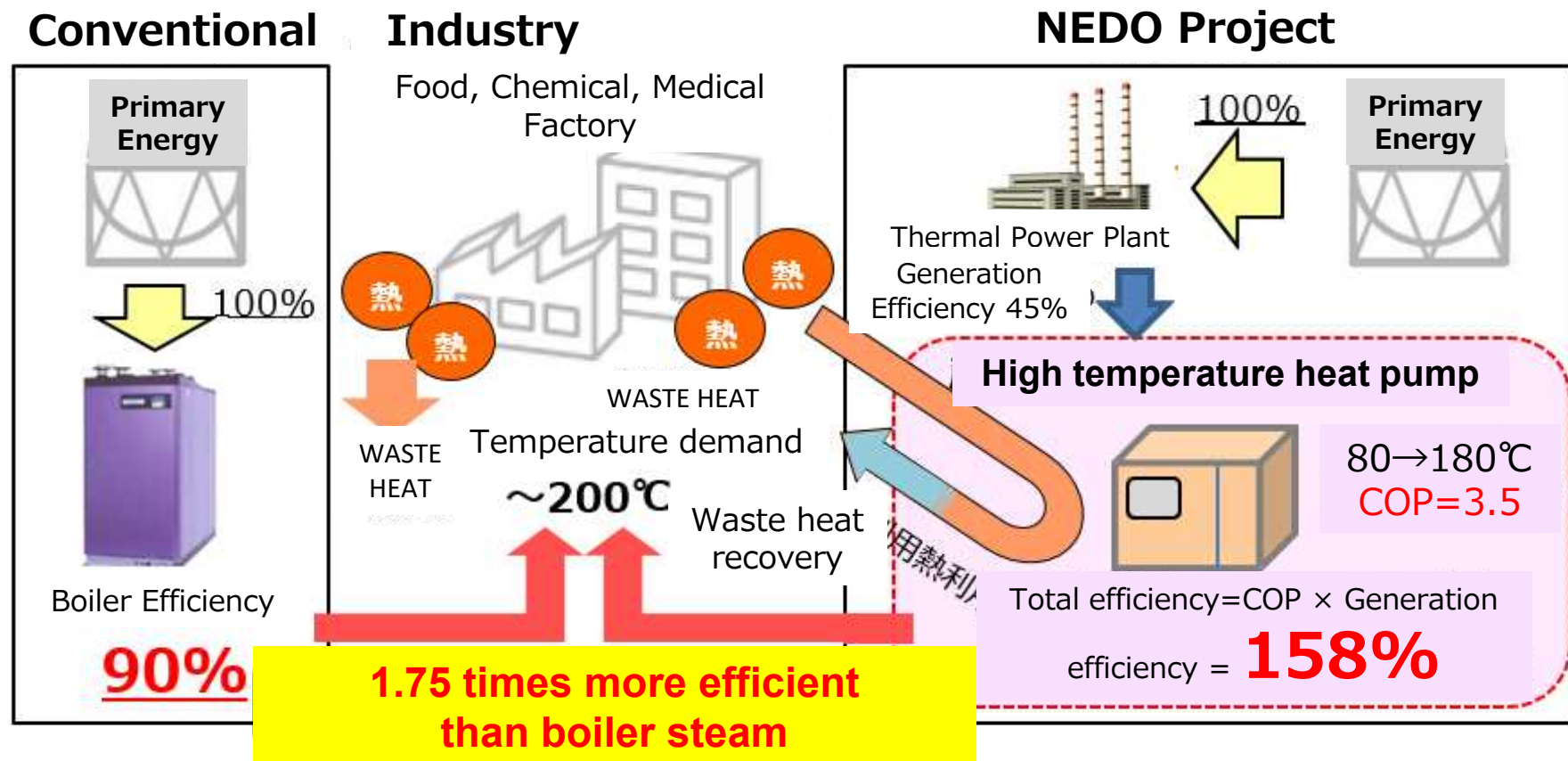
Project developer : MAEKAWA MFG. CO., LTD.

Project period : 2013-2022



- Heat pump system that collects unused heat of 80~100°C that is discharged from heating process and supplies 160~200°C of thermal liquid or steam with high efficiency (COP>3.5).

