FAHRENHEIT
Cooling Innovation.

HyCool eLearning

Hybrid Heat Pump

Lesson 4. Operation and Maintenance

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eLEARNING COURSE

Lesson 1. Basics

Lesson 2. Construction and Features

Lesson 3. System Planning

Lesson 4. Operation and Maintenance

What questions will this course answer?

What are the operating limits and who can operate the HHP?

What are the operating modes of the HHP?

How to switch the HHP on and off? What settings can be changed by the user on the HMI?

What are the common issues with the HHP?

What are the maintenance requirements and who can perform the maintenance tasks?

**More detailed information on operation & maintenance, as well as on proper system planning can be found in the operation manuals, which are delivered with the HHP.*

Operating limits

The adsorption heat pumps are very sensitive to operating conditions. Too low drive temperatures and too high re-cooling temperatures will lead to poor performance of the HHP. Too low chilled water temperature can lead to freezing and damage to HHP.

In the compression heat pump, cold water temperatures below zero are allowed. In such application, however, antifreeze must be used in this circuit!

To avoid freezing of water in hydraulic circuits, the HHP can be stored and operated only in rooms with temperature above 5°C.

OPERATING LIMITIS		
	DESCRIPTION	LIMITS
ADSOPRTION HEAT PUMP	Maximal operating pressure in hydraulic circuits	4 bar
	Drive temperature (HT)	55 °C to 95 °C for silica gel 75 °C to 95 °C for zeolite
	Re-cooling temperature (MT)	< 45 °C
	Chilled water temperature (LT)	> 8 °C
	Surrounding temperature	> 5 °C
COMPRESSION HEAT PUMP	Maximal operating pressure in hydraulic circuits	4 bar
	Maximal refrigerant pressure	28 bar
	Re-cooling temperature (CMT)	< 55 °C
	Chilled water temperature (LT/CLT)	-10 °C to +15 °C
	Surrounding temperature	> 5 °C

Operating limits

Safety valves in hydraulic circuits are mandatory to avoid the increase in pressure over the allowable limit! The operator must follow national regulations on the pressurized tanks (e.g., frequent control of safety valves).

Pressure limiting devices are installed in the refrigerant circuit of the compression heat pump, hence no additional refrigerant pressure control is needed from the operator.

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Who can operate the machine?

- Standard operation of the HHP does not require any special qualifications. However, **operators must read the operating instructions** supplied with the machine before beginning any work. The operator has access only to the HMI control panel. During standard operation, the operator should not interfere with the interior of the HHP (refrigerant circuit, vacuum modules).
- Regular inspection of the system must be performed by **trained personnel**.
- Commisioning, maintenance and service of the HHP must be performed by **certified personnel** only.

Operating modes of the AdHP

In principle, every adsorption heat pump (AdHP) of Fahrenheit can operate in two modes: **active cooling**, and **free cooling**. **Heating mode** is also available upon request. In case of no cooling demand or lack of sufficient drive heat, the AdHP turns into **Stand-by mode**.

ACTIVE COOLING

Active cooling mode is the main task of the adsorption heat pump and its standard operation mode.

In active cooling mode, the adsorption heat pump cools water in LT circuit down to the desired temperature (set by the operator on the HMI).

For this mode of operation, the source of drive heat with appropriate temperature and in sufficient quantity is needed, as well as a heat sink (e.g., dry cooler).

It is also important to activate the cold distribution system. Without it, the cold water temperature at the outlet of the AdHP quickly drops and the AdHP switches to Stand-by due to freeze-protection.

FREE COOLING

Free-cooling is a method of using low external air temperatures to assist in chilling water. When outdoor temperatures are lower than the desired temperatures in the cold distribution circuit, the AdHP utilizes the cool outdoor air as a free cooling source.

The water from cold distribution circuit is cooled directly in the dry cooler (or cooling tower etc.). The heat from the cold distribution circuit can be transferred to the dry cooler indirectly through the hydraulics of AdHP.

In this mode, the AdHP consumes no drive heat. The only drive energy input is electricity to run the circulation pumps.

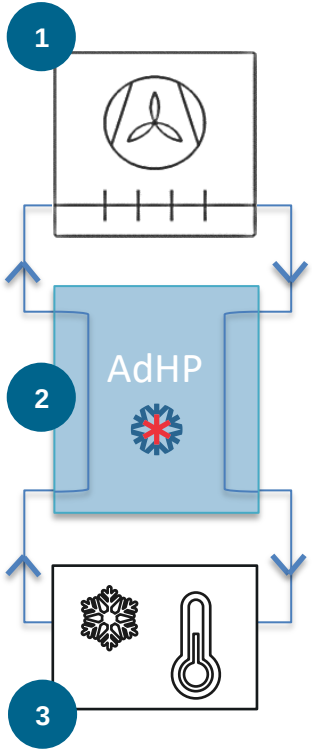
To use free cooling, an outdoor temperature sensor or an activation signal from a master controller is required !

