



Refrigerating systems and heat pumps

OPERATING MANUAL

Refrigerating systems and heat pumps



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1. General

1.1. Normal use

These refrigerating systems and heat pumps are devices that are used for handling air in AHUs.

These AHUs are to be exclusively deployed for the ventilation of rooms and buildings, the maintenance of the requisite room climate as well as the removal of dust particles and other airborne contaminants.

The manufacturer must be consulted before any alternative applications are undertaken.

The refrigerating system or heat pump may only be operated in conjunction with the operation of the AHU.

1.2. Safety notice



This operating and maintenance manual must be observed by all persons working with this plant.

The general assembly, start-up and maintenance manual for central ventilator units from the AT 4/6 series is to also be observed (request if required).

The requirements demanded by the respective applicable national or international standards, provisions and safety regulations must be observed during all activities.

Any works performed on the plant may only be performed by qualified and authorised specialist personnel.

Only access and work on the plant once the following points have been fulfilled:

- Disconnect from power supply (switch off at all poles).
- Secure against unauthorised activation (e.g. lockable maintenance switch).
- Minimum waiting time for systems with a frequency converter is 15 minutes (due to residual voltage).
- All moving parts are stationary.
- Allow heat exchangers, pipes and components to cool down to the ambient temperature.
- Wear protective equipment.

After completion of the works, the following must be ensured before switching on:

- No persons are in the danger area or inside the plant.
- All safety devices are in place and functioning.

The systems use a refrigerant. In order to protect the environment, this may never be released into the atmosphere.

Never open the refrigeration circuit. Doing so may cause injury due to the high pressure within the sealed refrigeration circuit.

**Warning!**

- Life threatening due to lack of oxygen!
- Refrigerant vapours are heavier than air – the resulting displacement of oxygen can lead to asphyxiation.
- Take extra care when accessing sealed and lower-lying rooms!
- Avoid physical contact with refrigerant and compressor oil – otherwise, there is a risk of injury to the eyes and skin.
- Wear protective equipment (BGR 500 Chap. 2.35-3.6).
- Read and observe safety data sheets.
- Information on first-aid measures can be found on the safety data sheet of the relevant refrigerant.
- There is a risk of burn injury due to the heat surfaces of pipes, heat exchangers and compressors.

Refrigerating systems, heat pumps and the auxiliary electrical components may not be installed in explosion-hazard areas (as defined by German ATEX regulations).

1.3. Warranty

The validity of the warranty is conditional upon the agreement of a service agreement with our Service Centre or a qualified engineering company and the written documentation of regular, proper servicing in the form of entries made to the log book for refrigerating systems.

Our warranty is no longer valid if damage is caused through improper handling, operation or maintenance or through negligence and the failure to observe regulations and recommendations.

The warranty may also become invalid due to the incomplete performance of maintenance works.

Modifications or changes to the plant undertaken by the customer or any other unauthorised persons will render the manufacturer's warranty and the Declaration of Conformity invalid.

1.4. Transport / assembly / installation

Plants or components, containing refrigerating systems or heat pumps, must be kept upright (never tilted) at all times during transport and assembly.

Knocks and hard impacts should be avoided.

When setting up this air handling unit, suitable consideration of the provision stipulated by the German Water Resources Act (WHG) must be taken in order to prevent any contamination of the ground and ground water by escaping compressor oil in the event of a fault.

1.5. Directives, regulations and standards

The following directives, regulations and standards apply during the construction and in relation to the installation, operational start-up and maintenance:

Applicable directives:

Directive 2006/42/EC	Machinery Directive
Directive 2004/108/EC	EMC Directive (Electromagnetic compatibility)
Directive 2006/95/EC	Low Voltage Directive
Directive 97/23/EC	Pressure Equipment Directive
Regulation (EC) No 842/2006	Regulation on certain fluorinated greenhouse gases (fluorinated gases regulation)

Possibly applicable harmonised standards:

DIN EN 1886	Ventilation for buildings – Air handling units – Mechanical performance and measurement processes
DIN EN 12599	Ventilation for buildings – Test procedures and measuring methods for handing over installed ventilation and air conditioning systems
DIN EN 13053	Ventilation for buildings – Air handling units – Rating and performance for units, components and sections
DIN EN ISO 12100 Parts 1 and 2	Safety of machinery – Basic concepts, general principles for design
DIN EN ISO 13857	Safety of machinery – Safety distances to prevent upper and lower limbs from entering hazard zones
DIN EN 60204-1	Safety of machinery – Electrical equipment of machines, general requirements
DIN EN 61000-6-1/-2/-3/-4	Electromagnetic compatibility
DIN VDE 0100-100	Erection of low-voltage installations – Application, purpose and principles
DIN VDE 0100-530	Erection of low-voltage installations – Selection and erection of electrical equipment – Switch gear and control gear
DIN VDE 0113-1	Electrical equipment of machines – General requirements
DIN EN 14121	Safety of machinery – Risk assessment
DIN EN 378: 2008 Parts 1-4	Refrigerating systems and heat pumps – Safety and environmental requirements

Possible applicable national standards and technical specifications:

VDMA 24167	Fans – Safety requirements
VDMA 24186	Room ventilation systems: maintenance service program
VDI 2079	Room ventilation systems: acceptance test for air conditioning systems
VDI 3801	Operation of room ventilation systems
VDI 3803	Room ventilation systems: structural and technical requirements
VDI 6022	Hygienic requirements for ventilation and air conditioning devices, office rooms and conference rooms
German accident prevention regulations (UVV) BGV A1	Prevention principles
UVV BGV D6	Cranes
Accident Prevention and Insurance Association Rules (BGR) 500	Operating work equipment (including Chap. 2.35 operating refrigerating systems, heat pumps and cooling facilities)

1.6. Emergency measures

In the event of fire, the flaps must be closed and the device disconnected from the power supply at the main switch. Rooms must be closed to minimise aeration. Alert fire service.



Warning!

To protect against any noxious substances that may have been released, rooms may only be accessed with heavy-duty respiratory protection apparatus – see BGR 500 for more.



The rupture of pressurised containers during a fire can cause severe personal injury and damage to property.

Do not remain directly in the danger area!

2. Function and component description

2.1. General description

A refrigerating system or heat pump is a closed circuit in which a refrigerant circulates without being consumed.

The system functions by absorbing heat at a low temperature level and releasing it at a high temperature level through the input of propulsion energy (compressor).

The heat (Q_{zu}) is absorbed in the evaporator by a refrigerant with a low boiling point.

The vaporous medium is then compressed in the compressor, causing it to become heated.

In the condenser, the refrigerant gives off heat (Q_{Ab}) to the cooling medium (air or water) through condensation. The medium is expanded in the expansion valve before being fed back into the evaporator at low pressure. This completes the circuit of the refrigerating system or heat pump and it once again begins from the start.

A refrigerating system is exclusively used for cooling. The refrigerating system with heat pump change-over is used both for heating in winter (heat pump) and for cooling in summer (refrigerating system).

2.2. Compressor

The compressor is where the vaporous refrigerant is sucked in at low pressure (from the evaporator) and compressed at a higher pressure.

The compressor works like a pump and allows the refrigerant to circulate in a cooling circuit.

Scroll compressors, reciprocating compressors and screw compressors are used.

2.3. Condenser

The condenser is where the vaporised, overheated refrigerant is cooled to condensation temperature and liquefied. Because the heat is removed from the refrigerant during liquefaction, the condenser is forced to release this heat into the cooling medium that surrounds it (air or water).

2.4. Evaporator

The evaporator is where the liquid refrigerant is injected and transformed into the gaseous state.

It evaporates by extracting the requisite evaporation heat from the process medium (e.g. air intake).

2.5. Throttle element

In the throttle, the high pressure of the liquid refrigerant is reduced to the low pressure of the evaporator. Thermostatic expansion valves (TEV) and electronic expansion valves (EEV) are used as throttle.

2.6. Technical refrigeration equipment

Depending on the design of the refrigerating system or heat pump, the following components are used for technical refrigeration equipment:

- filter dryer
- liquid receiver
- inspection glass
- solenoid valve
- hot gas bypass valve
- high pressure switch (manual reset)
- low pressure switch (automatic reset)
- 4-way valve
- oil separator
- liquid separator
- check valve
- oscillation damper

3. Start-up

3.1. Requirements

The following structural requirements must be in place to ensure a smooth operational set-up:

- unimpeded access to the plant.
- completion of the assembly of the AHU including all utility services.
- external components (e.g. sensor, thermostat, pressure cell, flap servomotor, etc.) are properly installed.
- the plant is fully ready for operation.
- the clockwise rotating field of the mains supply must be in place.
- uninterrupted availability of all necessary supply media.
- it must be possible to operate the plant from a suitable operating point.
- the operating personnel must be present for the instruction.

