Industrial Heat Pump

Siemens Energy

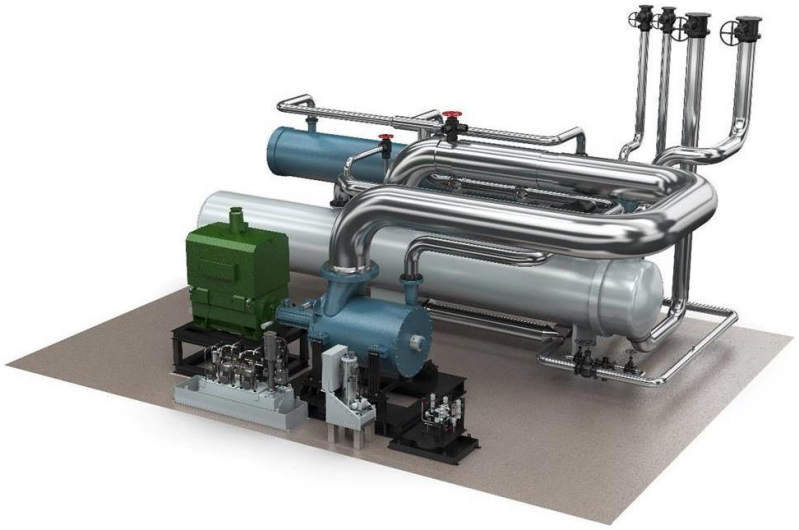

Figure 1: Exemplary model of a new Siemens Energy high temperature heat pump

Summary of technology

Siemens Energy heat pumps are specifically tailored for a particular application depending on required capacity, temperatures of sink and source, boundary conditions at site as e.g. electrical connection or available space. A large variety of different cycle designs is possible:

- Closed system in different configurations (with or without flash box, internal heat exchanger, cascade, etc.)
- Compressor drive can be electrical or mechanical (gas engine or gas/steam turbine), both variants within Siemens Energy scope.
- Most relevant applications are chemical, pulp & paper, food & beverage and district heating
- Turbo compressor technology as geared-type or single-shaft depending on application and available space.
- Carnot COPs are in the range of 55 to 70% depending on application (see table 1). COP refers to real outer COP with given temperatures of the actual source and sink media.
- Development status:
  - 50 large scale heat pumps with capacities up to 30 MW and temperatures up to 90 °C built in the 1980s and 90s. Most of them still running today in service of Siemens Energy (fig. 2).
  - Laboratory demonstration of a kW-size heat pump with temperatures up to 160 °C with R1233zd among other tested refrigerants.
  - Pilot plant with 8 MW capacity and 120 °C supply temperature currently being built for Vattenfall in Berlin for a district heating application.
- Source and sink media are preferably water (also steam at sink side). Other media like air or polluted water as heat source can be considered with alternative heat exchanger design or additional measures like ball-cleaning systems.
- Flexible operation and part-load capability is optionally ensured by bypasses, speed-controlled drive and volume flow control (inlet guide vanes).
- Heat exchangers are supplied within scope of Siemens Energy by experienced manufacturers. Plate and shell/tube heat exchangers are possible.

Figure 2: Picture of an existing Siemens energy heat pump

Table 1: Performance.

$T_{source,in}$	$T_{source,out}$	$T_{sink,in}$	$T_{sink,out}$	$COP_{heating}$
[°C]	[°C]	[°C]	[°C]	[-]
2	0.5	43	105*	2.5
35	30	60	120*	2.7
115	105	105	150**	4.1
80	60	20	190***	2.9

*pressurized hot water
**steam
***steam, incl. steam compression

Project example

Pilot plant at Vattenfall in Berlin near Potsdamer Platz for the Berlin district heating network:

- Demonstration of novel high temperature heat pump technology by partners Vattenfall and Siemens Energy supported with subsidies from German government BMWi and PTJ [1]
- Heat recovery of existing turbo chillers at ~30 °C
- Heat supply capacity up to 8 MW for district heating at temperatures from 85 to 120 °C
- Inlet guide vanes, drive speed control and bypasses
- Highly flexible both in thermal power and temperature resulting in high annual utilization

1 https://press.siemens-energy.com/global/de/pressemitteilung/vattenfall-und-siemens-energy-treiben-mit-grosswaermepumpe-die-klimafreundliche

FACTS ABOUT THE TECHNOLOGY

Heat supply capacity:
8 to 70 MW in one unit with one turbo compressor

Temperature range:
Cycle design is tailored based on application. Heat sink up to 160 °C is possible. Large temperature lifts >100 K are possible

Working fluid:
R1233zd(E) and/or R1234ze(E) depending on application (other fluids under development)

Compressor technology:
Turbo (geared-type or single-shaft depending on application)

Specific investment cost for installed system without integration:
250 to 800 €/kW (thermal supply capacity). Depending mainly on capacity, temperature lift and scope

TRL level:
TRL 9 (up to 90 °C); Pilot plant in industrial environment with 120 °C currently built

Expected lifetime: 20-40 years

Footprint: Strongly depending on unit size

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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.