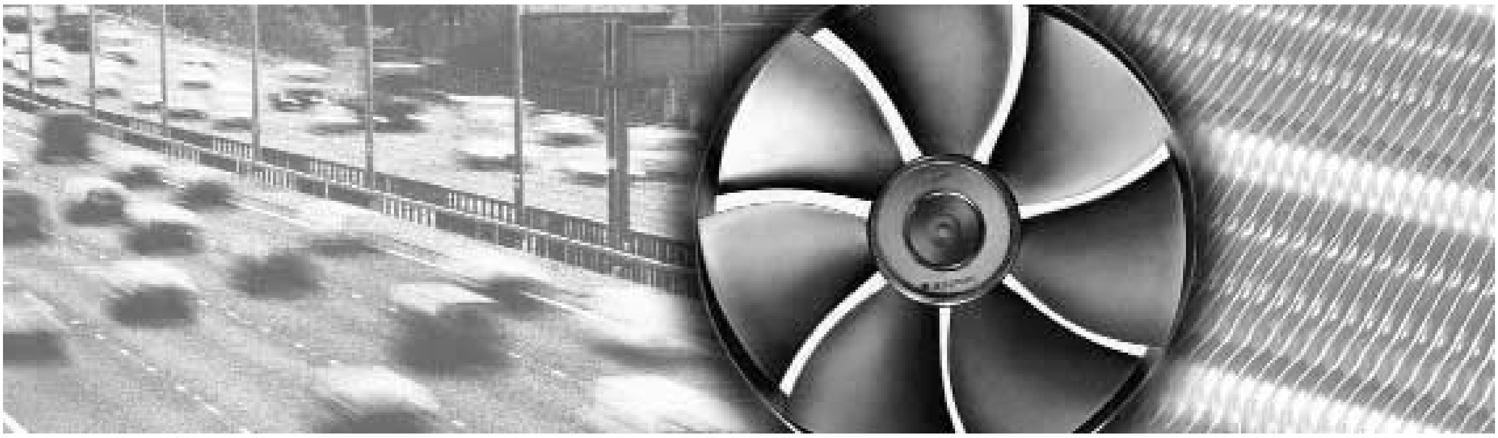
SÜTRAK
Training User Manual

Basic of Air Conditioning

36,25,26,014-00 **Rev. 1.2 / 2010**



DRIVING THE MOBILITY OF TOMORROW

Eberspächer

Content

General Thermodynamic Principles

Main Component

Other Components

Refrigerant and Refrigerant Oils

Capacity Control

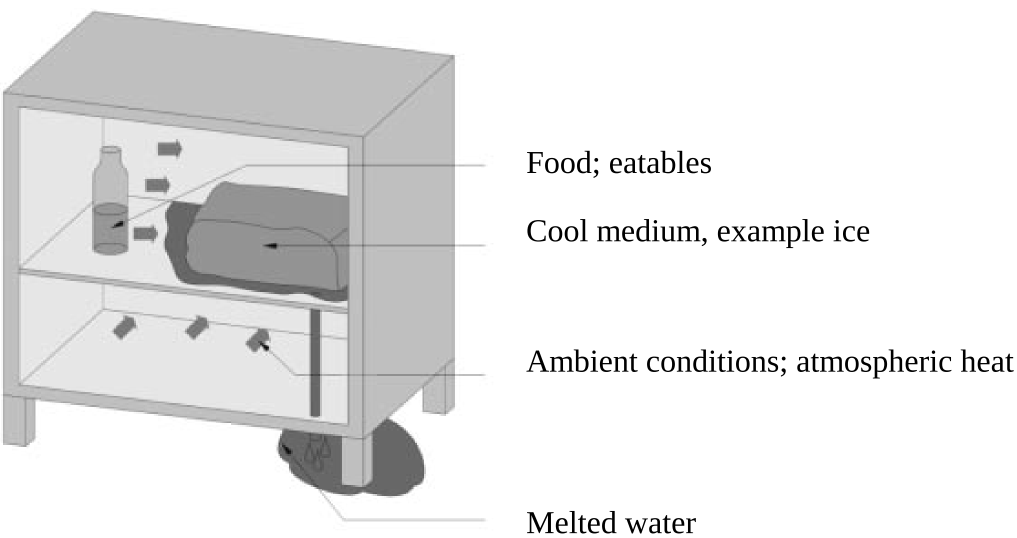
Content

Theory of Operation - Basic Refrigeration Cycle

Properties of Materials

In reality “cold will never be produced”, but heat will be removed from an area.
In order to remove surplus warmth in the area to be air-conditioned, we need thus a material with a lower temperature than those, which prevails in the area.
Heat exchange takes place. The area becomes cool and the medium warmer. If the medium achieves a too high temperature, a heat exchange will no longer be possible. Utilise the latent heat in order to take up warmth without serious rise of the temperature.
The use of the melting heat is one of the oldest methods for the cooling of a medium (use of the ice for cooling purposes).
Since the heat of vaporization is generally larger than the melting heat, it would still be more suitable to use this change in status. In the case however water can be only used in rare cases as cooling medium, since the evaporation temperature is only 100 °C.

A piece of ice was placed on the top and near the food was stored. “Heat” was carried by convection from the stored food to the ice. Air motion is caused by differences in the temperatures of air, the ice, the food, and the refrigerators walls. The ice melted and the run-off water carried the heat to a pan underneath.
The fact remained that to carry heat away from the food and the ice box walls, the ice had melt. In doing so, latent heat of fusion was absorbed by the ice.



Other materials evaporate however already at lower temperatures.

Material	Melting temperature* (°C)	Heat of melting* (kJ/ kg)	Boiling temperature* (°C)	Heat of vaporization* (kJ/ kg)
Water	**0**	**334**	**100**	**2257**
Ambient air	**-**	**-**	**-191,4**	**196,8**
R 12	**-158,3**	**34,3**	**-29,8**	**166**
R 134a	**-108**	**45,8**	**-26,2**	**215**

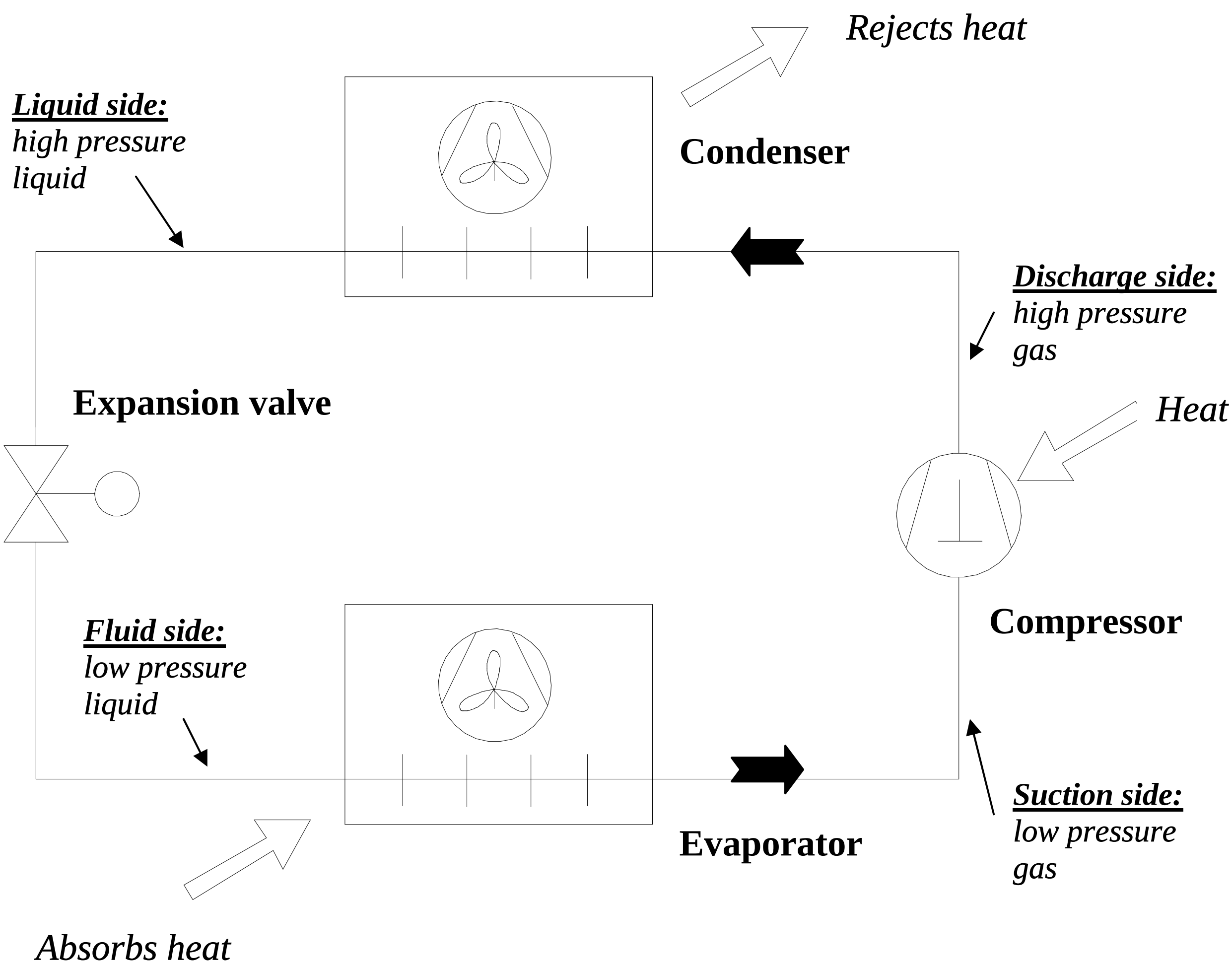
*at atmospheric pressure; 1.013 mbar (15,5 psi)

Pressure - Temperature Relationship

Varying the pressure on a liquid affects the temperature at which the liquid will boil. Increasing the pressure on a liquid raises the boiling point (= temperature at which the liquid becomes a gas), and decreasing the pressure lowers the boiling point.

A liquid cannot exist at a temperature higher that it is boiling point or saturation temperature.

