FAHRENHEIT
Cooling Innovation.

HyCool eLearning

Hybrid Heat Pump

Lesson 2. Construction and features of the HHP

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eLEARNING COURSE

Lesson 1. Basics

Lesson 2. Construction and Features

Lesson 3. System Planning

Lesson 4. Operation and Maintenance

LESSON CONTENTS

How is the adsorption heat pump built?

How is the hybrid heat pump built?

Influence of the operating temperatures on the performance of the HHP

Energy balance of the HHP

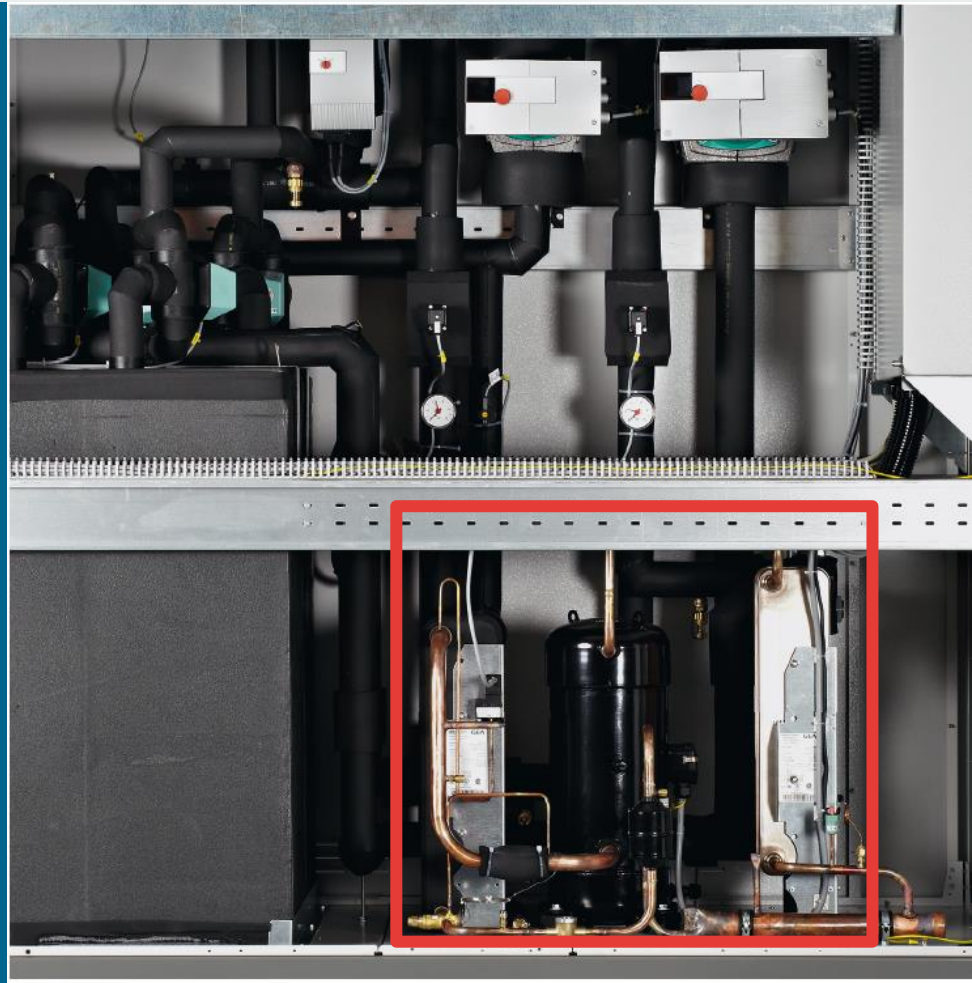
If you haven't already completed part of the eLearning course called HHP BASICS, be sure to return to it. In this, as well as in the next two parts of the course, we will be referring to the information explained in the BASICS presentation.