General concept of Free-cooling

1. **Dry Cooler**
   Water is cooled down with the use of cold ambient air.

2. **Adsorption Heat Pump**
   Cold water flows through the hydraulic circuits of AdHP to the cooling distribution system.

3. **Cooling Distribution System (e.g., fan-coil)**
   Cold water flows through the fan-coil and cools down the air in the room. Water warms up and returns to AdHP.



Operating modes of the HHP

Depending on the layout of the HHP (serial, parallel or cascade connection), different modes of operation are available. The optimum mode of operation is set depending on the current conditions such as cooling demand, outdoor temperature, availability of driving heat, other temperature ranges (e.g., chilled water return temp.). The basic modes of HHP operation are:

MONOVALENT ADSORPTION	MONOVALENT COMPRESSION	BIVALENT ADSORPTION & COMPRESSION
▪ Adsorption unit covers 100% of the load, the compression chiller is by-passed. ▪ There is enough drive heat for the operation of adsorption unit and the outdoor temperature is too high to use free-cooling. ▪ Not available in cascade layout.	▪ Compression chiller covers 100% of the load, the adsorption units can be by-passed. ▪ There is NOT enough drive heat for the operation of adsorption unit and the outdoor temperature is too high to use free-cooling. ▪ Not available in cascade layout.	▪ Both adsorption and compression chillers are active. ▪ Adsorption unit can cover only a part of the cooling load (due to peak cooling load, restricted amount of drive heat available or high re-cooling temperature etc.). ▪ Compression chiller cools the chilled water to the desired temperature. ▪ In case of cascade layout, the adsorption unit cools down the condenser of compression unit, therefore the bivalent mode is the basic (standard) mode of operation.

Operating modes of the HHP

Depending on the layout of the HHP (serial, parallel or cascade connection), different modes of operation are available. The optimum mode of operation is set depending on the current conditions such as cooling demand, outdoor temperature, availability of driving heat, other temperature ranges (e.g., chilled water return temp.). The basic modes of HHP operation are:

FREE COOLING WITH ADHP	FREE COOLING WITH ADHP & COMPRESSION COOLING (only in cascade layout)
▪ The cooling load is dissipated to the environment, taking advantage of the low ambient temperatures e.g., in winter. ▪ The cooling load is dissipated in the dry cooler, it is possible due to hydraulic and thermal connections in the adsorption unit. ▪ Compression chiller can be by-passed.	▪ Outdoor temperatures are low enough to ensure the condensing temperature of the compression chiller as low or lower than with the use of adsorption chiller. ▪ The condensation heat of the compression chiller is dissipated in the dry cooler. ▪ The operation of the system resembles the standard operation of the compression chiller.

Operating the HHP

The operator's main activities are performed by means of HMI (Human-Machine interface, control panel) of the HHP. Depending on the version of the HHP, there may be one common control panel for the whole HHP or two separate HMIs for the adsorption and compression heat pump.

Switching the HHP on/off

To switch on the HHP, one should first turn on the main switch to activate the power supply, and then switch on the HHP on the HMI control panel. The switching off procedure is in reverse order. Firstly, use the HMI to turn off the HHP and then disconnect the power supply by the main switch. The power supply to the HHP can be switched off by the main switch only if the information on the HMI states that it is safe to do so!

Changing the set point for cold water temperature

The operator can set the desired temperature of the cold water (LT / CT circuit). In some versions of HHP, the set point must be set separately for the adsorption and the compression heat pump. While changing this setting, the operator should comply with the operating limits of the HHP.

No.	Description
1	Display
2	Main overview
3	Alarm display/Alarm history (a red light shows an active alarm)
4	One step back/cancel change of value
5	One line up/Increase input value
6	One line down/decrease input value
7	Select line/confirm change of value

Operating the HHP

Changing the free-cooling settings of the AdHP

If the activation of the free-cooling mode is controlled by outside temperature (Pt1000 sensor connected to the HHP) and NOT by a master controller, there are 2 important parameters governing the free-cooling mode, which are set on the HMI. First one is the switch-on (switch from active cooling to free-cooling operation) condition and the second one is the switch-off (switch from free-cooling to active cooling operation) condition. The third parameter is set in reference to the set point of cold water temperature and governs the switching between free-cooling and Stand-by. Values of these parameters (switch on/off conditions) are set during the commissioning but can as well be changed later on by the operator.

Changing the language of HMI

There are two languages available in the HMI – German and English. Upon delivery, German language is set as default, but it can be easily changed on the HMI.

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6	One line down/decrease input value
7	Select line/confirm change of value

Operating the HHP

Changing the settings for the HT tank

If a hot water tank is installed in the system, its temperature can be used to control the operation of HHP. If the drive temperature is too low, the operation of HHP is not always effective. The switch-off condition defines the minimal temperature of the hot water tank at which HHP switches to Stand-by. HHP switches again to normal operation after the temperature in the tank reaches the value specified as switch-off condition. The switch-on condition is defined as a hysteresis to the switch-off condition. It specifies how many Kelvins (Celsius degrees) the temperature in the storage tank should be higher than the switch-off temperature in order to switch HHP from Stand-by to Active cooling mode. Values of both parameters (switch on/off temperatures) are set during the commissioning but can as well be changed later on by the operator.