Schematic Refrigerant System



Refrigerant Properties

A refrigerant is a fluid that is used inside the refrigeration system to transfer heat.
These materials were developed particularly for the cooling and climatic industry and are usually called refrigerants.
Since refrigerants are quite expensive (compared with water for example) are them after evaporation again to be used to be able. In addition they would have to be liquefied.

A liquid boils and condenses - the changes between the liquid and gaseous states - at a temperature which depends on its pressure. When boiling, it must obtain the latent heat of evaporation. When it condenses, the latent heat must be given up again.

The basic refrigeration cycle makes use of the boiling and condensing of a working fluid at different temperatures and, therefore, at different pressures.

In **the evaporator**, heat is added to the fluid at lower temperatures and pressure and provides the latent heat to make the fluid boil and change to a vapour.

This vapour is **then mechanically compressed** to a higher pressure and a corresponding higher saturation temperature. At this higher temperature, the latent heat can be removed from the refrigerant in **the condenser**, so that it changes back to a liquid.
The total cooling effect will be the heat transferred to the working fluid during the evaporating process.

The system requires a connection between the condenser and the inlet to the evaporator to complete the circuit. Since these are at different pressure, this connection will require a pressure-reducing and metering valve.
The pressure reduction in this valve causes a corresponding drop in temperature, so that some of the fluid will flash off into vapour to remove the energy for cooling. Therefore the volume of the working fluid increases at the valve by this amount of flash gas. That is the reason why the valve is called **the "expansion valve"**.

Operation high and low side pressure and temperature

ORIENTATIVE PRESSURE AT DIFFERENT OUTSIDE AND INSIDE TEMPERATURES									
Outside temperature		**Condensation temperature**		**High side pressure R-12 systems**		**High side pressure R-22 systems**		**High side pressure R-134a systems**	
°C	*°F*	°C	*°F*	bar gauge	*psig gauge*	bar gauge	*psig gauge*	bar gauge	*psig gauge*
25	*77*	45-55	*113-131*	9,8-12,7	*142,7-183,6*	16,3-20,7	*236,1-300,7*	10,6-13,9	*153,7-201,7*
30	*86*	50-60	*122-140*	11,2-14,3	*162,3-206,8*	18,4-23,3	*267,0-337,3*	12,2-15,8	*176,6-229,2*
35	*95*	55-65	*131-149*	12,7-16,0	*183,6-231,8*	20,7-26	*300,7-376,9*	13,9-17,9	*201,7-259,4*
40	*104*	60-70	*140-158*	14,3-17,9	*206,8-258,9*	23,3-28	*337,3-419,8*	15,8-20,2	*229,2-292,3*
45	*113*	65-75	*149-167*	16,0-19,9	*231,8-288,2*	26-32,1	*376,9-466,3*	17,9-22,6	*259,4-328,1*
Interior temperature		**Evaporating temperature**		**Low side pressure R-12 systems**		**Low side pressure R-22 systems**		**Low side pressure R-134a systems**	
°C	*°F*	°C	*°F*	bar gauge	*psig gauge*	bar gauge	*psig gauge*	bar gauge	*psig gauge*
20	*68*	-10-0	*14-32*	1,2-2,1	*17,3-30,2*	2,5-4,0	*36,7-57,5*	1,0-1,9	*14,6-28,0*
25	*77*	-5-+5	*23-41*	1,6-2,6	*23,3-38,1*	3,2-4,8	*46,4-70,0*	1,4-2,5	*20,8-36,2*
30	*86*	0-+10	*32-50*	2,1-3,2	*30,2-46,9*	4,0-5,8	*57,5-84,0*	1,9-3,1	*28,0-45,6*
35	*95*	+5-+15	*41-59*	2,6-3,9	*38,1-56,7*	4,8-6,9	*70-99,8*	2,5-3,9	*36,2-56,3*

NOTE: At the limits of the normal operating conditions, unusual pressures and temperatures may occur.

For example: Engaging the system at high and hot outside temperature, at high interior temperature and compressor high speed:

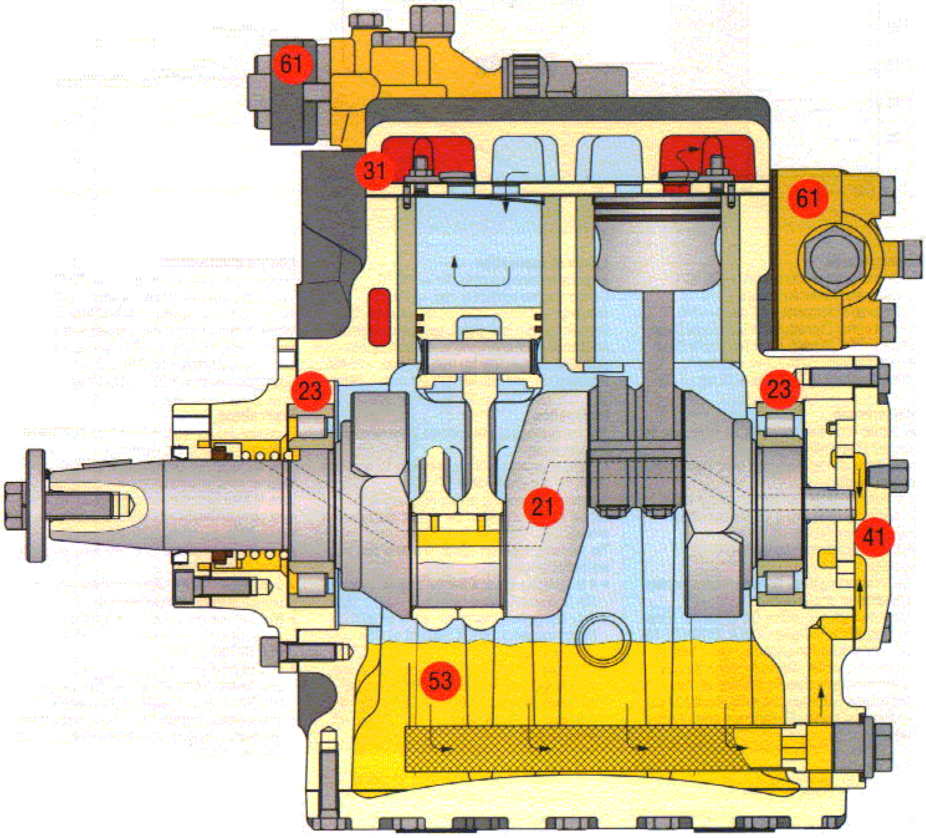
- leads to high refrigerant pressure in evaporator;
- high refrigerant pressure and very high temperature after compression;
- compressor magnetic clutch may cycle a few of times (high pressure switch cuts out the clutch) until interior temperature lowers.

Compressor

Basics

The function of a compressor is to increase the pressure of the gaseous refrigerant.

Make sure that the applied refrigerant is appropriate for the compressor.



Definition

Open compressor:

- motor in separate housing as compressor
- shaft seal required to control refrigerant leakage
- typically transportation and large commercial or industrial application

Hermetic compressor:

- motor in same housing as compressor, cooled by refrigerant
- no rotating shaft seals required
- two basic types:

  à welded-hermetic compressor(not serviceable)
  à semi-hermetic compressor

Condenser

The function of the condenser section is to remove heat (which has been absorbed by the evaporator section from the coach interior air and the compressor) and expel it to the ambient (outside) air.

Processes inside the condenser

Desuperheat

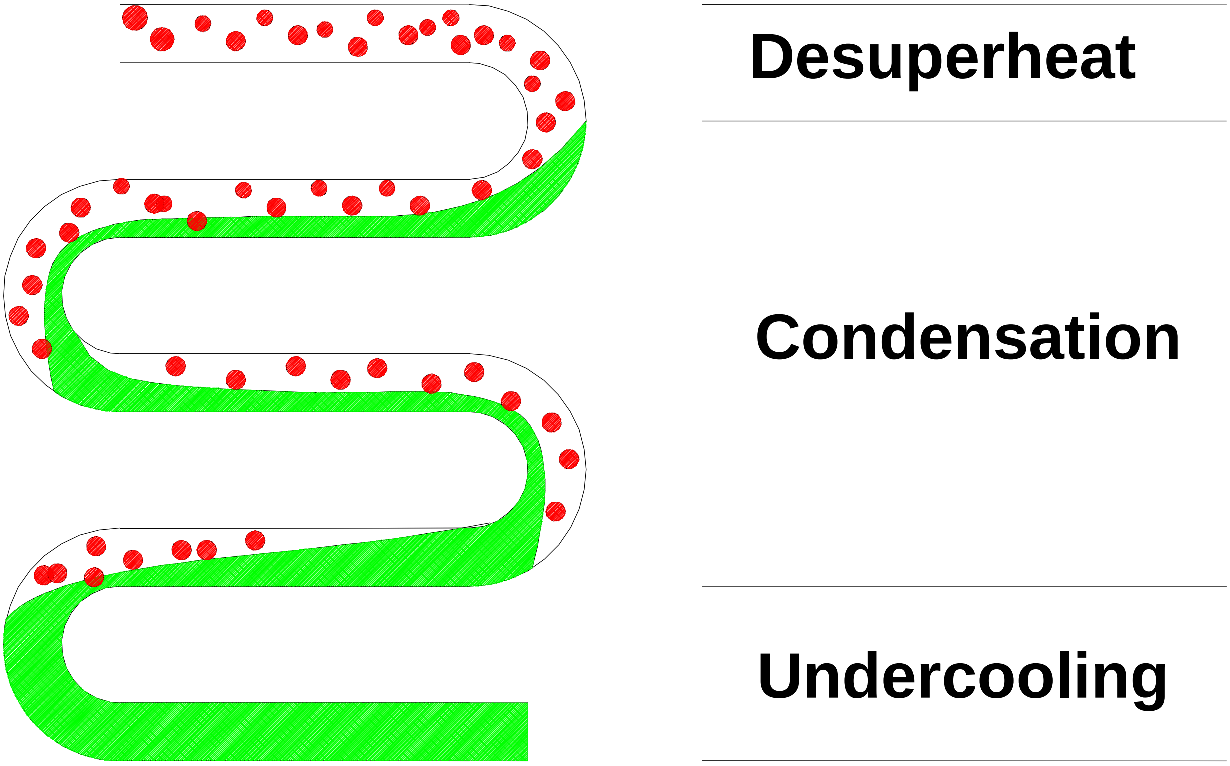
First the superheated refrigerant is desuperheated. This means that the temperature decreases until the dew point is reached.

