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, use low-GWP (global warming potential) refrigerants, and 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 drying and so on. We contribute to launching and popularization of heat pumps which are attractive to the end users on the market.

Main results

1 Development of high-efficient heat pumps using low-GWP refrigerants

Some residential heat pumps use HFC (hydro-fluoro-carbon) refrigerants as a substitute for fossil fuel boilers and electric boilers of central hot-water room heating systems* in cold regions. However, these are not widespread due to their very low heating capacity and COP (efficiency of heat pump defined as heating capacity divided by electric power consumption) at lower outside air temperatures, and the difficulty to achieve hot-water temperature over 70℃ required by central hot-water room heating systems due to the characteristics of HFC refrigerants.

In collaboration with Hokkaido Electric Power Company and SANDEN Corporation, we have developed a new residential heat pump for hot-water room heating, using CO_2 refrigerant and a cascade cycle that enables high heating capacity and COP in cold regions. The new system was launched on the market in May, FY2012 (Fig. 1).

2 Evaluation of the annual performance of residential heat pump water heaters

We have evaluated the annual performance of some residential heat pump water heaters using our test facility with the aim of setting a standard to promote energy conservation and reduce CO_2 emissions. We have collected the data of heating capacity, COP and so on, considering the effects of outside air temperature and humidity and hot water demand depending on the region, season, lifestyle and family structure of end users, etc. To improve heat pump efficiency, we have also developed and verified a method to simulate water temperature distribution and profile in the hot water tank considering hot water feed from the heat pump unit, hot water supply from the tank, and heat loss from the tank surface based on experiments (M12003).

3 Installation of a New Heat Pump Test Facility

We have designed, manufactured and installed a new unique test facility for development and evaluation of heat pumps in commercial and industrial use such as a steam generating heat pump in heating process and a hot air generating heat pump in drying process. The full-scale operation of this facility will start in the second half of FY2013 (Fig. 2).

* Systems which are a combination of hot-water panels within a house and a hot-water generating machine outside a house. These systems have been gaining popularity in cold regions due to their high comfort factor and safety.

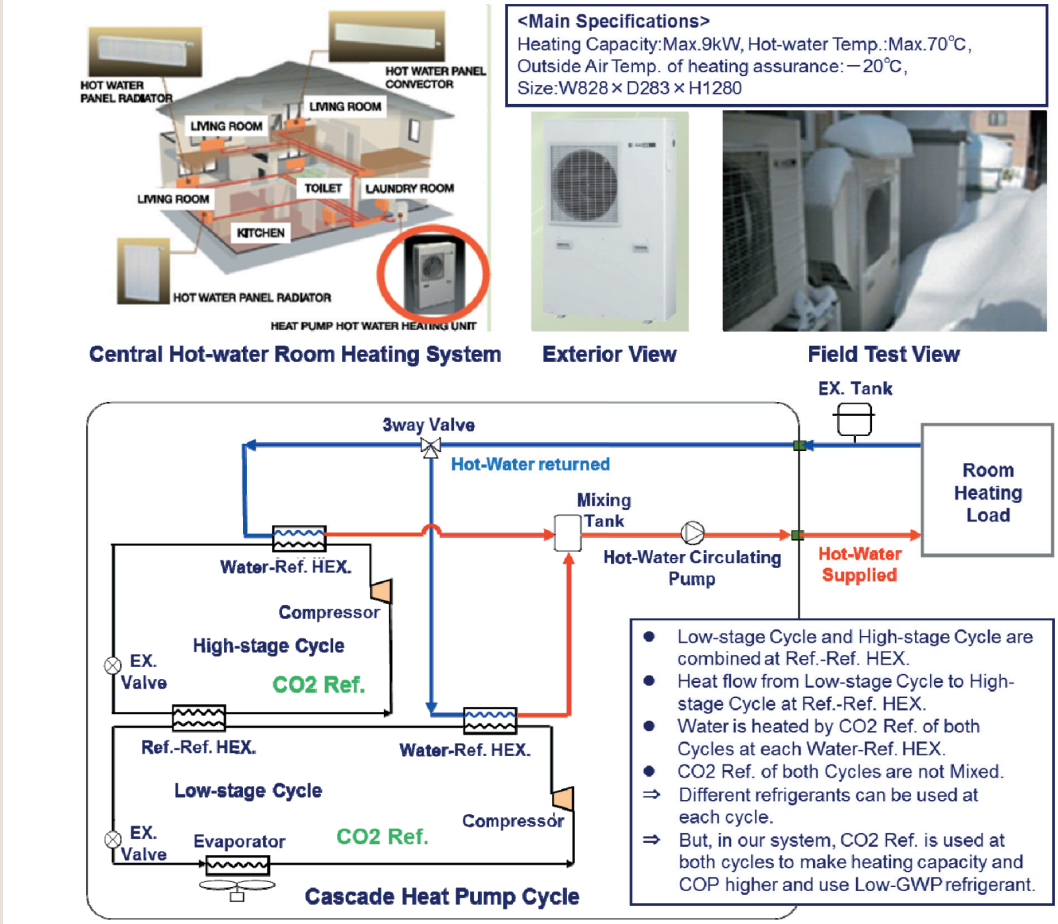

Fig. 1: New residential heat pump for hot-water room heating using CO_2 refrigerant

SANDEN Corporation started sales in May, FY2012. Product's name is "ecoruno".

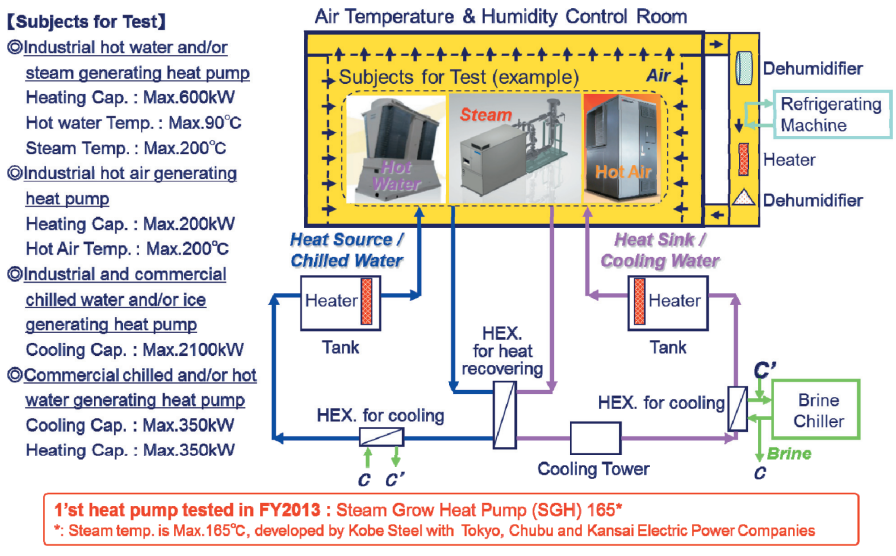

Fig. 2: New test facility for development and evaluation of heat pumps in commercial and industrial use

Full-scale operation will start in the second half of FY2013.
Photo: (left) CAONS by Toshiba Carrier, (Center) SGH by Kobe Steel, (Right) Eco Sirocco by Mayekawa.