Boilers using a large amount of fossil fuel to be replaced by High temperature heat pumps.



Maximum supply temperature **200°C**、COP=**3.5**

Feature : Low GWP refrigerant (GWP < 15)



Primary Prototype

Specifications

Item	Design
Refrigerant	n-butan or HFO
Compressor	Centrifugal
Lubricating oil	Oil free
Design pressure	6.0MPa
Heating capacity	500kW
COP	3.5
Heat source	80°C
Heat supply	80 → 180°C
Maximum supply temperature	200°C

Applied to

Food, Beverage, medical, Chemical etc.

- Rated performance was evaluated with 300kW of primary prototype which using n-butan (R600) .
- Low GWP HFO refrigerant and oil free compressor are adopted for 300kW of secondary prototype.
- Performance test and reliability confirmation are on going with secondary prototype.



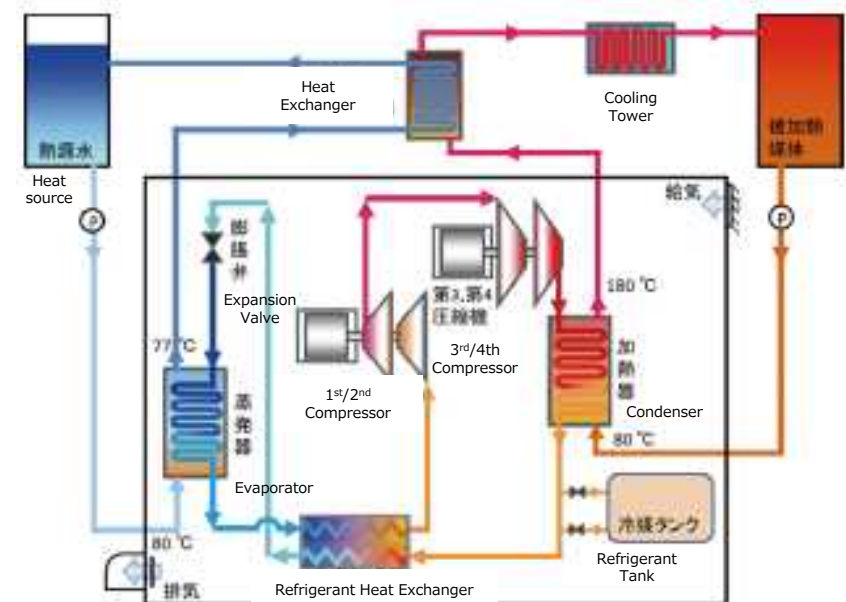
Inside of Secondary Prototype



Secondary Prototype



Oil free Centrifugal compressor



System flow of Secondary Prototype

**IEA Technology Collaboration
Programme on Heat Pumping
Technologies
(International collaboration regarding
waste heat recovery and utilization)**



IEA Technology Collaboration Programme on Heat Pumping Technologies
Established : 1978

Member Countries(17); Austria, Belgium, Canada, China, Denmark, Finland, France, **Germany**, Italy, **Japan**, Korea, Netherland, Norway, Sweden, Switzerland, UK, US

Scope of technologies: heat pumping technology - all technologies where heat is pumped from a lower temperature level to a higher one, such as heat pumps, air conditioning and refrigeration.

Recent Annexes related to waste heat recovery in industry

Annex58 High temperature heat pumps (2021-2023)

As part of Task1 information about heat pump systems and successful demonstration cases are collected.