No.	Description
1	Display
2	Main overview
3	Alarm display/Alarm history (a red light shows an active alarm)
4	One step back/cancel change of value
5	One line up/Increase input value
6	One line down/decrease input value
7	Select line/confirm change of value

Operating the HHP

Changing the settings for the LT tank

If a hot water tank is installed in the system, its temperature can be used to control the operation of HHP. The switch-off condition defines the lowest temperature in the cold water tank at which HHP switches to Stand-by. The switch-on condition is defined as a hysteresis to the switch-off condition. It specifies how many Kelvins (Celsius degrees) the temperature in the storage tank should be higher than the switch-off temperature in order to switch the HHP from Stand-by to Active cooling mode. Values of both parameters (switch on/off temperatures) are set during the commissioning but can as well be changed later on by the operator.

Checking error messages

The operator can check the content of the error message on the HMI and take appropriate corrective measures in accordance with the operating manual.

No.	Description
1	Display
2	Main overview
3	Alarm display/Alarm history (a red light shows an active alarm)
4	One step back/cancel change of value
5	One line up/Increase input value
6	One line down/decrease input value
7	Select line/confirm change of value

Error messages of the HHP

The HHP is a robust machine, which operation is mostly problem-free. However, the most common errors, which can be encountered by the operator are listed below.

NO FLOW IN COLD WATER CIRCUIT

The flow switch in the cold water circuit indicates no flow. The reason may be: the circuit is blocked by closed valve, blocked strainer etc.; the circulation pump in this circuit is damaged or flow switch is damaged. The HHP switches to the frost protection phase and stays in it until the flow sensor indicates flow! No cooling capacity is provided.

ACTIVATION OF FREEZE PROTECTION

The temperature measured in the cold (LT/CLT), or re-cooling (MT/CMT) water circuit is too low. The reason may be the cold water circuit is blocked by closed valve, blocked strainer etc.; malfunction of the external re-cooling pump (problem in speed regulation); malfunction of the re-cooler (problem in speed regulation). The HHP switches to the frost protection phase and stays in it until the flow sensor indicates flow! No cooling capacity is provided.

PROBLEM WITH TEMPERATURE SENSOR

A temperature sensor reports an error. The operator should check if the temperature sensors are correctly connected.

Error messages of the HHP

The HHP is a robust machine, which operation is mostly problem-free. However, the most common errors, which can be encountered by the operator are listed below.

POOR PERFORMANCE OF THE HHP

The calculated cooling capacity of the last half-cycle is too low. The reason may be: too low temperatures in the cold (LT/CLT) and/or hot (HT) water circuits; too high re-cooling temperature. The operator should check all the external circuits (heat source, re-cooler, cold distribution circuit) to find possible reasons for incorrect temperature levels.

VOLUME FLOWS FAR FROM NOMINAL VALUES

Volume flows lower than specified in the data sheet lead to lower cooling capacity and COP delivered by the HHP. The volume flows are checked during the commissioning of the HHP. In case of any changes in the installation performed after the commissioning, the operator should make sure, that the nominal volume flows are provided.

Maintenance Schedule

	MEASURES	INTERVAL & PERSONNEL
INSPECTION OF THE SYSTEM	Visual inspection of the system for damaged insulation, leaks and defects in the electrical wiring. Checking the operating pressure of all hydraulic circuits, if necessary the working medium must be refilled. Inspection of the fans of the re-cooler and cleaning of the heat exchanger block, especially on the suction side. Function test of the pumps. Read the last error message and take appropriate measures.	**Interval:** every six months **Execution:** trained personnel
MAINTENANCE	General function test. Leakage and functional testing of all the valves and pumps of AdHP and the circuit separation. Checking all the set parameters, evaluation of error message, and if necessary, update of the software. Inspection of freeze-protection measures.	**Interval:** annually **Execution:** certified personnel
LEAK CHECK (IN CASE OF F-GAS REFRIGERANT)	The obligation of periodic leakage checking is regulated by EU f-gas regulation (517/2014).	**Interval:** according to the type and amount of refrigerant **Execution:** F-gas certified personnel
INSPECTION OF SAFETY DEVICES (IN CASE OF R290)	Inspection of safety devices and alarm systems of the compression chillers containing propane (R290) according to DIN EN 378-4.	**Interval:** annually **Execution:** certified personnel
MAINTENANCE OF PROCESS MODULES	Checking the vacuum stability of all process modules and restoring the vacuum if necessary	**Interval:** every 2 years **Execution:** certified personnel

That‘s all in Lesson 4.

Thank you for your attention !