Climate-neutral heat pumps
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Use of natural refrigerants in heat pumps for industry, retail and trade

Heat pumps in the private sector normally use geothermal energy or the ambient air as energy source. By contrast, large heat pumps in industry, retail and trade can revert to sources such as waste heat from refrigeration and air-conditioning, discharged process waste air or wastewater with a higher temperature level. It is therefore possible to achieve using heat pumps far higher water outlet temperatures with the same energy input, thus expanding the range of possible applications and avoiding increased carbon emissions.

In order to make heat pumps even more environment-friendly, recently manufacturers have started to make greater use of natural refrigerants such as ammonia, carbon dioxide or water as working substances. "Besides being climate-neutral, the convincing features of these refrigerants include above all their excellent thermodynamic properties and a high level of economic efficiency", says Monika Witt, Chairwoman of eurammon, the European initiative for natural refrigerants. "They have proven to be reliable and safe in refrigeration for more than a hundred years. Given the growing significance being attributed to energy efficiency and to protecting resources, the heat pump sector is now also making increasing use of the potential offered by natural refrigerants."

Superlative ammonia heat pumps

Johnson Controls for instance has installed one of Europe's largest ammonia heat pumps for the Swiss Post. The largest building in Switzerland needs lots of energy for heating and cooling. This is taken from the wastewater of a nearby sewage plant, constituting an energy source with a potential of 266 million kWh low temperature waste heat per year. The refrigerating capacity of the heat pumps is 4.3 MW, with a heating capacity of 5.6 MW at 62°C hot water outlet temperature. Around 50% of the heat energy is taken from the treated wastewater from the sewage plant, with another 30% from the waste heat rejected by the building air-conditioning system. If no room heat is needed, the combined heating/ refrigerating machine uses the wastewater to cool the rejected heat from the refrigeration system. This applies particularly in the summer, when the many automated letter sorting systems demand an increased cooling load of 4.9 MW.

The whole ammonia system is installed in a plant room of around 70 m². Three Sabroe reciprocating compressors are used for first-stage refrigeration at an evaporation temperature of 5°C and a condensation temperature of 30°C. These compressors can also be used as a pure refrigerating system without using waste heat. In heat pump mode, the ammonia is compressed by five Sabroe high-pressure reciprocating compressors from 30°C to 65°C saturation temperature. The high-pressure liquid is supercooled and expanded in two

stages via the intermediate pressure vessel. The coefficient of performance (COP) in the heating phase is 3.97 without supercooler. The system which was commissioned in 2007 reduces the consumption of fossil fuels by 85% with a reduction in carbon emissions of 3,400 t per year.

CO_2 for refrigeration and heating

A water/water heat pump working with trans-critical carbon dioxide has been developed by Star Refrigeration. 'Envitherm' provides high efficiency cooling and uses the waste heat to generate hot water. As a refrigerating machine, the heat pump cools water from 12°C to 6°C at a capacity of 41 kW. The plate heat exchanger gas cooler uses the waste heat produced by the reciprocating compressor and heats mains water from 10°C to 70°C, with a capacity of 50 kW. The COP is more than 3 for cooling and more than 4 for heating. Ideal for installing in new or existing facilities, the package is connected to both the chilled water/glycol and hot water circuits within a facility. The complete factory tested heat pump package operates with a 25 kg carbon dioxide charge and requires only water connections and an electrical supply. It is ideal for generating hot water either for storage or instant use in applications such as food production, hotels, office buildings and hospitals.

Heat pump with natural refrigerant R723

Since the start of the year, Frigopol has been offering an air/water heat pump for industrial use that works with the natural refrigerant R723 – a refrigerant blend consisting of ammonia and dimethyl ether. Working at a capacity of 24 kW, the system provides hot water at a temperature of up to 45°C for room heat and at a temperature of up to 65°C for process water. The main component of the heat pump filled with 3.5 kg R723 is a semi-open compressor with frequency control to allow variable capacity adjustment between 50 and 100%. For example, the electric motor is cooled with water that then flows directly into the hot water circuit. This electric motor is a water cooled stator which is a special construction with a piping around the motor. To defrost the evaporator, high pressure hot gas is taken through the evaporator so that no energy has to be taken from the hot water circuit. The compact heat pump is soundproofed and installed outside the building.

Backing from the EU

"The examples show that manufacturers are already working actively at viable future concepts for heat pumps", says Monika Witt from eurammon. "Further impetus for technological innovations is bound to come from the latest EU directive adopted in June for promoting the use of renewable energies, whereby for the first time, heat pumps are recognised as an energy source."

Source: eurammon

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