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



Figure 1: Hot water supply heat pump

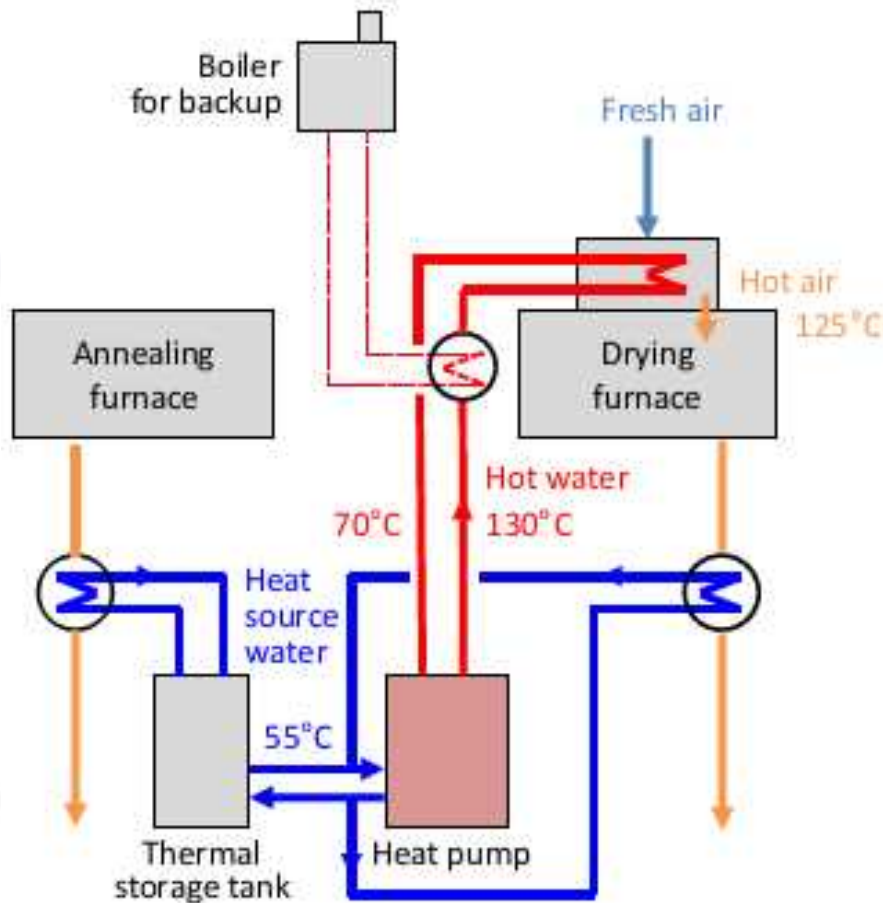


Figure 2: System configuration

FACTS ABOUT THE CASE

Installation 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

Mechanical vapor recompression for drying process at Hadano water treatment center



Figure 1: Heat pump-based sewage sludge drying system

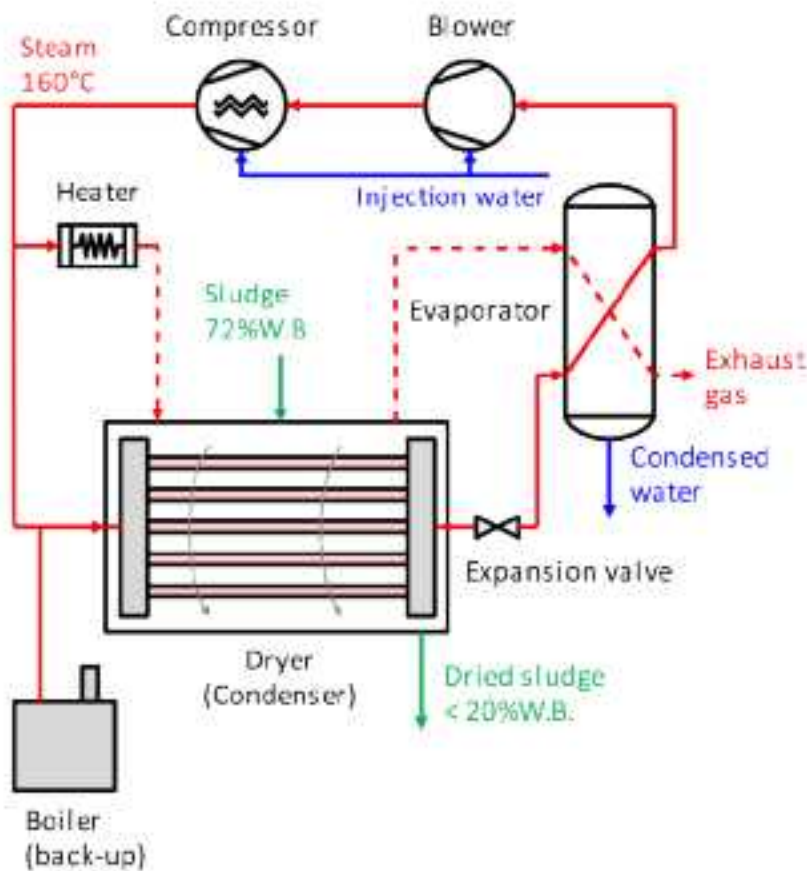


Figure 2: System configuration

FACTS ABOUT THE CASE

Intallation year: 2016

Working fluid used: R718 (water)

Compressor technology: Roots blower (Anlet) + Twin-screw compressor (KOBELCO)

System manufacturer: Hadano city office, Okawara Mfg. Co., Ltd. and Kansai Electric Power Co., Inc.