**Warning!**

All works involving electrical connections or cabling must be performed by an electrical engineer. The applicable standards must be observed.

3.2. Note

The completion, operational start-up and maintenance of refrigerating systems and heat pumps may only be performed by the manufacturer or by a specialized company for refrigeration that it recommends.

All works may only be performed by qualified and authorised specialist personnel.

4. Maintenance

4.1. General

Pursuant to Regulation (EC) No. 842/2006 (fluorinated gases regulation), the operators of refrigerating systems and heat pumps have a statutory obligation to arrange for leakage tests and for maintenance to be regularly performed by a certified engineer.

According to the definition set out in EN 378-4, the plant log (log book for refrigerating systems) must be updated following the completion of the maintenance works.



Warning!

In order to prevent damage occurring to the compressor, only the oil that is permitted by the compressor manufacturer may be used (see compressor information).

When refilling the refrigerant, only the refrigerant that is specified on the identification plate may be used.

4.2. Service intervals

During the warranty period, a service must be carried out every 6 months.

Pursuant to Regulation (EC) No. 842/2006 Article 3, the impermeability of refrigerating systems and heat pumps must be checked in accordance with the following guidelines:

- a) At least once every twelve months for applications containing 3 kg or more of F gases (this shall not apply to equipment with hermetically sealed systems, which are labelled as such and contain less than 6 kg of fluorinated greenhouse gases);
- b) At least once every six months for applications containing 30 kg or more of F gases;
- c) At least once every three months for applications containing 300 kg or more of F gases;

The applications must be checked for leakage within one month after a leak has been repaired to ensure that the repair has been effective.

4.3. Service plan

No.	Components / Function	Design	
		At every service	As required
1	Compressor (<i>reciprocating and rotation compressors</i>)		
1.1	External check for dirt, damage and corrosion	X	
1.2	Functional cleaning		X
1.3	Check of mounting, oscillation and operating noise	X	
1.4	Measure suction pressure	X	
1.5	Measure suction gas temperature upstream of the compressor	X	
1.6	Measure compression pressure	X	
1.7	Measure compression temperature at the outlet side	X	
1.8	Check oil level	X	
1.9	Check oil for acidity (acid test)	X	
1.10	Change oil		X
1.11	Readjust oil pressure		X
1.12	Check that oil separator is functioning	X	
1.13	Check that crank case heating is functioning	X	
1.14	Check that start unloader is functioning	X	
1.15	Check that capacity control is functioning	X	
1.16	Check shaft seal for impermeability		X
1.17	Check power valve		X
1.18	Check bearing temperatures of compressor	X	
1.19	Check upstream of coolant supply for impermeability	X	
1.21	Drive motor		
1.21.1	Check bearings for noise, oscillation and overheating	X	
1.21.2	Check direction of rotation	X	
1.21.3	Check that connection terminals are tight; tighten if necessary	X	
1.21.4	Measure voltage, power consumption and phase asymmetry	X	
1.21.5	Lubricate bearings		X
1.21.6	Check that safety devices are functioning	X	
1.24	Instrumentation and control (see VDMA 24186 Part 4)	X	
2	Condenser		
2.1	External check for dirt, damage and corrosion	X	
2.2	Functional cleaning		X
2.3	Measure condensation temperature	X	
2.4	Measure sub-cooling temperature upstream of coolant supply at the condenser outlet	X	
2.5	Measure medium temperature at the condenser inlet and outlet	X	
2.6	Air-cooled condenser		
2.6.1	Ventilator (see VDMA 24186 Part 3)	X	
2.6.2	Check that condensing pressure control is functioning		X
2.6.3	Check upstream of coolant supply for impermeability	X	
2.7	Water-cooled condenser		
2.7.1	Determine frost protection temperature (freezing point) of the heat transfer media	X	

