Cascade Solution of High Temperature Industrial Heat Pump System With Multiple Functions.

Emerson

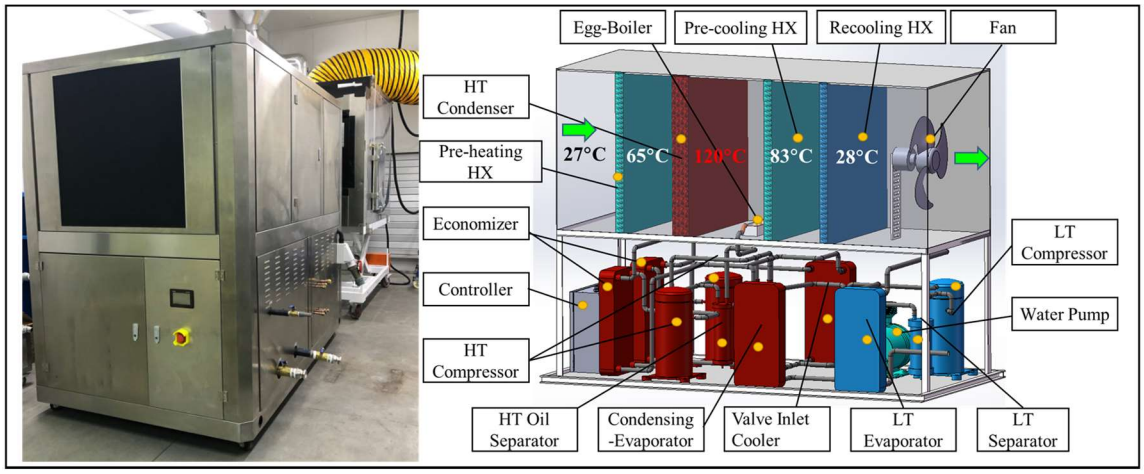

Figure 1: Prototype and Internal Design

Summary of technology

This cascade system is designed for two functions. One is to obtain stable hot air supply at 120°C. It uses Enhanced Vapor Injection (EVI) technology and HT refrigerant flow control valves. Applications include industrial processes requiring hot air above 100℃, such as the coating process of Lithium batteries, PCB board drying, rubber fluid making, etc. The other function of the cascade system is designed to expand multiple heat sources such as industrial wastewater heat recovery or air conditioning processes.
Figure 1 shows the prototype unit.

The system illustrated in figure 2 can be divided into three sections: LT cycle, HT cycle and hot air chamber. The LT cycle consists of a simple loop with R410A refrigerant. It uses an Emerson variable speed compressor, (model ZWW050), and a plate heat exchanger type (PHX) for the evaporator function.
The HT cycle uses the R245fa refrigerant. Two EVI fixed-speed compressors also developed by Emerson specifically for high-temperature applications are installed in parallel. Compared to conventional compressors, their operating envelope is significantly higher.

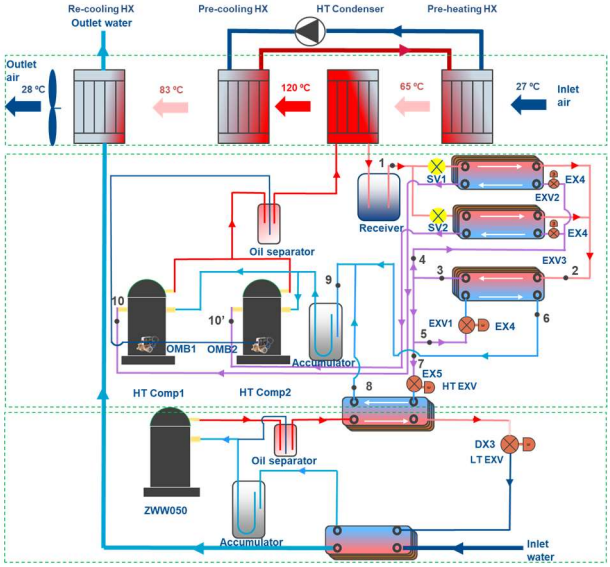

Figure 2: High Temperature Industrial Heat Pump System Layout

A heat recovery water loop is in the hot air chamber, and it is designed for pre-heating and pre-cooling functions of inlet air (designed temperature at 27 °C) to improve the capability and the efficiency of the system.

The re-cooling heat exchanger is just installed to ensure that the outlet air temperature reach a safe temperature level.

The internal heat recovery loop can heat the inlet air up to 65 °C and cool the outlet air down to 83 °C. In real field applications, this function can also be transferred into waste heat recovery of other heat sources.

Emerson offers full solutions for industrial heat pump applications such as high temperature heat pump compressors, high temperature refrigerant flow control parts and advanced oil management solutions.

Project example

Table 1 shows the performances of the cascade system in different conditions, including rated and variable inlet water temperatures.
Based on the performance results, the hot air temperature exceeds 120°C without any problem in these working conditions, which meet the requirements for HT applications. The HT EXV inlet temperature is also successfully controlled below 85°C, which helps to guarantee a reliable operation under high temperature working environments.
Under the working conditions no.1, the heating COP can reach up to 1.74 with a supply air temperature of 121.6 °C, which will bring serious competitive advantages to replace gas and electrical boilers. This HTHP can be also used to leverage low grade heat sources and recover wastewater heat.

Table 1: Performances in Different Conditions

No.	Unit	1	2	3
Inlet Air Temperature	[°C]	27	30	30
Inlet Water Temperature	[°C]	12	20	30
Hot Air Temperature	[°C]	121.6	120	120.2
Heating Capacity	[kW]	29.7	29.9	31.2
Total Compressor Power	[kW]	17.1	19.1	18.3
Heating COP	[-]	1.74	1.57	1.64

FACTS ABOUT THE TECHNOLOGY

Heat supply capacity: 30kW

Temperature range:
Supply temperature 120°C;
Ambient temprature 15~30°C;
Water temperature 10~30°C.

Working fluid: R245fa, R410A*, water

Compressor technology: Sroll & EVI Scroll

Specific investment cost for installed system without integration: Prototype for function and solution demonstration purpose, no cost control.

TRL level: TRL6

Expected lifetime:~15-20 yrs (TBC)

Market Readiness: Expected Availability: 2025

Size: LxWxH= 2.3m x 1.4m x 1.9m, footprint is 3.2 m2

** Low GWP substitution refrigerants will be tested.*

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.