Performance in design point:

- Heat source: 93°C (0.078 MPa, steam)
- Heat sink: 160°C (0.6 MPa, steam)
- Heat supply capacity: 675 kW
- $COP_{\text{Heating}} = 2.9$

Link to webpage:

https://www.jeh-center.org/asset/00032/monodukurinidenki/vol6_hadanocity.pdf

Steam supply heat pump for distillation process at Hokkaido Bioethanol



Figure 1: Steam supply heat pumps

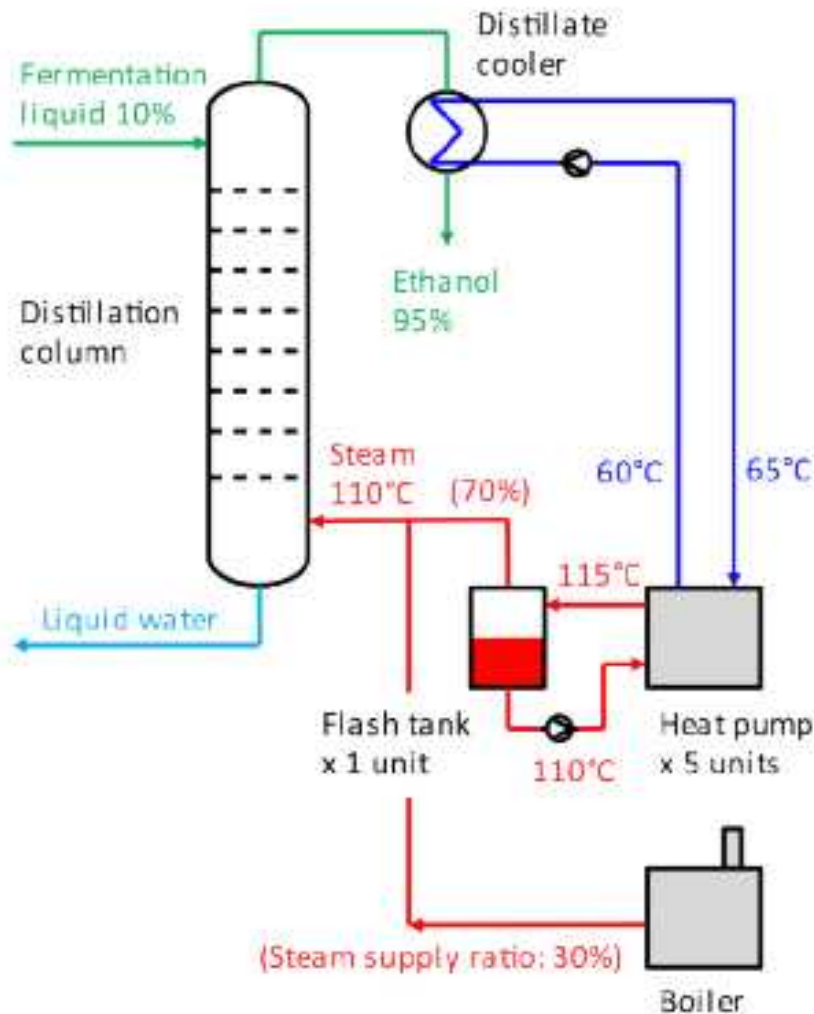


Figure 2: System configuration

FACTS ABOUT THE CASE

Installation 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_hokkaidobaiotanoru.pdf.pdf

Summary

1. Development of high temperature heat pump which can supply up to 200°C is completed in 2022 and its social implementation will start from 2023.
2. NEDO is participating in IEA HPT TCP Annex58 “High temperature heat pumps” and contribute to realized demonstration cases.