No.	Components / Function	Design	
		At every service	As required
2.7.2	Check that cooling water controls are functioning	X	
2.7.3	Readjust cooling water controls		X
2.7.4	Pump (see VDMA 24186 Part 3)		
2.7.5	Check upstream of coolant and water supply for impermeability	X	
2.7.6	Check freezing protection	X	
2.7.7	Refill anti-freeze agent		X
3	Evaporator		
3.1	External check for dirt, damage and corrosion	X	
3.2	Functional cleaning		X
3.3	Measure evaporation pressure in evaporator	X	
3.4	Measure evaporation temperature at the evaporator outlet	X	
3.5	Determine refrigerating agent overheating temperature	X	
3.6	Measure medium temperature at the evaporator inlet and outlet	X	
3.7	Evaporator (air/refrigerating agent)		
3.7.1	Ventilator (see VDMA 24186 Part 4)	X	
3.7.2	Check that evaporator pressure control is functioning	X	
3.7.3	Check that condensation drain is functioning	X	
3.7.4	Clean condensation drain		X
3.7.5	Check that defrost and condensation drain heater is functioning	X	
3.7.6	Check upstream of coolant supply for impermeability	X	
3.7.7	Check hygienic condition	X	
3.8	Evaporator (liquid/refrigerating agent)		
3.8.1	Determine frost protection temperature (freezing point) of the heat transfer medium (with upstream heat exchanger)	X	
3.8.2	Check refrigerant level (with flooded evaporators)	X	
3.8.3	Pump (see VDMA 24186 Part 4)	X	
3.8.4	Check upstream of coolant and water supply for impermeability	X	
4	Plant components in refrigeration circuit		
4.1	Pipes		
4.1.1	External check for dirt, damage and corrosion	X	
4.1.2	Check compensators and insulation for damage	X	
4.1.3	Check for tightness	X	
4.1.4	Change filter dryer		X
4.1.5	Check liquid level in the inspection glass of the fluid supply line	X	
4.1.6	Check liquid indicator for coloration	X	
4.1.7	Check fluid level in the refrigerant receiver	X	
4.1.8	Check upstream of coolant supply for impermeability	X	
4.2	Valves		
4.2.1	External check for dirt, damage and corrosion	X	
4.2.2	Check that solenoid valves are functioning	X	
4.2.3	Check that throttle is functioning	X	
4.2.4	Readjust throttle	X	
4.2.5	Check that shut-off valves are functioning	X	
4.2.6	Check upstream of coolant supply for impermeability	X	

No.	Components / Function	Design	
		At every service	As required
4.3	Measurement and display devices		
4.3.1	External check for dirt, damage and corrosion	X	
4.3.2	Check that pressure display is functioning (plausibility check)	X	
4.3.3	Check that temperature display is functioning (plausibility check)	X	
4.3.4	Check that level display is functioning (plausibility check)	X	
4.3.5	Check upstream of coolant supply for impermeability	X	
4.4	Instrumentation, control and safety devices		
4.4.1	External check for dirt, damage and corrosion	X	
4.4.2	Check for correct function	X	
4.4.3	Check technical data	X	
4.4.4	Check upstream of coolant supply for impermeability	X	
4.4.5	Instrumentation and control (see VDMA 24186 Part 4)	X	
5	Air supply devices (ventilator, filter, air ducts, etc.)		
5.1	Check for dirt, corrosion and secure attachment	X	
5.2	Functional cleaning		X
5.3	Check that all components are functioning and for damage	X	
5.4	Change damaged or defective components		X
6	Pipe network (secondary circuit) <i>(pumps, dirt trap, shut-off, equalisation and control valves, piping, expansion tank, insulation, etc.)</i>		
6.1	External check for dirt, corrosion and secure attachment	X	
6.2	Functional cleaning		X
6.3	Check that all components are functioning and for damage	X	
6.4	Change damaged or defective components		X
6.5	Check impermeability (visual check)	X	
6.6	Check frost-protection of heat carriers of systems connected to circuit	X	
6.7	Check sieve of dirt trap for dirt and damage	X	
6.8	Clean or change dirt trap sieve		X
6.9	Check pressure pad in the expansion tank	X	
6.10	Assemble pressure pad in the expansion tank		X
6.11	Ventilate		X
6.12	Instrumentation and control (see VDMA 24186 Part 4)	X	

AL-KO THERM recommends that refrigerating systems and heat pumps be serviced in accordance with VDMA 24186.