Vapour compression heat pump

The vapour compression heat pump components are:

1. Compressor
2. Evaporator
3. Condenser
4. Expansion valve
5. Copper piping
6. Instrumentation

In HyCool project, natural refrigerants R290 and R1270 are used. However, heat pumps with synthetic refrigerants (with low GWP) can also be used as part of the HHP.



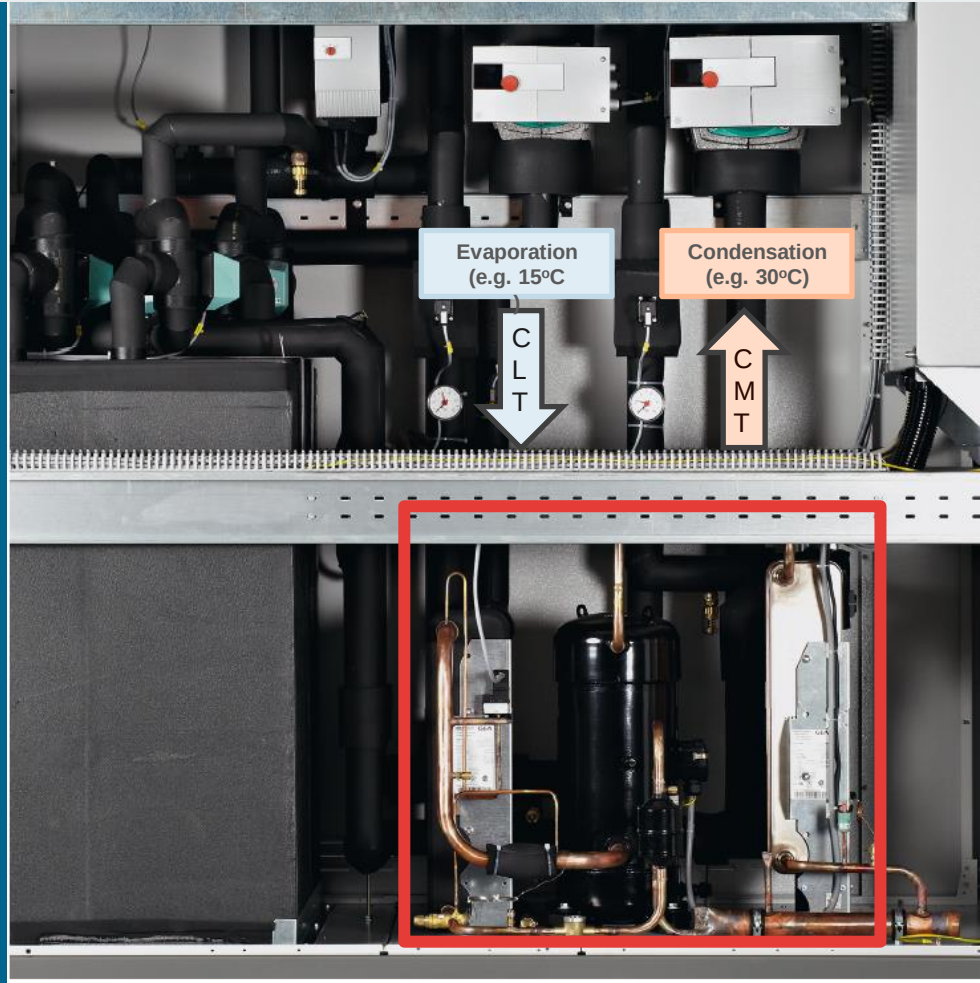
Vapour compression heat pump

The HHPs usually contain a vapour compression heat pump with water-cooled condenser.

