Development and Evaluation of Advanced Heat Pumps

Background and Objective

Heat pumps are attracting attention in and outside Japan as an effective technology to promote energy conservation and reduce CO_2 emissions. Much research and development is carried out to improve efficiency, to use low-GWP (global warming potential) refrigerants, and to expand applications to a wide variety of thermal demand.

In this project, we aim to develop and evaluate highly efficient, compact, and low-priced heat pumps using low-GWP refrigerants for residential hot water supply, room heating, industrial process heating and so on. We contribute to the launching and popularization of heat pumps attractive to end users.

Main results

1 Commencing full-scale operation of a New Heat Pump Test Facility

We have designed, manufactured and installed a new unique test facility for the development and evaluation of heat pumps in industrial and commercial applications such as a steam generating heat pumps in sterilizing processes and hot air generating heat pumps in drying processes. Full-scale operation of this facility commenced in the second half of FY2013 (Fig. 1).

Making use of this facility, we aim to obtain data on efficiency and heating capacity under various operating conditions necessary for end users, to construct testing and evaluating methods, to extend our knowledge of generation and utilization of steam and so on, and to strengthen relationships with end users, manufacturers and so on.

2 Evaluation of an industrial steam generating heat pump

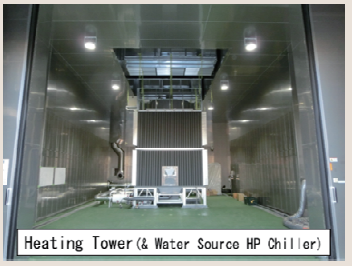
With our New Heat Pump Test Facility, we are testing for the industrial steam generating heat pump, SGH165*1, to evaluate efficiency and heating capacity under various operating conditions whose parameters are heat source water temperature equivalent to drain temperature in factories, steam temperature and so on (Fig. 2).

3 Evaluation of a large capacity commercial heating system

With our New Heat Pump Test Facility, we are also testing for the commercial heating system which is a combination of a heating tower*2 and a water source heat pump chiller, to evaluate characteristics of frosting*3 and performance of defrosting*3 under various operating conditions which have parameters such as air temperature and air humidity (Fig. 3).

*1 SGH is an abbreviation of Steam Glow Heat pump and applicable to industrial heating processes such as sterilization, concentration, drying, distillation and so on. There are two SGHs, one is SGH120 generating 120℃ steam and the other is SGH165 generating 165℃ steam, by recovering waste heat from factory drainage.
*2 A heating tower is a heat exchanging system in which brine, or antifreeze solution, absorbs heat from cold outside air. A water source heat pump chiller can generate hot water for room heating by use of an air source heat in combination with a heating tower.
*3 Frosting means freezing of water contained in cold outside air on the surface of a heat exchanger. As frost becomes a thermal resistance and an obstruction of air flow in a heat exchanger, defrosting, or the melting frost, is needed for the operation of a heating tower and an air source heat pump.

【Specification of Tested Heat Pumps】
Industrial Hot Water Generating : max. 600kW
Industrial Steam Generating : max. 600kW
Industrial Hot Air Generating : max. 200kW
Turbo Chiller : max. 2,100kW
Air Source Chiller : max. 350kW
【Conditions of Temperature and Humidity】
Heat Source/Sink Air : −20～50℃, 30～90%
Heat Source/Chilled Water : 10～90℃
Heated/Cooling Water : 10～90℃