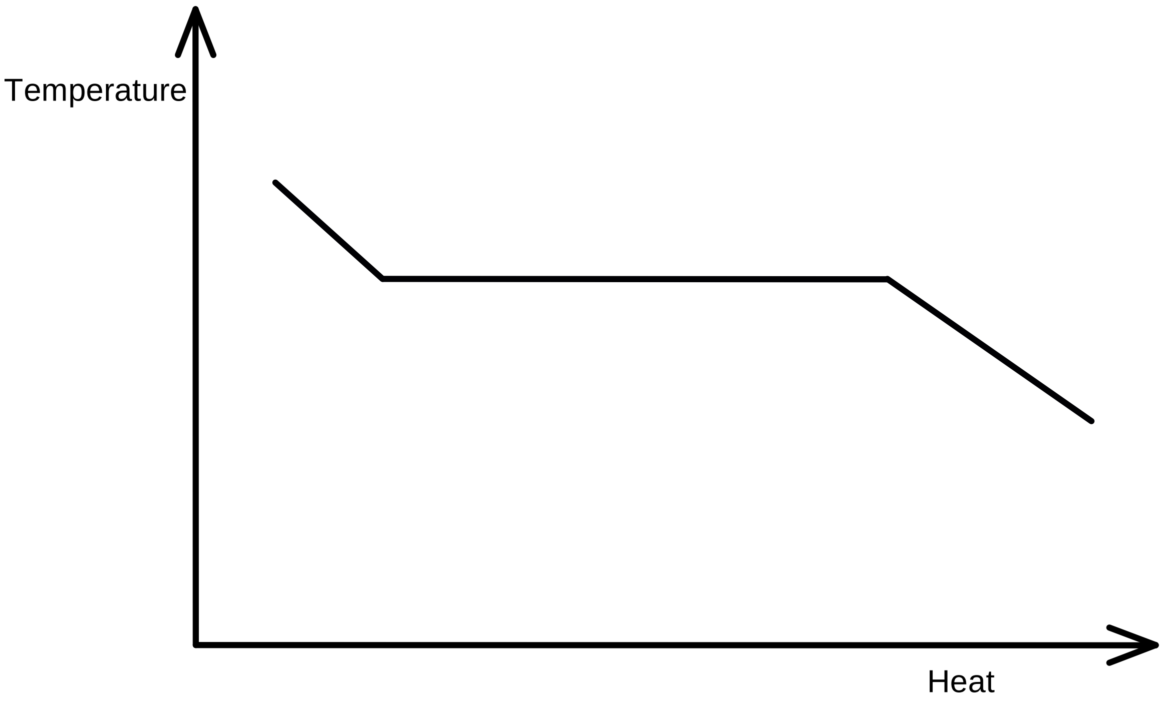
Condensation

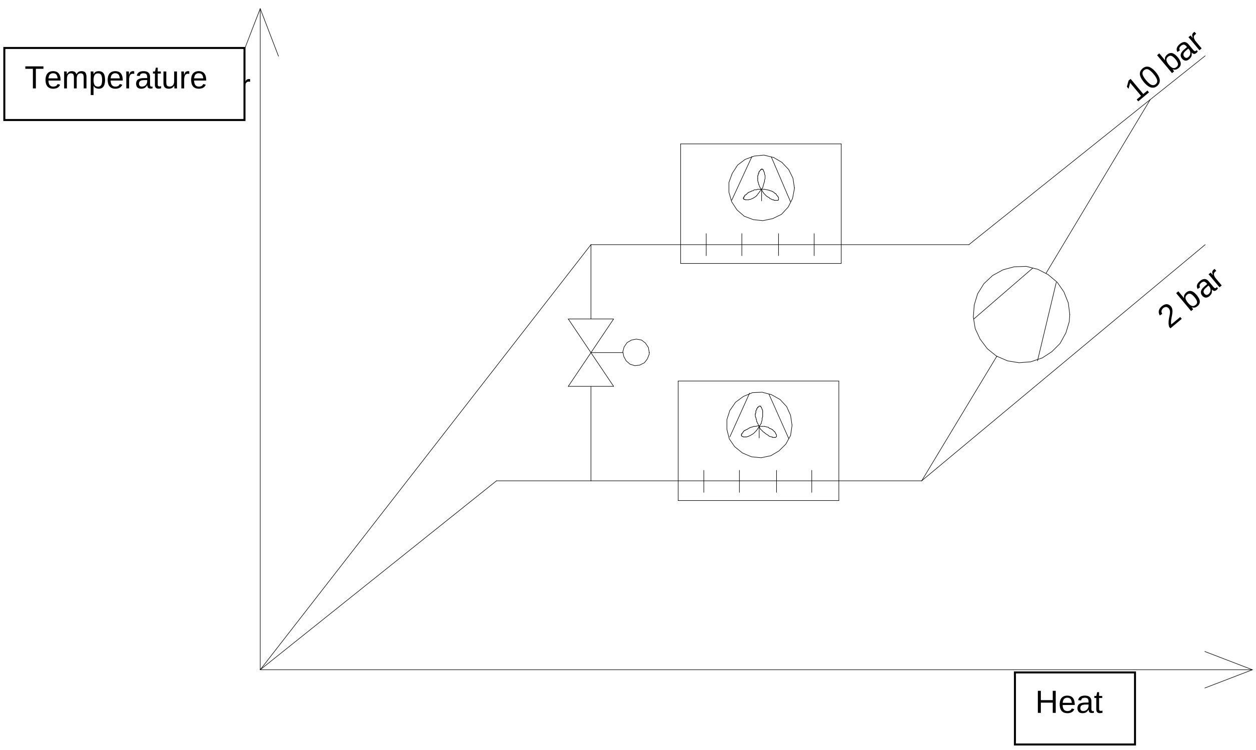
Condensation sets in as soon as the condensation temperature is reached. At a constant ambient temperature the refrigerant gives off heat. This temperature remains constant until the change is completely finished.

Undercooling

To decrease the pressure of the refrigerant when it leaves the condenser, it has to run through a throttling device which - as its name already indicates - throttles the flow of the refrigerant. Inside this throttling device, the refrigerant has to pass a narrow spot.
In case gaseous refrigerant should flow through this narrow spot, it would "choke" the throttling device due to its higher volume and thereby considerably reduce the amount of liquid refrigerant that passes through this device. As a result, the capacity of the air-conditioning unit would be decreased.
To make sure that only liquid refrigerant flows through the throttling device, the refrigerant has to be undercooled after its complete condensation. During this process the temperature decreases at constant pressure.
The optimum undercooling takes place at 3 K. This means that the temperature of the refrigerant at the condenser outlet should be 3 degrees lower than the condensation temperature.


Desuperheat
Condensation
Undercooling


Temperature
Heat


Temperature
10 bar
2 bar
Heat

Expansion valve

The expansion valve is an orifice, through which the liquid refrigerant is forced by the pressure difference between the condensing and evaporating conditions.

Purpose

The expansion valve controls the flow of refrigerant to the evaporator in order to:

– maintain the maximum cooling capacity of the evaporator, regardless of change in heat load

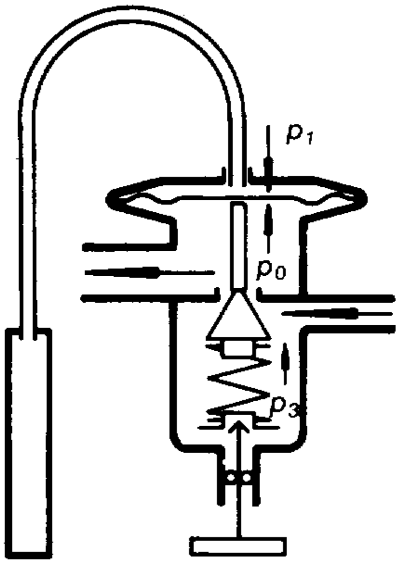
– avoid liquid refrigerant returning to the compressor

– separate high and low pressure sides of the system

Air conditioners in the bus world, are using thermostatic expansion valves (TEV) as follow:

- TEV without equalizer line
- TEV with equalizer line

First version: TEV without equalizer line



P1 = Po + P3

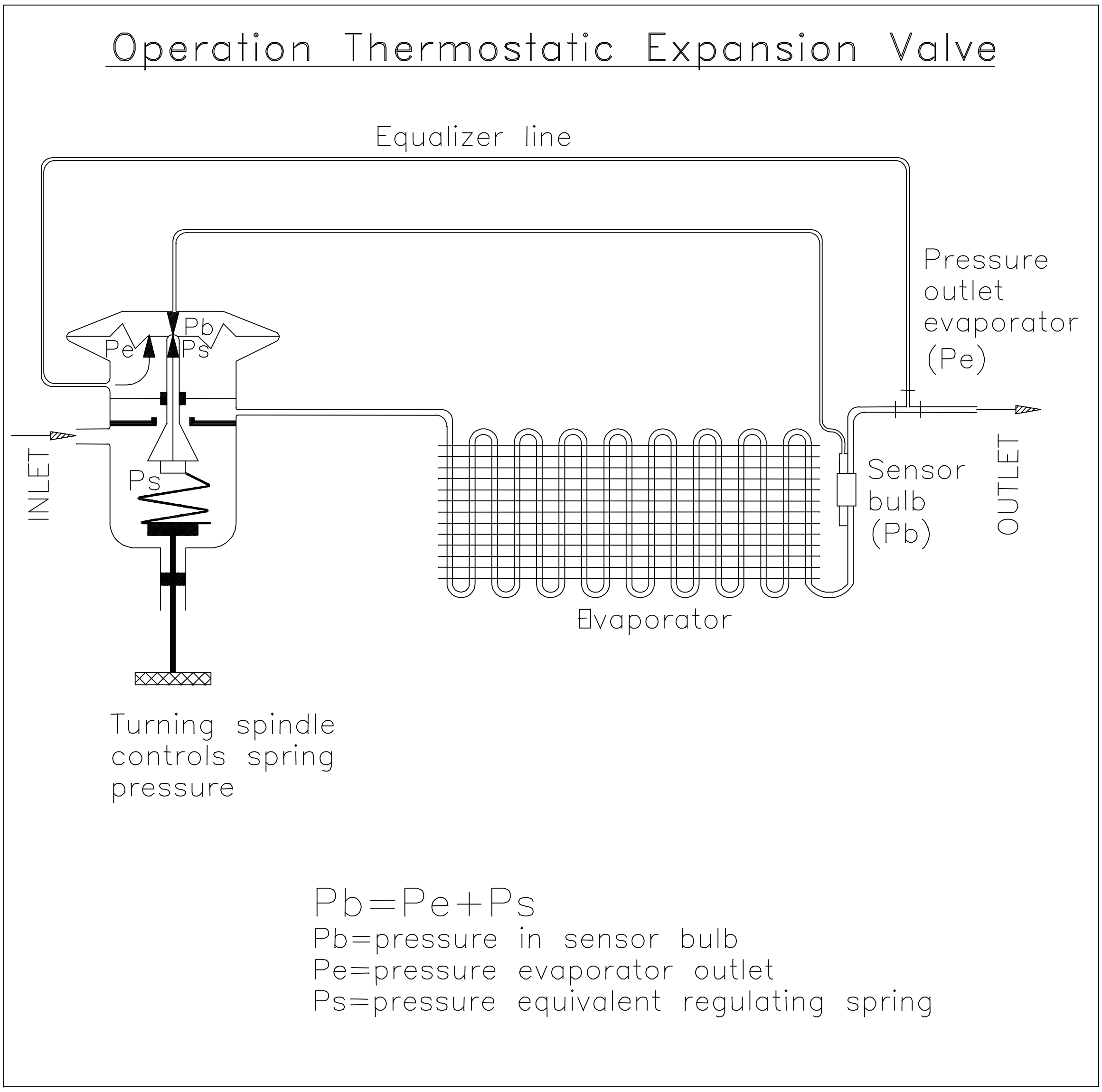
P1 = Pressure from filled sensor bulb
Po = Pressure evaporator inlet
P3 = Pressure equivalent regulating spring

Too small superheat reduces system protection, where too much superheat reduces system efficiency. The superheat is controlled by the sensor bulb charge and is adjusted with the regulated spindle of the fix point from 4 Kelvin superheat.

Never change/ turn the position of that regulated spindle in all TEV´s, if can be damage serious the compressor !

Sometimes it is possible to change the adjustment point of the superheat, but only with an agreement from Eberspächer Sütrak.

Second: Standard TEV version with equalizer line



The degree of opening is influenced by three pressures acting on the valve diaphragm.

1. The **pressure in the equalizer line (Pe),** which corresponds to the pressure, where the gas **leaves the evaporator**.

As the suction pressure (Pe) decreases, the pressure under the diaphragm decreases, the needle valve moves away from the seat and allows more refrigerant to enter the evaporator. As the suction pressure increases, the pressure under the diaphragm increases, the needle valve moves towards the valve seat and allows less refrigerant to enter the evaporator.

2. The **pressure in the sensor bulb (Pb),** which depends on the temperature of the suction gas, leaving the evaporator.

The sensor bulb senses the temperature of the low pressure gas leaving the evaporator. As the temperature of the outlet line increases, the gas pressure in the sensor bulb (Pb) increases and forces the valve to open. As the temperature of the outlet line decreases, the gas pressure in the sensor bulb decreases and forces the valve needle towards the valve seat.

During normal operation, evaporation will cease part way through the evaporator. The, saturated gas appears which becomes superheated on its way through the last part of the evaporator. The temperature rise of the saturated gas is called "superheat". The bulb temperature will thus be evaporating temperature plus superheat, e.g. at 0ºC (32ºF) evaporating temperature the bulb temperature could be 6ºC (43ºF).

If the evaporator receives too little refrigerant the vapor will be further superheated and the temperature at the outlet pipe will rise. The bulb temperature will then also rise and with it, the vapor pressure in the bulb element, since more of the charge will evaporate. Because of the rise in pressure, the diaphragm is forced down, the valve opens and more liquid is supplied to the evaporator. Correspondingly, the valve will close more if the bulb temperature becomes lower.

3. The **pressure equivalent (Ps)** of the regulating spring.

The spring is factory set (Ps), and compensates between sensor bulb pressure and evaporator pressure to operate with a superheat of 4 to 7ºC (9 to 13ºF).

The thermostatic expansion valve must insure the state of the refrigerant, leaving the evaporator is a "superheated gas". This ensures optimal capacity (all refrigerant evaporated) and compressor protection (no liquid return).

The thermostatic expansion valve is substantially an undamped proportional control and hunts continuously. The compressor runs at variable speed and sometimes partially unloaded. Pressures may suddenly change, so that valves may be seen to fully close and fully open at times. The continual hunting of the thermostatic expansion valve means that the evaporator surface has an irregular refrigerant feed, resulting into a slight loss of heat transfer efficiency.

Evaporator

The function of the evaporator is to remove heat from the bus interior air and transfer it (through the medium of R 134a, etc.) to the condenser section for expulsion, and remove excess humidity which condenses on the outside of the coil then runs into a drain pan and is finally carried away through drain lines.

Processes inside the evaporator

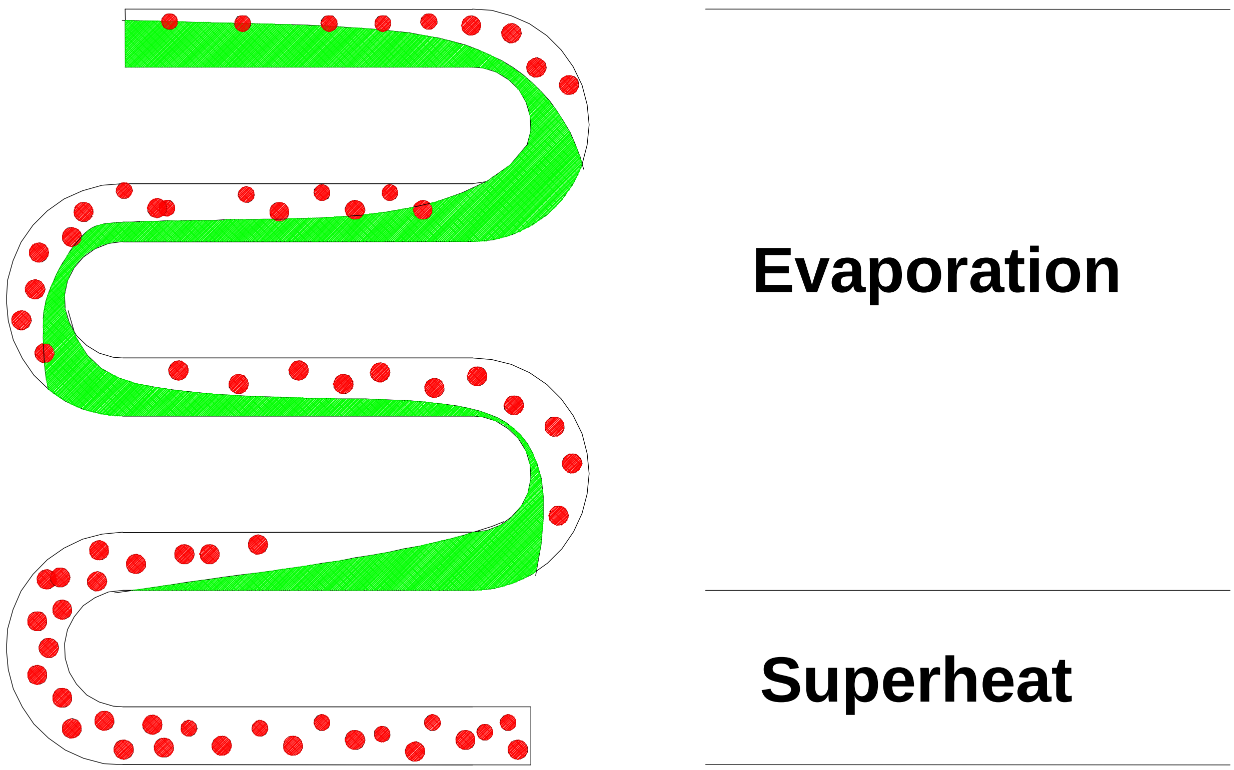
Evaporation

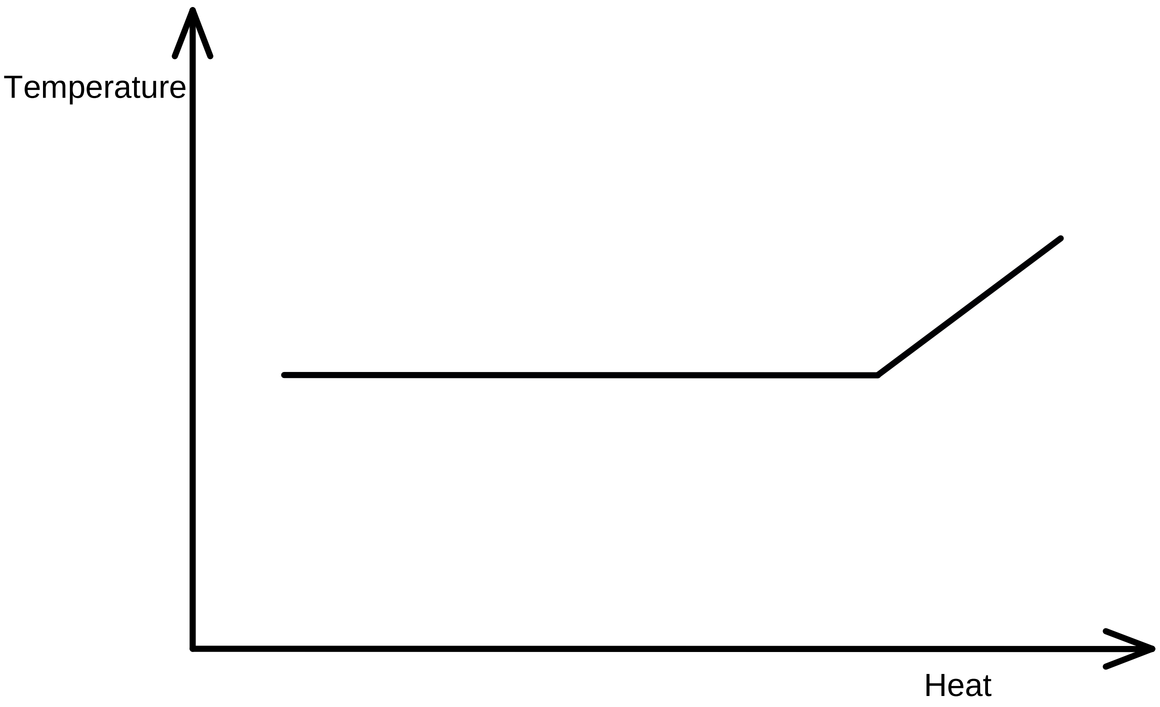
Immediately after the refrigerant has passed the expansion valve nozzle, it is partly in a liquid and partly in a vapor state. This so-called wet steam enters the evaporator. While the portion of vapor increases, the portion of liquid becomes smaller.
Evaporation is completed when there is no more liquid refrigerant.