There are two hydraulic circuits:

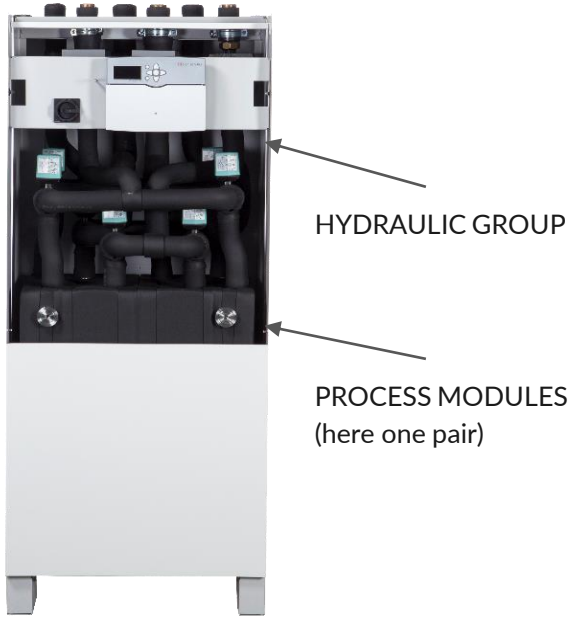
1. **CLT (chiller low temp.) circuit**
   Allows circulation of cold-water and distraction of heat from the cooled room or process.

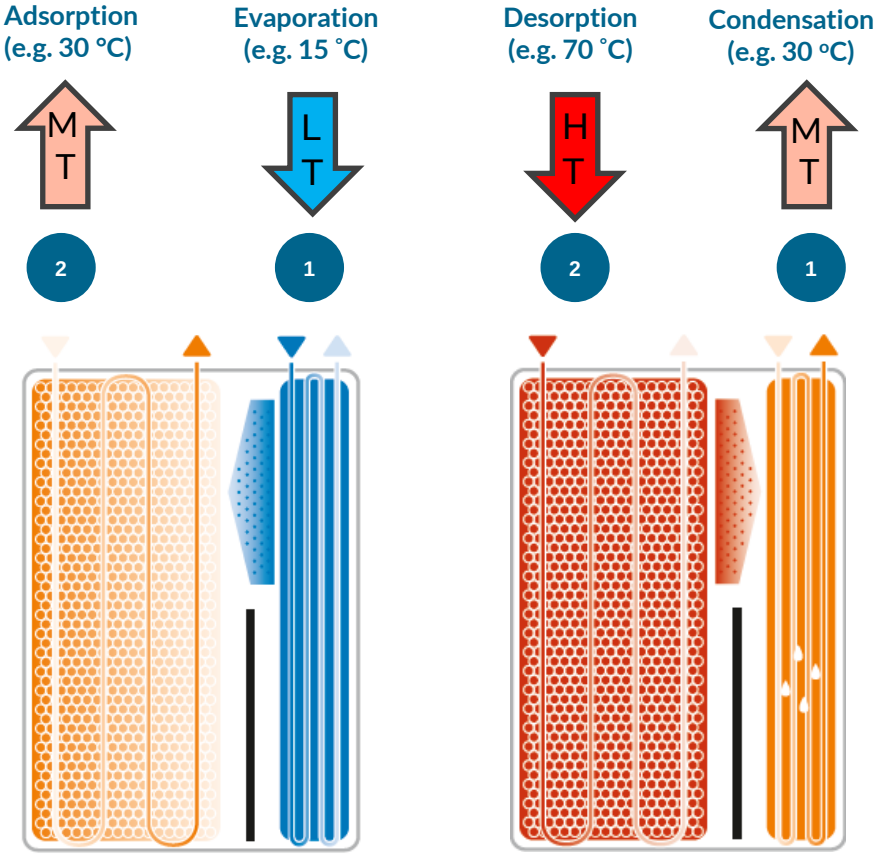
2. **CMT (chiller medium temp.) circuit**
   Allows the dissipation of condensation heat.



Construction of the Adsorption Heat Pump

- Process modules are the core of the adsorption heat pump. They can be seen as an equivalent of the mechanical compressor.
- One process module consists of two heat exchangers closed in a vacuum tight, stainless-steel envelope. Each module is thermally insulated.
- The modules are grouped in pairs. The adsorption heat pump contains at least one module pair. For higher cooling capacity, more module pairs can be added.
- Another important part is the hydraulic group consisting of pumps and three-way valves directing the heat transfer fluid at right temperature levels to the corresponding heat exchangers.