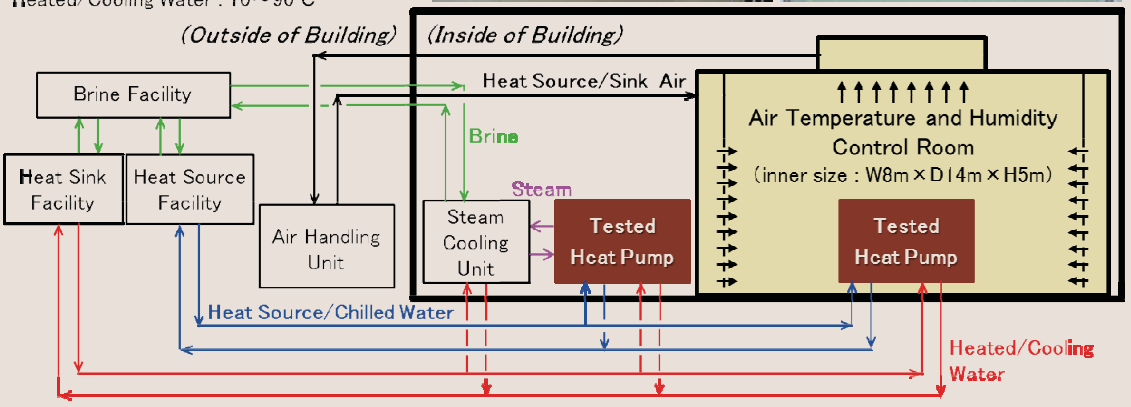


Fig. 1: New test facility for development and evaluation of heat pumps in industrial and commercial use

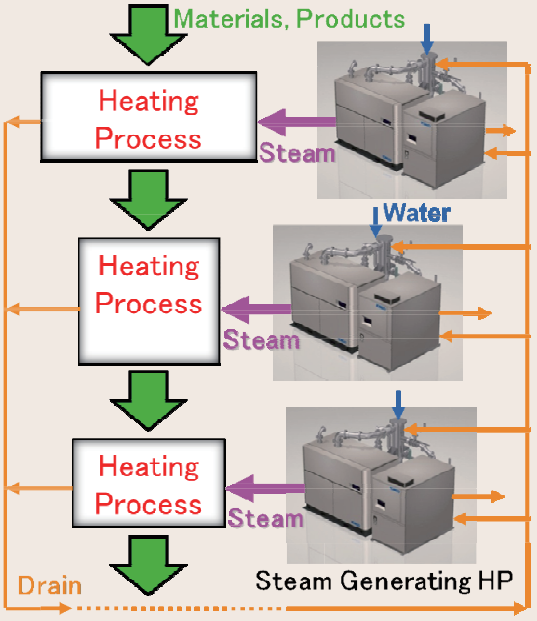


Fig. 2: Industrial steam generating heat pump

Steam condenses and turns into drainage after being used in various heating processes in factories. Efficient use of energy is possible by recovering waste heat of drainage. The higher the temperature of drainage, the higher the efficiency of steam generating heat pumps.

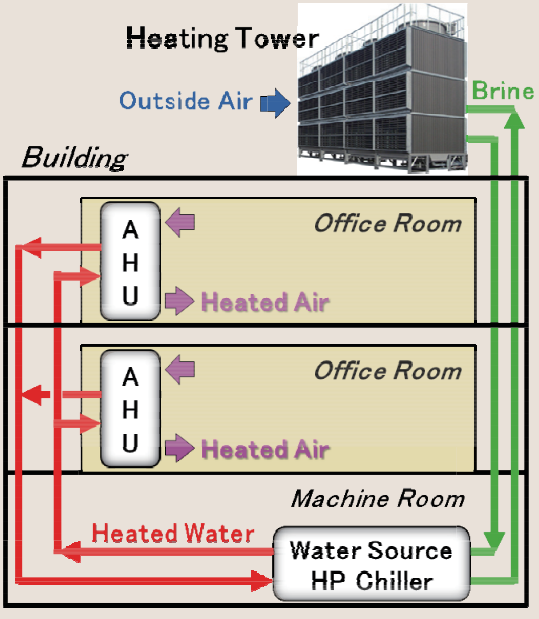


Fig. 3: Heating Tower

In a heating tower, brine, or antifreeze solution, absorbs heat from cold outside air. A water source heat pump chiller absorbs heat from brine and generates heated water. In an air handling unit, heated water releases heat in indoor air to heat a room.