All measurement data should be documented in a test log.

5. Troubleshooting



Warning!

Diagnoses, elimination of defects and operational restarts may only be performed by authorised personnel. This applies in particular to electrical devices within the switch cabinet (e.g. testing, changing fuses)!

5.1. Contact

If you have any questions about our products, please contact the manufacturer of your air handling unit or one of our branch offices. You can also directly contact:

AL-KO THERM GmbH
Hauptstraße 248–250
89343 Jettingen-Scheppach

Telephone: (+49) 27 43 / 93 388 - 0
Fax: (+49) 27 43 / 93 388 - 48
e-mail: service.center@al-ko.de
Web: www.al-ko.de

5.2. General faults

Fault messages should be reported to the operator of the refrigerating system controls. (See description of refrigerating system control.)

No.	Possible cause	Possible manifestation	Recommended fault correction ¹⁾
1	Noise coming from compressor – is too loud		
1.1	Oil level low	Switch off oil pressure switch	Oil return
1.2	Inner mechanical parts of compressor are broken	Compressor makes knocking sound	Compressor must be overhauled
1.3	Liquid slugging	<ul style="list-style-type: none"> ■ Suction pipe unusually cold and compressor frosted in region of crank case bottom ■ Knocking sounds coming from compressor ■ Oil foaming in the oil inspection glass of the compressor 	Overheating! Check the sensor position and/or regulate overheating
1.4	Expansion valve will not close	Compressor making knocking sound and suction pipe is very cold	Repair or replacement
2	Compressor will not start		
2.1	Wrong voltage	Phase monitoring, excess current circuit breaker activated, not enough starting torque for the compressor motor	Check mains voltage
2.2	Phase failure	Phase monitoring activated	Check mains voltage
2.3	Phases are interchanged (clockwise rotating field – very important for screw and scroll compressors)	Phase monitoring activated	Check mains voltage
2.4	Excessive heat at the motor winding	Internal motor protection activated	The compressor must cool for approx. one hour. The sensors must then be checked. If these are working properly, then the trip unit is defective. Check motor and cylinder cooling

No.	Possible cause	Possible manifestation	Recommended fault correction ¹⁾
2.5	The high pressure limiter has been activated	Condensing pressure too high	With air-cooled condensers: Check aeration, e.g. air volume and temperature, check level of dirt on the surfaces of the heat exchanger With water-cooled condensers: Check heat exchanger medium, such as temperature, volume flow, control valves etc.
2.6	Low-pressure control device or delimiter activated	Suction pressure too low	Check refrigerating agent filling level, check aeration of evaporator, check plant load compared to design
3	Other faults		
3.1	Surge operation	Compressor switches too often	Plant load too low, compressor load too high compared to current load – check air volume and temperature and evaporator inlet, check that capacity control is functioning
3.2	Oil level too low	Insufficient oil at compressor	Check oil return, refill oil if required
3.3	Dryer blocked	Bubbles in inspection glass and cold fluid supply line downstream of dryer	Change the dryer and seal properly
3.4	Inspection glass indicator showing pink	Too much moisture in the refrigerant	Change the dryer and seal properly

¹⁾ For recommended fault elimination, always contact AL-KO THERM GmbH or a specialized company for refrigeration that is recommended by AL-KO THERM GmbH.

6. Shutdown

6.1. Decommissioning

Before commencing works, disconnect from power supply (switch off at all poles).

Secure against unauthorised activation.

Warning: Certain plant components are pressurised.

If the plant is to be shut down for a longer period of time, the requirements for the individual components must be observed.

The manufacturer's information must also be observed (request if required).

Warning: danger of freezing during winter.

6.2. Dismantling and disposal

Before commencing works, disconnect from power supply (switch off at all poles).

Secure against unauthorised activation.

Warning: Certain plant components are pressurised.

The disassembly and disposal of the plant or individual components must be performed by an authorised engineer.

All materials must be appropriately separated and sorted so that they can be recycled accordingly.

The locally applicable laws and regulations must be observed for the environmentally friendly disposal of all components and operating materials (e.g. refrigerant, compressor oil, brine).

See corresponding safety data sheets (request if required).

AL-KO