Adsorption heat pump

1 Evaporator/Condenser is a heat exchanger on which water evaporates and condenses in alternating phases. By means of this HEX the cold water (LT) is cooled down and the condensation heat is collected and then dissipated (MT).

2 Adsorber/Desorber is a heat exchanger coated with the sorbent. By means of this HEX the sorbent is cooled down during adsorption (MT) and heated up during desorption (HAT).

LT (low temp.) circuit heat of evaporation e.g. from the cooled room

MT (medium temp.) circuit dissipation of adsorption and condensation heat

HT (high temp.) circuit hot water from the source, heat for desorption process

Adsorption
(e.g. 30 °C)

MT

2

Evaporation
(e.g. 15 °C)

LT

1

Desorption
(e.g. 70 °C)

HT

2

Condensation
(e.g. 30 °C)

MT

1

Left module

Right module

Adsorption heat pump

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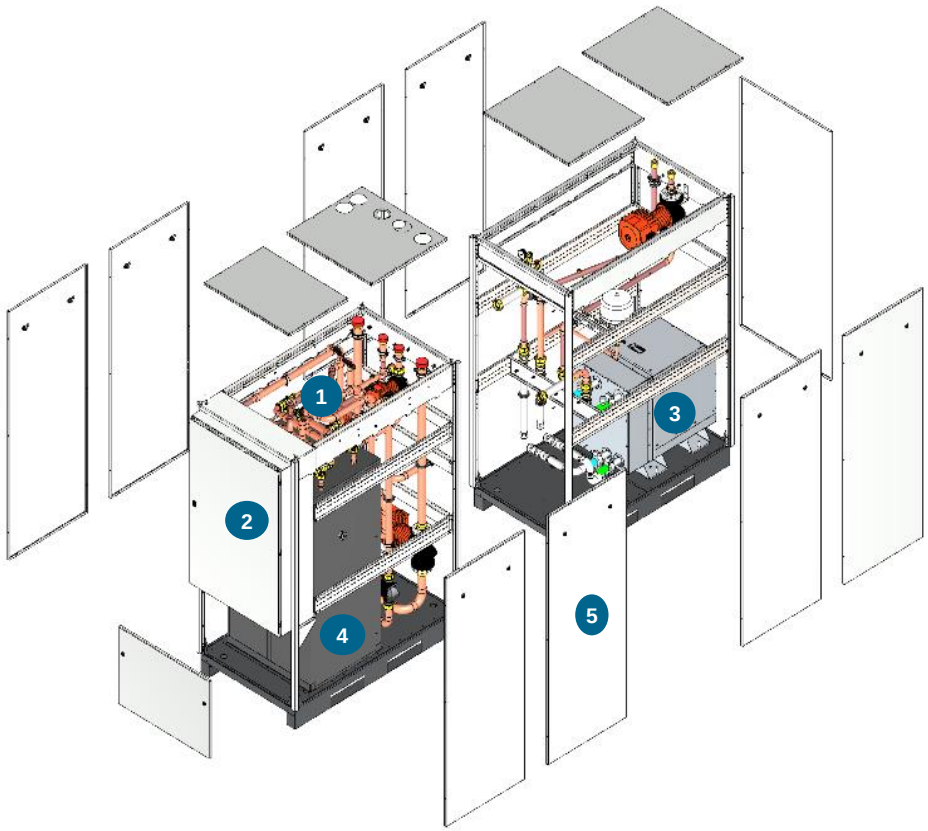


Hybrid heat pump

1 **HYDRAULIC GROUP**
Hydraulic circuits of the HHP: hot water, re-cooling water, and cold water. Contains three-way valves, pumps, expansion vessels, shut off valves, temperature sensors etc.