Superheat

On principle, only gases may be compressed. As liquid entering the compressor may lead to a breakdown of the compressor, the refrigerant entering the compressor must be gaseous. To make sure that only gaseous refrigerant enters the compressor, it has to be superheated after its complete vaporization. During this process the temperature increases at constant pressure.

Calculate superheat at evaporator outlet with the average of recorded values.
Superheat should be 5 to 9ºC (5 to 9 K or 9 to 13ºF).
This means, the optimal of the refrigerant temperature from the evaporator outlet should be 7 Kelvin warmer, than the measured suction evaporation temperature.


Evaporation
Superheat


Temperature
Heat

Filter-drier

Even if the air conditioning system is mounted properly, the refrigerant cycle cannot be kept free from humidity.

To avoid damages the excessive humidity has to be absorbed (excessive humidity may lead to corrosion damage, acidification, sediment, and freezing of the expansion valve).

Thus the function of the filter-drier is to store up this humidity.

It also serves as a filter for all kinds of soiling (dirt, foreign substances ...) and acids.

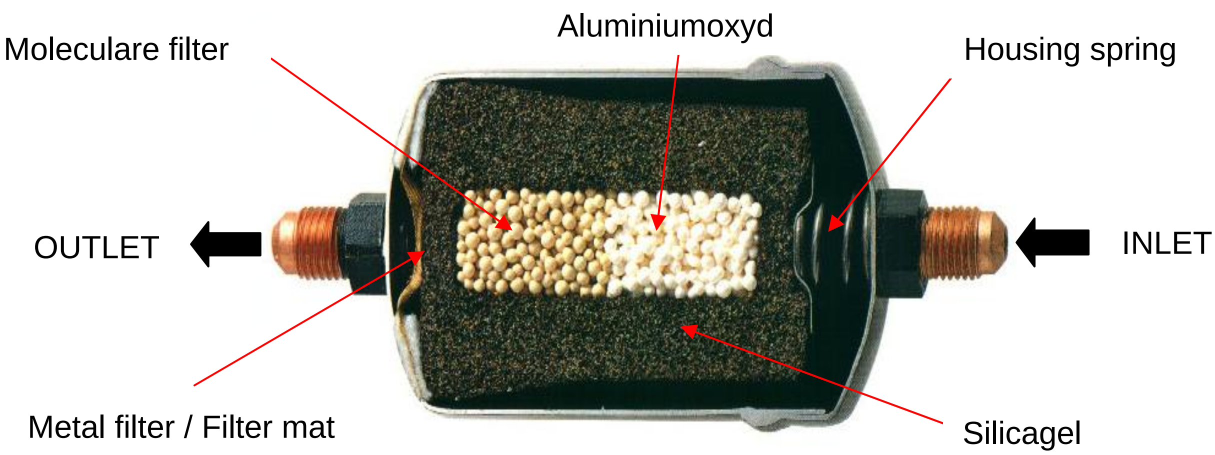
The filter-drier is mounted in the liquid line - behind the refrigerant receiver - to prevent oil from clogging the filter (in a liquid state refrigerant and oil are bound).

The filter-drier has to be changed annually. Some models allow change of filter cartridge only (casing remains).

If you mount a new filter-drier, look for the flow direction of the refrigerant (marked on the filter housing).

If a full filter-drier causes a cooling on the housing or feeling cool by simply touching, whether the drier is full may be determined.

The filter-drier is constructed as follows:



Pressostats / Pressure switches

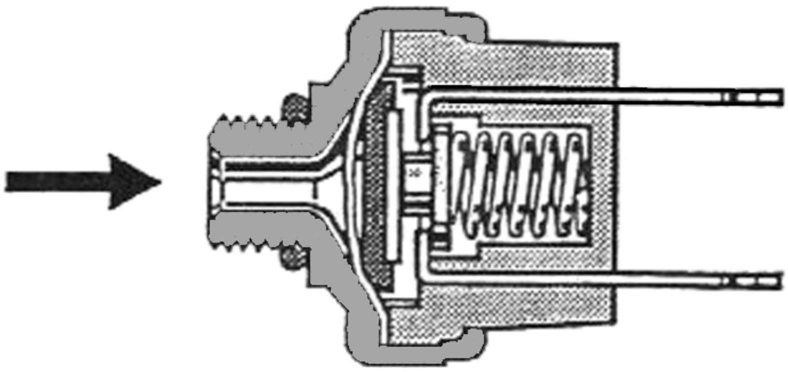
The function of pressostats is to monitor the pressure relations in the refrigerant cycle. For this purpose they are mounted on the high and low pressure side. The pressostats serve to switch off the compressor at excessive pressure (through the electro-magnetic clutch), to avoid damages.

Low-pressure pressostat

The low-pressure pressostat switches off the air conditioning unit as soon it records a pressure below 0,35 bar (depending on the product). The cut-in pressure is at 1,75 bar above the cut-out pressure, so that the system only starts again at a pressure of at least 2,1 bar.

High-pressure pressostat

The high-pressure pressostat switches off the air conditioning unit as soon it records a pressure higher than 23,5 bar (depending on the product). The cut-in pressure is at about 6,9 bar below the cut-out pressure, so that the system only starts again at a pressure of maximum 16,6 bar.

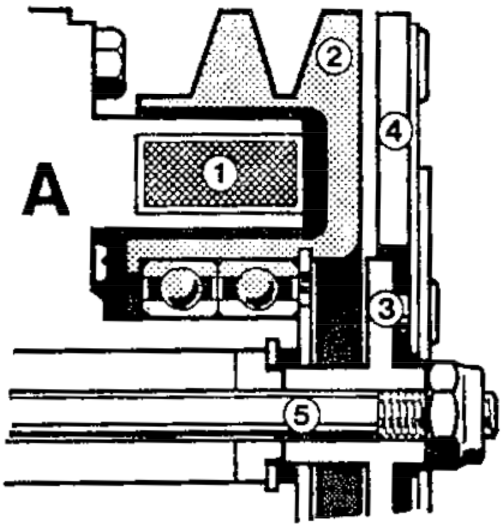


Some systems are equipped with adjustable pressostats.

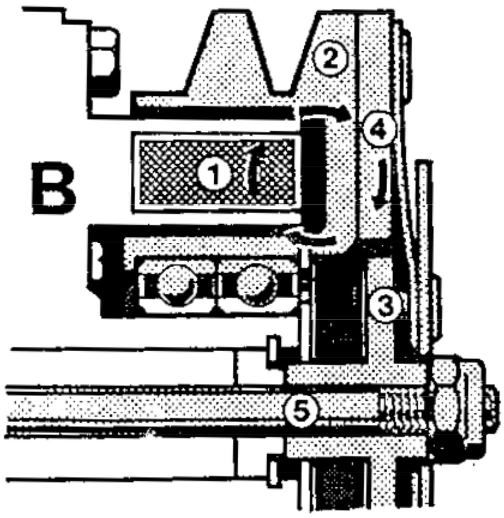
Electro-magnetic clutch

Principle of operation

If the air conditioning system is not engaged, the pulley runs free. When the system is switched on the magnetic coil clutch is energized, a magnetic field is created which presses the diaphragm to the pulley. Now the compressor operates, as the diaphragm is located directly on the crankshaft of the compressor.



