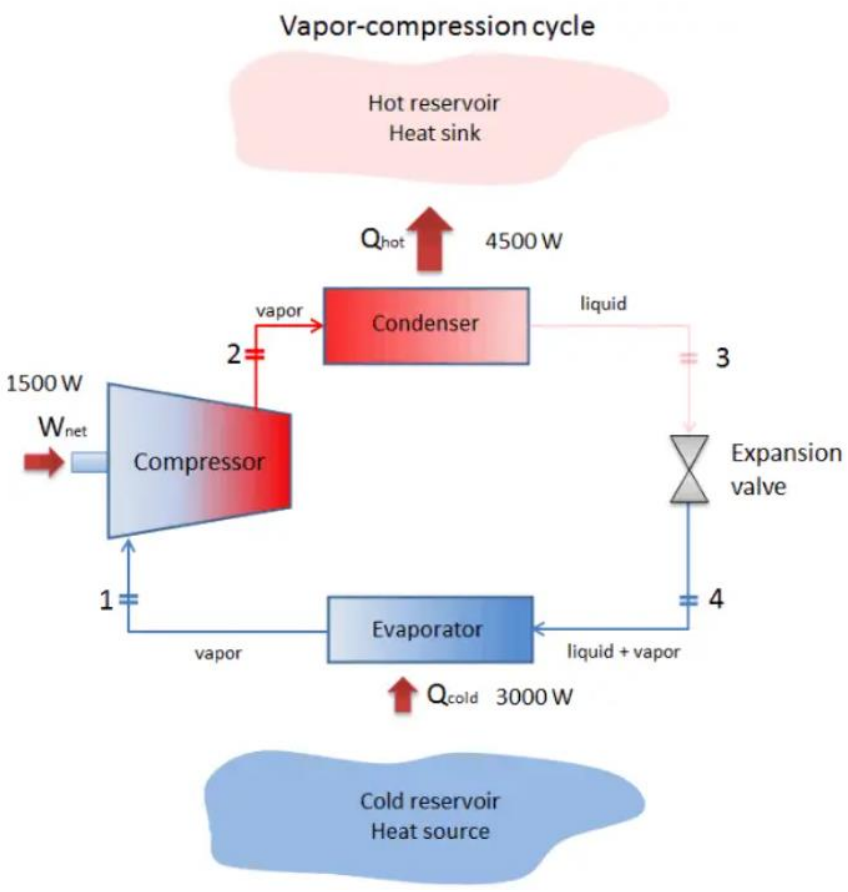
Monday, 20 January 2025

Newsletter:
Coefficient of Performance – Chillers/Heat Pump

The efficiency of refrigeration systems and heat pumps is denoted by its Coefficient of Performance (COP). The COP is determined by dividing the total electrical energy input to the system and the total cooling or heating capacity obtained from the system.

Refrigeration Cycle

In a vapour compression cycle, A compressor moves heat from a heat source to the heat sink as shown in the below diagram. Typically, an evaporator is a heat source from which the heat is removed, and condenser is a heat sink to which the heat is added. In a chiller, the evaporator is the functional heat exchanger and in a heat pump, condenser is the functional heat exchanger.



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COP

COP is denoted by the unit of kW/kW or W/W which represents the amount of cooling capacity or heating capacity derived from the system per kW of electrical energy consumed by the system in the process. In a refrigeration system, electrical energy consumption is by the compressor. The compressor releases most of this energy to the refrigerant as heat. Therefore, the available heat at the condenser is more than the heat extracted at the evaporator.

COP = Q/W

Where,

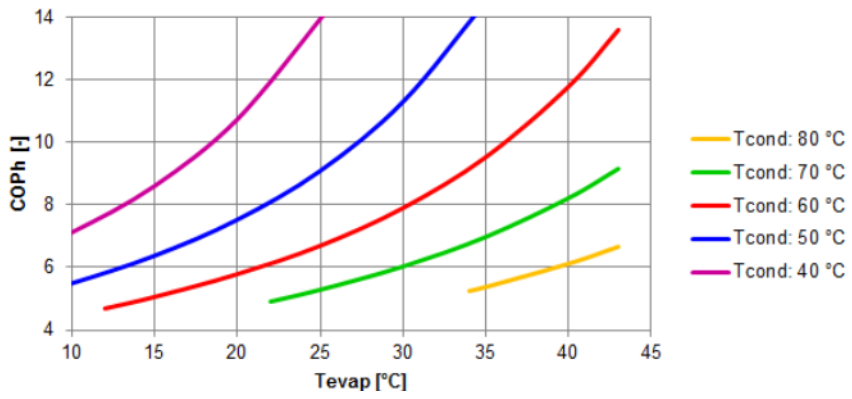
Q is the useful heat energy added or removed by the refrigeration system in **kW**

W is the work done or electrical energy input to the system in **kW**

A COP value of 4 means that the addition of 1 kW of electric energy is needed to have a release of 4 kW of heat at the condenser for a heat pump. At the evaporator side 3,0-3,5 kW of heat is extracted. The additional heat is generated by the compressor. On the other hand, for a refrigeration system a COP of 4 indicates that 1 kW of electricity is needed for an evaporator to extract 4 kW of heat. Due to this important difference in COP definition, for a heat pump one often speaks of COPh. In this abbreviation 'h' means heating.

Efficiency of Heat Pumps

The efficiency of a heat pump, COPh, depends on several factors. Especially the temperature difference between waste heat source and potential user is an important factor. The temperature difference between condensation and evaporation temperature mainly determines the efficiency: the smaller the difference, the higher the COPh. The figure below shows the influence of this temperature difference on the COPh value.



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Other Factors affecting the Efficiency of refrigeration systems

Another important factor that influences efficiency is the applied refrigerant. Ammonia, a natural refrigerant for example, is a very efficient refrigerant with a COPh of 6 for an evaporation temperature of 30 °C and condensation temperature of 70 °C. These same conditions only give a COPh of 4,5 for refrigerant R134A. R32 is another efficient conventional refrigerant with low gdp compared to other older refrigerants.

Other factors that will affect the efficiency of a refrigeration system are system controls, efficiency of peripheral equipment like fans, pumps, etc, insulation of pipes and heat exchangers and system design.

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