2 **CONTROL CABINET**
Hydraulic circuits of the HHP: hot water, re-cooling water, cold water. Contains three-way valves, pumps, expansion vessels, shut off valves, temperature sensors etc.

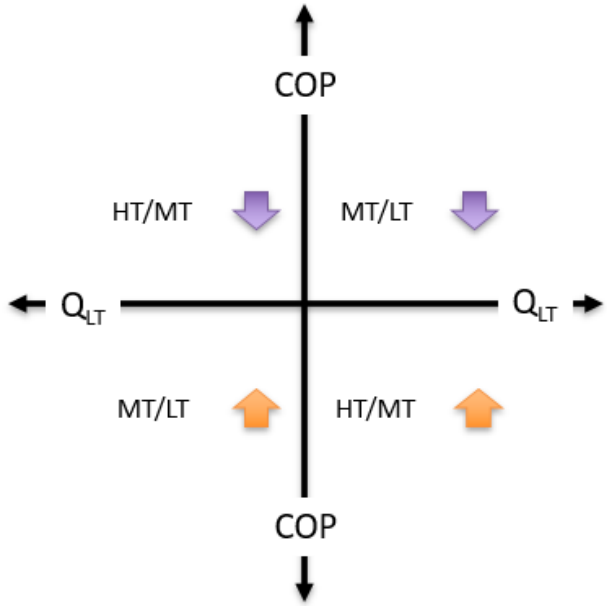
3 **COMPRESSION HEAT PUMP**
In this example, the main components of compression heat pump, such as compressor, evaporator, condenser and expansion valve, are closed in a ventilated housing.

4 **ADSORPTION PROCESS MODULES**
Two identical, vacuum-tight, welded, and diffusion-tight insulated process modules. Individual modules alternate between adsorption and desorption processes.

5 **CASING**
The adsorption and compression heat pumps can be placed in one housing (like in this picture) or in two or more separate casings.

Influence of operating temperatures on the performance of Adsorption Heat Pump

Decrease in the ratio of drive to re-cooling temperatures causes higher COP but leads to lower cooling capacity.



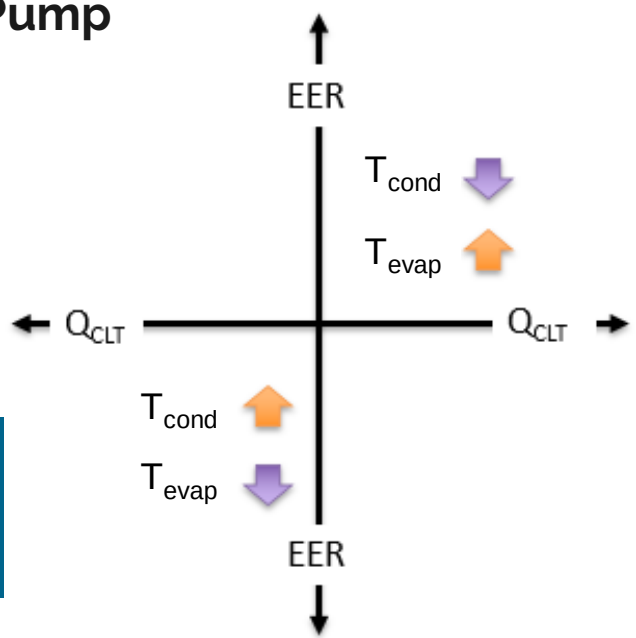
Decreasing the ratio of re-cooling to cold water temperatures cause an increase in both cooling capacity and COP

Decreasing the ratio of re-cooling to cold water temperatures cause a decrease in both cooling capacity and COP.

Increase in the ratio of drive to re-cooling temperature causes higher cooling capacity but leads to lower COP.