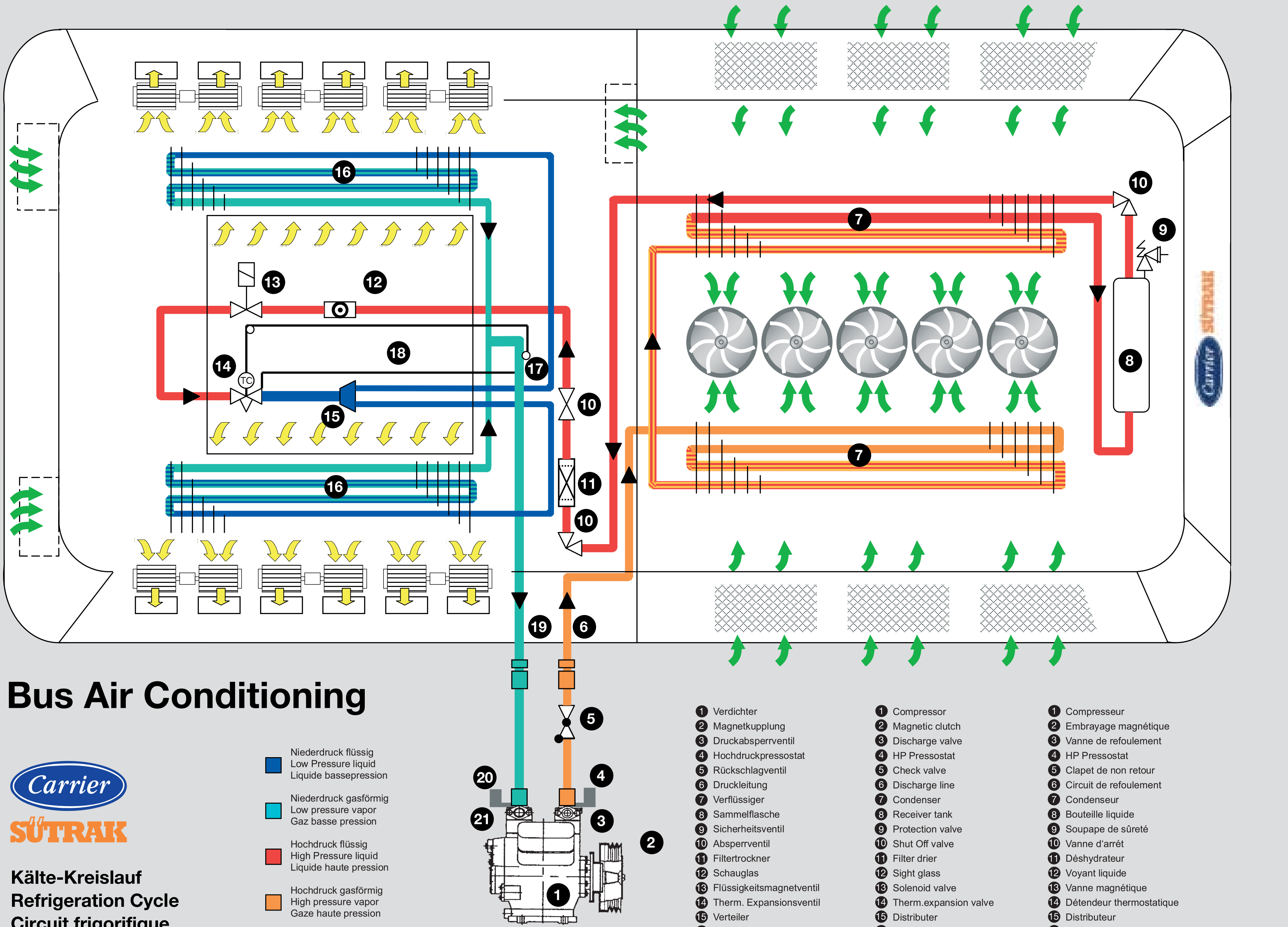
A Clutch not engaged



B Clutch engaged

1. **Solenoid**
2. **Pulley**
3. **Hub**
4. **Diaphragm**
5. **Drive shaft**

The most common reason for clutch failure is excessive heat.
Excessive heat can be generated by frequent cycling of the clutch due to abnormal system pressures, tipping elements, poor contact in electric wiring etc.
Excessive heat can also be generated by leaving the coil energized, while the engine is not running or no drive belts to the compressor.



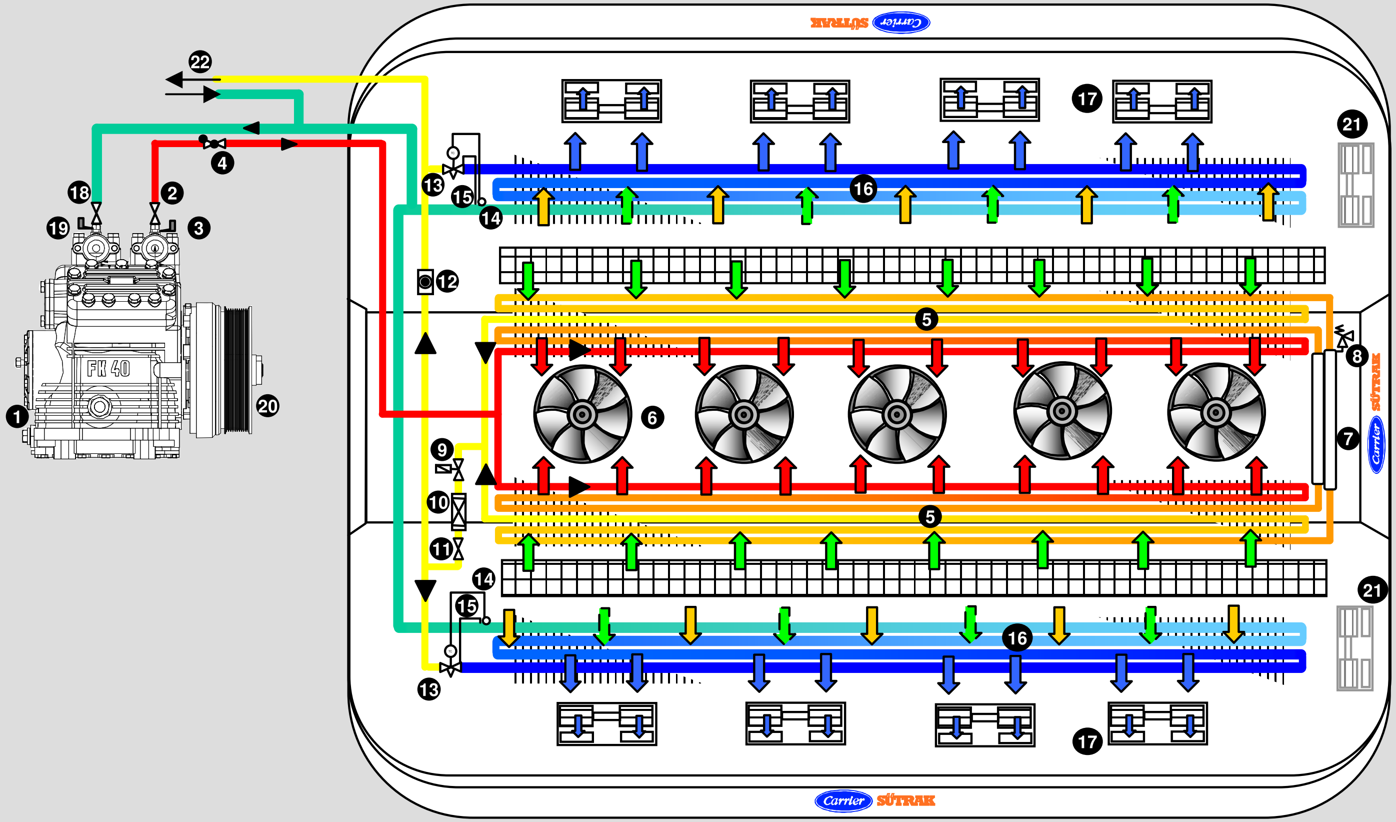
Bus Air Conditioning

Carrier
SÜTRAK

Kälte-Kreislauf
Refrigeration Cycle
Circuit frigorifique

Blau / Blue / Bleu	Niederdruck flüssig Low Pressure liquid Liquide bassepression
Türkis / Turquoise / Turquoise	Niederdruck gasförmig Low pressure vapor Gaz basse pression
Rot / Red / Rouge	Hochdruck flüssig High Pressure liquid Liquide haute pression
Orange / Orange / Orange	Hochdruck gasförmig High pressure vapor Gaze haute pression
Gelb / Yellow / Jaune	Umluft Circulating Air Air recycle
Grün / Green / Vert	Außenluft Ambient air Air ambient

1	Verdichter	Compressor	Compresseur
2	Magnetkupplung	Magnetic clutch	Embrayage magnétique
3	Druckabsperrventil	Discharge valve	Vanne de refoulement
4	Hochdruckpressostat	HP Pressostat	HP Pressostat
5	Rückschlagventil	Check valve	Clapet de non retour
6	Druckleitung	Discharge line	Circuit de refoulement
7	Verflüssiger	Condenser	Condenseur
8	Sammelflasche	Receiver tank	Bouteille liquide
9	Sicherheitsventil	Protection valve	Soupape de sûreté
10	Absperrventil	Shut Off valve	Vanne d'arrêt
11	Filtertrockner	Filter drier	Déshydrateur
12	Schauglas	Sight glass	Voyant liquide
13	Flüssigkeitsmagnetventil	Solenoid valve	Vanne magnétique
14	Therm. Expansionsventil	Therm.expansion valve	Détendeur thermostatique
15	Verteiler	Distributer	Distributeur
16	Verdampfer	Evaporator	Evaporateur
17	Fühler	Bulb	Capillaire d'égalisation de pression
18	Druckausgleichsleitung	Compensation line	Ligne d'égalisation de pression externe
19	Saugleitung	Suction line	Circuit d'aspiration
20	Niederdruckpressostat	LP Pressostat	BP Pressostat
21	Saugabsperrventil	Suction valve	Vanne d'aspiration



Hochdruck - gasförmig High pressure – vapor Haute pression - Gaze	
Hochdruck - flüssig High pressure – liquid Haute pression-liquide	
Niederdruck - flüssig Low pressure – liquid Basse pression-liquide	
Niederdruck-gasförmig Low Pressure – vapor Basse pression - gaze	

