CO_2 Air Heater Heat Pump / Eco Sirocco

Mayekawa Mfg.

Figure 1: External appearance

Summary of technology

In hot air drying processes, hot air is commonly produced by gas burners or steam boilers. The Eco Sirocco air heater heat pump was developed to replace or reduce use of the gas burners and boilers by supplying hot air up to 120°C, or act as a preheater when the drying temperature is above 120°C.The heat pump was commercialized in 2009 and is applicable in both drying and dehumidifying processes.

The heat pump uses water or brine as the heat source medium (see Figure 2). The heat source temperature is of a wide range from 0°C to 40°C, which realizes two types of heat recovery, wastewater or chilled water supply. At the heat sink side, the heat pump heats ambient air of (-10-43°C) and supplies hot air of (60-120°C).

The heat sink temperature glide is large. To achieve higher efficiencies a transcritical heat pump cycle is used. R744 (CO_2), with critical temperature and pressure of 31.0°C and 7.38 MPa, is used as the refrigerant.

Use of R744 as the refrigerant results in high operating pressures. The maximum suction and discharge pressures are 7 MPa and 15 MPa, respectively. The compressor is a reciprocating type. The heating capacity is about 100 kW.

The heating capacity can be varied by changing the rotation speed of the compressor with an inverter.

The gas cooler (air heater) consists of aluminum-fin, copper-tube heat exchanger, and is designed for high pressure specifications up to 15 MPa. The maximum air flow rate is 8,500 m^3/h.

It is possible to use an air-to-refrigerant heat exchanger on the heat source side when recovering heat from the dryer exhaust air. However, a water-to-refrigerant heat exchanger was selected because of the following reasons:

- An air-to-refrigerant heat exchanger requires an air duct which is not easily installed and is complicated to handle.
- It is easier to recover heat from other processes or generated chilled water can be supplied to other processes when using a water-to-refrigerant heat exchanger.

Performance of the heat pump is shown in Table 1. As shown, this heat pump is suitable for application in drying processes with large temperature glides at the heat sink.

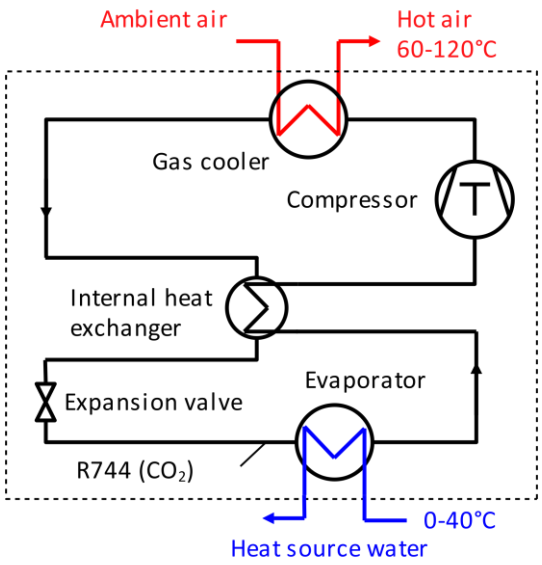

Figure 2: System configuration

Table 1: Performance

$T_{source,in}$ [°C]	$T_{source,out}$ [°C]	$T_{sink,in}$ [°C]	$T_{sink,out}$ [°C]	$COP_{heating}$ [-]
30	25	20	120	3.1
30	25	20	100	3.7
30	25	20	80	4.5
30	25	20	60	5.5

Project example

More than 90 units of this hot air supply heat pump have been installed in various drying processes such as paint drying of electric transformers, laminating of plastic films, and regeneration of the desiccant dehumidifier.

As an example, the heat pump was applied to provide part of the heat load needed in drying of electric transformer casings after paint coating. The drying process needs hot air of 170°C and 150°C. Previously, LPG (liquefied petroleum gas) burners were used to provide hot air. Application of the heat pump to provide hot air up to 120°C reduced use of LPG.

On the other hand, paint used in the electrodeposition coating process has to be maintained at a constant temperature. Chilled water produced at the heat source side is used.

FACTS ABOUT THE TECHNOLOGY

Heat supply capacity: 100 kW

Temperature range: Heat source water (or brine) 0-40°C, Ambient air -10-43°C, Hot air 60-120°C

Working fluid: R744 (CO_2)

Compressor technology: Reciprocating

Specific investment cost for installed system without integration:

TRL level: TRL 9

Expected lifetime: 15 years

Size: Weight 1,750 kg, Footprint 1.7 m^2

The heat pump, therefore, saves energy by reducing electric consumption of the existing chiller as well as reduction in LPG consumption.

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