CO_2 Heat Pump System for Hot Water Production

Fenagy A/S

Figure 1: Fenagy H600 heat pump with CO_2 as working fluid.

Summary of technology

The technology from Fenagy is an electric driven heat pump using CO_2 as working fluid and is targeted on district heating and industrial applications. The racks are designed and built according to specific customer needs with thermal supply capacities between 0.3 MW to 1.8 MW.

The energy uptake can be either from air (AW) or water (WW). Reciprocating compressors from either Dorin or Bitzer are typically used, with optional variable speed drive. Internal heat exchangers are used to increase the temperature before the compressor and optimize the performance.

When using CO_2 as a working fluid, the heat pump systems can be made relative compact, and the systems especially has a high potential for applications with large temperature glides, where it is possible for the CO_2 to match the temperature profiles.

For improving the performance in high-temperature applications, Fenagy is currently developing systems with active recovery of the expansion losses.

Case study

A typical application with competitive performances for CO_2 heat pump system is the supply of hot water being heated from 30 °C to a supply temperature of 120 °C. These conditions can be found in well-integrated industrial processes with a high amount of

Figure 2: Fenagy H1800-AW/WW heat pump.

heat recovery, and hence low temperature waste heat.

The calculations for the expected $COP_{heating}$ in such an application are shown in Table 1 for four different operating conditions.

Table 1: Estimated performance.

$T_{source,in}$	$T_{source,out}$	$T_{sink,in}$	$T_{sink,out}$	$COP_{heating}$
[°C]	[°C]	[°C]	[°C]	[-]
0	-5	30	120	2,46
0	-5	30	120	2,61*
5	0	30	120	2,63
5	0	30	110	2,91*

*including expander

The systems are using only medium temperature (MT) compressors due to the low outlet temperature in the gas cooler. The maximum temperature and pressure for the CO_2 in the cycle is around 160 °C and 125 bar(a).

In order to reach highest performances, it is important to recover work from the expansion of the high-pressure refrigerant. This can be done be using an ejector, but concepts for expansion machines are also currently being developed. The estimated performance where an expander is included are also shown in table 1.

FACTS ABOUT THE TECHNOLOGY

Heat supply capacity: 0.3 MW – 1.8 MW

Temperature range: Upper supply limit is 120 °C.

Working fluid: R-744

Compressor technology: Reciprocating.

Specific investment cost for system without integration: 250-425 €/kW

TRL level: For concept study of high temperature application (supply temperature of 120 °C) TRL 5-6 estimated.

Expected lifetime: 20 years

Size: 2.4 m/11.0 m/1.4 m for height/length/ width (valid for 1.8 MW capacity)

Homepage:

https://www.fenagy.dk/en/home

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