Außenluft
Exterior Air
Air d'exterieur

Erwärmte Abluft
Warmed Up Extraction Air
Air à extraction réchauffé

Warme Innenraumluft
Warm Interior Air
Air d'interieur chaude

Gekühlte Innenraumluft
Cooled Interior Air
Air d'interieur surgelé

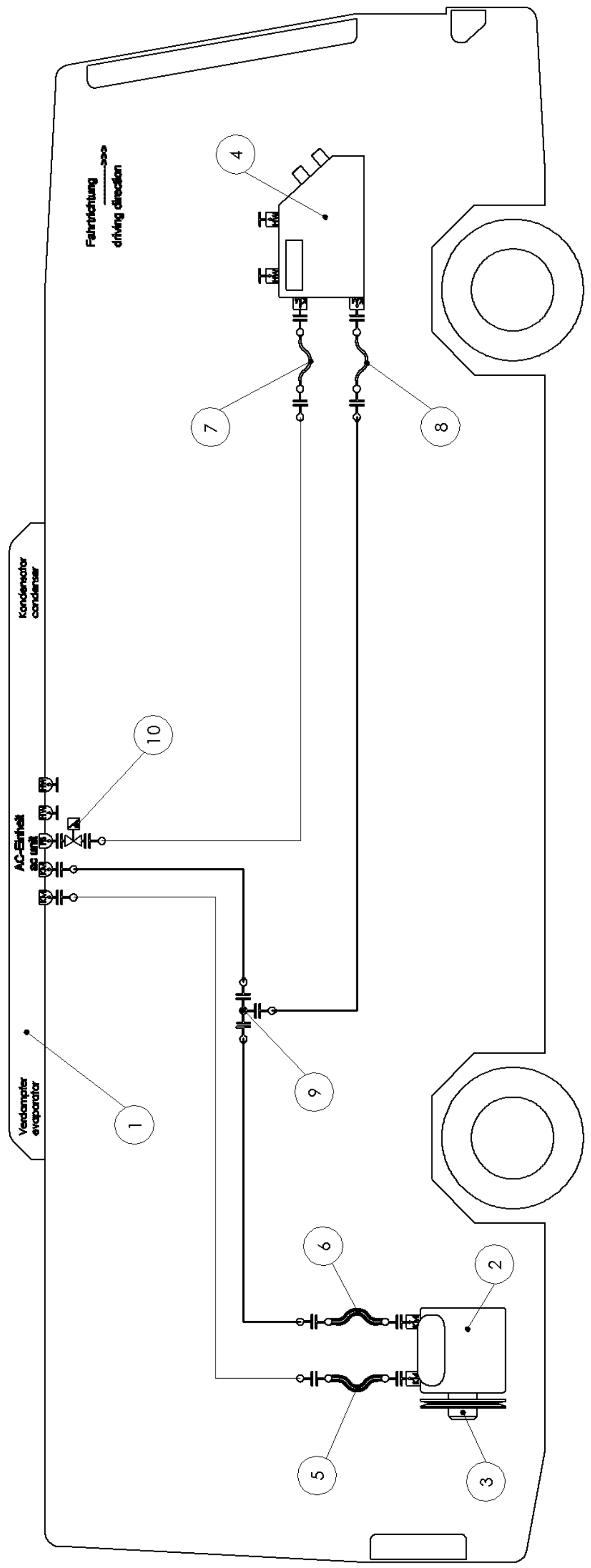
Bus Air Conditioning

Carrier
SÜTRAK

Kältekreislauf – Parallelanlage
Refrigerant Cycle – Parallel Unit
Circuit frigorifique – Unité parallele

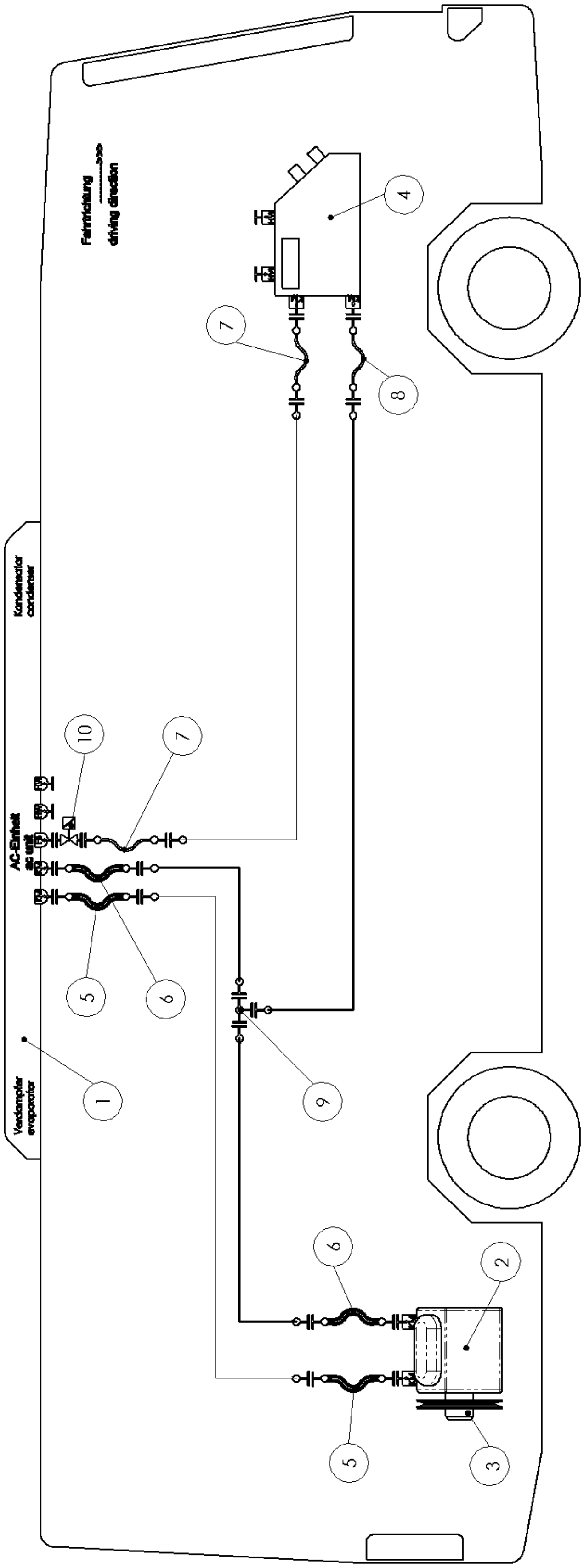
1	Verdichter	Compressor	Compresseur
2	Druckabsperrventil	Pressure Shut Off Valve	Vanne de refoulement
3	HD Pressostat	HP Pressostat	HP Pressostat
4	Rückschlagventil	Check Valve	Clapet de non retour
5	Verflüssiger	Condenser	Condenseur
6	Verflüssigerlüfter	Condenser Fan	Ventilateur de condenseur
7	Sammler	Receiver	Reservoir
8	Überdruckventil	Pressure-Relief Valve	Soupape de sûreté
9	Magnetventil	Solenoid Valve	Vanne magnétique
10	Trockner	Drier	Déshydrateur
11	Absperrventil	Shut Off Valve	Vanne d'arrêt
12	Schauglas	Sight Glass	Voyant Liquide
13	Expansionsventil	Expansion Valve	Détendeur
14	Fühler	Sensor	Sonde
15	Ausgleichsleitung	Compensation Line	Ligne d'égalisation
16	Verdampfer	Evaporator	Évaporateur
17	Verdampfergebläse	Evaporator Blower	Ventilateur d'évaporateur
18	Saugabsperrventil	Suction Shut Off Valve	Vanne d'aspiration
19	ND Pressostat	LP Pressostat	BP Pressostat
20	Elektromagnetkupplung	Electro Magnetic Clutch	Embrayage magnétique électr.
21	Fortluftgebläse	Extraction Blower	Ventilateur d'éxtraction
22	Frontbox Anschluss	Frontbox Connection	Raccord de frontbox

Refrigerant cycle of a roof top AC-unit



1. Air conditioning unit
2. Compressor
3. Magnetic clutch
4. Front box / Front evaporator
5. Discharge line
6. Suction line
7. Liquid line to front box
8. Suction line from front box
9. T-connection suction line
10. Liquid solenoid valve

Refrigerant cycle of a roof top AC-unit



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Refrigerants

All new Eberspächer Sütrak air conditioning units run with refrigerant R 134a.

Until 1992 all air conditioning units were filled with refrigerant R-12. Due to its high ozone depletion potential, this refrigerant is forbidden nowadays and must not be refilled in existing systems.

The now used refrigerant R 134a is chlorine atom free and therefore does no contribute to the destruction of the ozone layer.
However, this substance still has a considerable potential to intensify the greenhouse effect.
For this reason it is strictly forbidden to evacuate R 134a into the atmosphere.

R 134a belongs to the substances which are not combustible, non-flammable and not toxic. However, if it gets into contact with skin, it may cause frostbite and severe burns. Contact with the eyes may lead to loss of sight. Therefore, works at air conditioning systems should not be carried out without eye protectors and safety gloves.

Comparison R-12 / R 134a

Systems filled with R 134a almost reach the same cooling capacity as those filled with R-12.
If the system runs with R 134a, the temperature of the gas at the compressor outlet is about 5 K lower than with R-12, and thus more uncritical.
The filling quantity of R 134a is approximately 90% of that of R-12.

First aid in case of accidents with refrigerants

Inhaled:
Remove subject from the contaminated area. Use oxygen or cardiopulmonary resuscitation if necessary. Consult with a physician in case of respiratory and nervous symptoms.

Frostbite
Warm the frostbite part of the skin up with lukewarm running water to body temperature.

Eyes
If refrigerant gets in contact with the eyes, immediately flush eyes with running water for several minutes, while keeping the eyelids wide open.

Consult with a ophthalmologist or doctor in case of persistent pain.

Removal of refrigerants

Observe the legal rules for removal of refrigerants. In Germany, use orange recycling bottles.

CAUTION: Refrigerant bottles must not be overcharged. A raise in temperature increases the pressure and may cause the bottle to explode.

The bottle can be filled with max. 75 % of the bottle filling volume, there is written on the bottle.

Refrigerant Oils

R 134a does not dissolve in conventional refrigerator oils (mineral oil, alkylbenzene). A protected oil circulation is therefore not ensured in cycles of standard dimensions. This is why compressor, refrigerant and oil industry developed special diester oils, which show sufficient solubility at good lubricating properties. In spite of the generally favourable properties of such oils, their water absorbing capacity is higher than that of common lubricants that have been used so far. This is why these oils should only be exposed to air for a short period of time when filling the system.

- Do not mix additives with refrigerant or refrigerant oil in the system for leak testing !
  The usage of additives (also usage of contrast substances for leak search)
  to refrigerant oil and/ or refrigerant leads to rejection of warranty claims.

- The following oils are allowed for the refrigerant R 134a:

DEA	Triton SE 55
FUCHS	Reniso E 68
ICI	Emkarate RL68 S
MOBIL	Arctic EAL 68

(Valid only for air conditioner without flexible pipes:)

CASTROL	Icematic SW 68

Refrigerator oil is often referred to as a necessary evil, because it is "vital" for the compressor, but rather causes problems in the other parts of the system (clogging, deposit ...). 5 to 10% of the oil circulated in the refrigerant cycle. The oil may cause the following problems:

- Humidity enters the system. The diester oil is very hygroscopic, i.e. it absorbs much water.

  Result: Acidification; metal components may corrode.

  Remedy: Do not store refrigerant unsealed, as it would absorb much humidity.

- Accumulation of refrigerant in the compressor crankcase when system is not engaged. When the system is not in service, more refrigerant dissolves in the oil, because the pressure is higher when the system is running than when it is switched off.

  Result: When starting, foam is formed in the crankcase (the refrigerant is given off the oil) The oil lubrication in the compressor is not working very well.