* Q_{LT} – cooling capacity, COP – thermal COP, ratio of Q_{LT} to Q_{HT}

Influence of operating temperatures on the performance of Vapour Compression Heat Pump

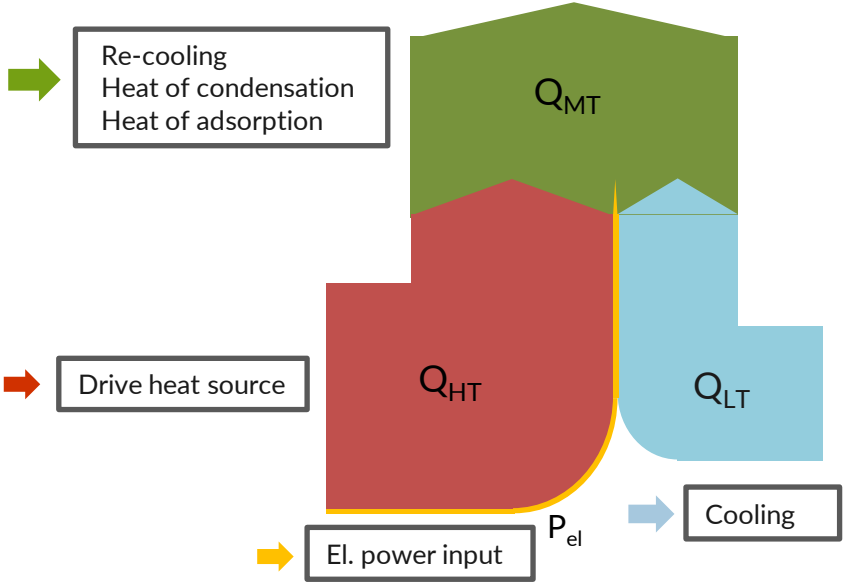


Increasing evaporation and/or decreasing condensation temperatures cause an increase in both cooling capacity and COP.

Decreasing evaporation and/or increasing condensation temperatures cause a decrease in both cooling capacity and COP.

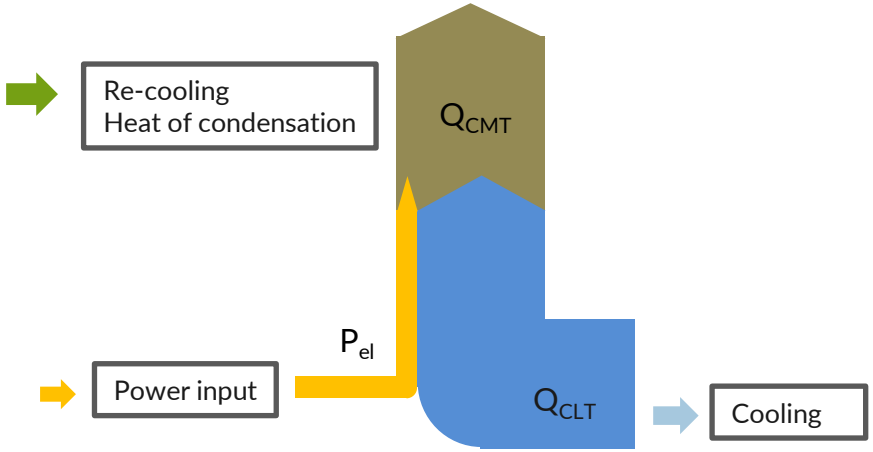
* Q_{CLT} – cooling capacity, EER – Energy Efficiency Ratio, ratio of Q_{CLT} to P_{el}

Energy balance of the HHP



Adsorption heat pump

$$Q_{HT} + P_{el} + Q_{LT} = Q_{MT}$$



Compression heat pump

$$Q_{CLT} + P_{el} = Q_{CMT}$$

Energy balance of the HHP

The overall energy balance of the HHP is as follows:

$$Q_{HT} + Q_{LT} + Q_{CLT} + P_{el} = Q_{MT} + Q_{CMT}$$

Since in cascade layout Q_{LT} is equal to Q_{CMT}, the energy balance simplifies for the cascade:

$$Q_{HT} + Q_{CLT} + P_{el} = Q_{MT}$$

That‘s all in Lesson 2.

You can now proceed to Lesson 3.