  Remedy: Install oil sump heaters.

- Oil recirculation is not ensured. The oil circulated by the oil ejection of the compressor is deposited somewhere in the circuit.

  Result:
  - Not enough oil in the compressor
  - The deposited oil is being entrained in one jolt and causes damages to the compressor

__Remedy:__ The dimensions of the lines have to be correctly dimensioned to ensure a minimum flow rate.

– suction line: approx. 6,0 m/s
– pressure line: approx. 5,0 m/s
– liquid line: approx. 0,5 m/s

In view of the little space that is provided in a coach such line sizes would be too large. Therefore smaller ones are mounted, which raises the flow rate (this influences the recirculation positively). However, at the same time pressure in the lines decreases dramatically, so that a compromise must be made between line size and pressure decrease.

- Because in our case the compressor is located lower than the condenser, there is a risk that the oil in the pressure line returns to the compressor when the system is out of operation. When starting the system, compressor valves may be damaged.

  __Remedy:__ Stationary refrigeration uses siphons in the pressure line. This solution is not applicable for coaches due to the use of flexible tubes. If the above described problem occurs, a return valve (one way valve)in the pressure line will solve the problem.

__IMPORTANT NOTE:__

__- Never use used refrigerant oil for units.__

__- The mineral oil (use in R 12 systems) are separate oil waste disposal.__

__- The diester oil will never mix with other oil waste disposal, too.__

Capacity Control

General

If an air conditioning system is not provided with a capacity control, there are only two possible working conditions:

0% capacity à *the system is switched off*

100% capacity à *the system is running*

Such a system is only conceivable if the space, which is to be cooled is well insulated and if heat does not permanently enter the space (e.g. refrigerator).

Unfortunately buses do not provide such conditions. Insolation and body heat permanently increase the temperature inside the passenger compartment. If the air conditioning unit of the coach were not adjustable, it would switch off as soon as the required inside temperature is reached and re-start some minutes later when heat has again entered the passenger compartment. Again a few minutes later the system would cut in again, because the set temperature would be reached again.

In this case the running time would be very short and quickly lead to material fatigue (electromagnetic clutch, belts). Fuel consumption would also be increased as the forces, which have to be overcome during starting are very high.

There are various possibilities to avoid short running times.

Reheat-Prinziples

The mostly simple way to control capacity is in fact to destroy it. Shortly before the required inside temperature is reached, counter-heating is activated. Thereby the temperature may be finely adjusted and the running time of the system is increased.

Compressor capacity control unloader

Purpose

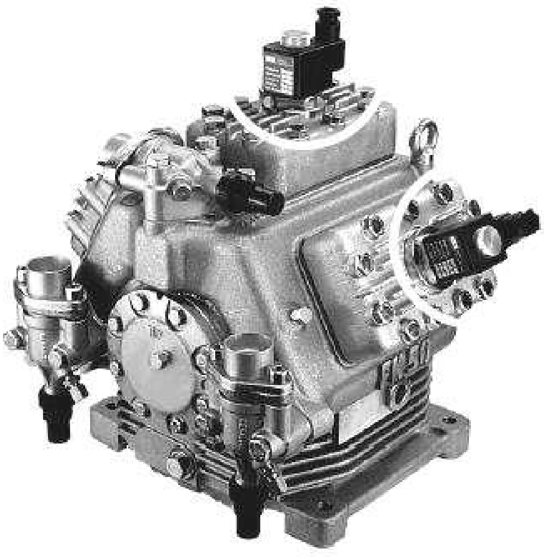
The capacity control unloader(s) is (are) installed to adapt the compressor output with respect to the requirements.

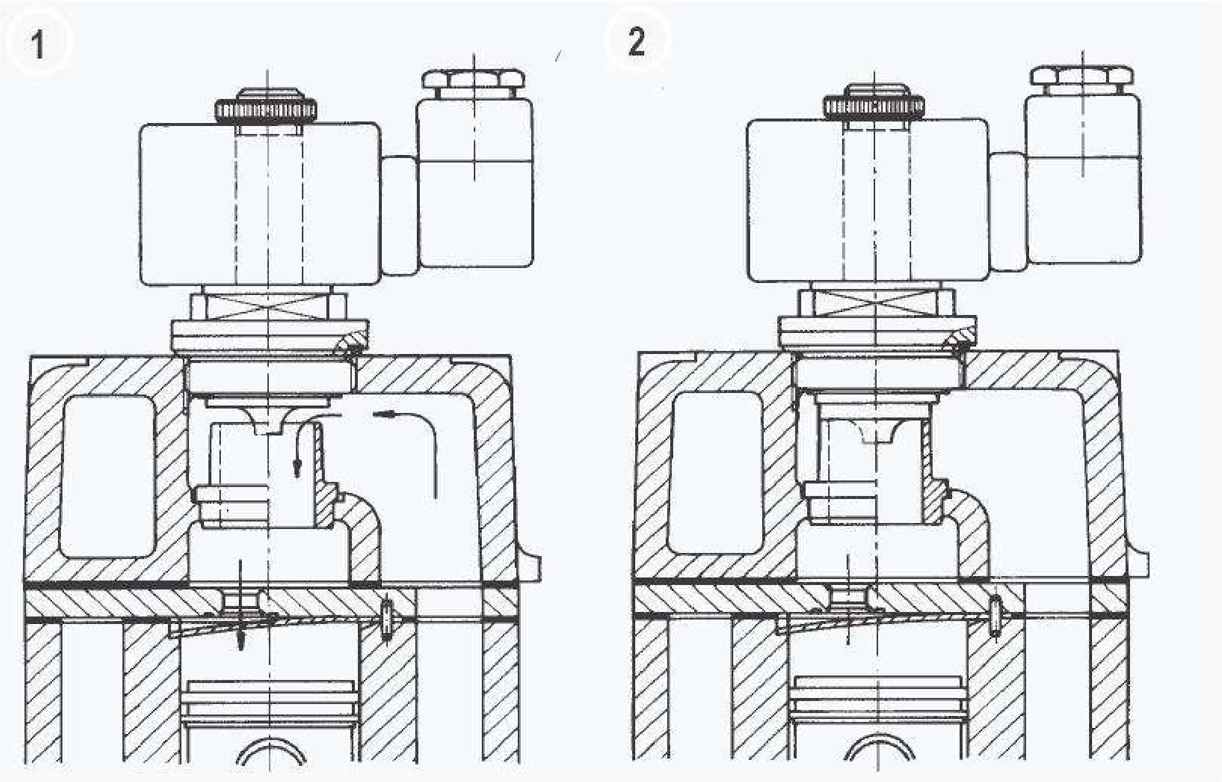
Theory of operation:

The serial capacity regulator with 6-cylinder-piston compressors will be operate as follow, according to the principle of cutting off the suction gas. A solenoid valve in the cylinder cover shuts off the suction inlets of a pair of cylinders. At the same time the pistons run almost idle and the compressor now works under partial load. Because a certain amount of gas leakage is admitted through the closed valve, the pistons, now free of load, are sufficiently lubricated and cooled so that the application limit of the compressor working under partial load does not need to be restricted.

Capacity-regulated operation creates a new balance in the refrigeration cycle. The evaporating temperature rises and the condensation temperature drops, because of the reduction in suction volume.

UNLOADER





FULL LOAD OPERATION

Solenoid valve dead
Suction inlets open

PARTIAL LOAD OPERATION

Solenoid valve actuated
Suction inlets close

The solenoid is connected with the control of the air conditioning unit and actuates at the temperature specified by the customer. Another frequent solution is to connect the defrost pressostat with the cutting off of the cylinders. In this case the capacity control starts on at 10ºC (to re-increase pressure), and cut off at 0°C, so that the system provides full capacity again.

The described regulation is a step-by-step capacity control. With a 6-cylinder piston compressor that provides the possibility to cut off the cylinders bank at each case.

The system may run at:

- *100% of its compressor capacity,*
  when all unloaders are not in operation and no 24V= connect at the electric solenoid.
- *Approx. 66% of its compressor capacity,*
  when only one unloader is in partial load operation and 24V= connect at the electric solenoid.
- *Approx 33% of its compressor capacity,*
  when two unloaders are in partial load operation and 24V= connect at the electric solenoids.

Capacity control through control of evaporator blowers

The speed of the evaporator blowers is directly connected with the cooling capacity. When the speed is reduced, less air passes the evaporator. As a result, that this air is cooled more, but the reduction of the volume flow leads to a reduction of the cooling capacity.

This kind of control is mostly infinitely variable and may be effected with the help of a potentiometer (speed: 2.200 r.p.m. to 1.400 r.p.m.).
It is also possible to control the blowers according to the interior temperature. In this case everything is controlled by the system climate control.

GENERAL GOOD PRACTICE

- The protective sealing plugs must remain in position on all replacement components and hoses until immediately before assembly

- It is essential that a second backing spanner is always used when tightening all joints. This minimises distortion and strain on components or connecting pipes.

- Components must not be lifted by connecting pipes, hoses or capillary tubes.

- Care must be taken not to damage fins on condenser or evaporator coils. Any damage must be rectified by the use of fin combs.

- Before assembly of tube and hose joints, use a small amount of clean new refrigerant oil on the sealing seat.

- Refrigerant oil for any purpose must be kept very clean and capped at all times. This will prevent the oil absorbing moisture.

- Before assembly the condition of joints and flares must be examined. Dirt and even minor damage can cause leaks at the high pressures encountered in the system.

- Dirty end fittings can only be cleaned using a clean cloth wetted with alcohol.

- All components must be allowed to reach room temperature before sealing plugs are removed. This prevents condensation should the component be cold initially.

- Before finally tightening hose connections ensure that the hose lies in the correct position, is not kinked or twisted, because later corrections are mostly not possible.

- Check hose is correctly fitted in clips or strapped to body and chassis.

- Components or hoses removed must be sealed immediately after removal, to avoid that dirt or moisture can enter.

- After a system has been opened for a longer time or after repairs, the drier must be renewed.

Commission an Air Conditioning Unit

As almost all failures of an air conditioning unit are caused by impurities inside the system, it is essential to ensure absolute cleanliness during installation or repair. Due to the fact that the refrigerant cycle is a closed cycle, impurities remain inside the system until they cause failures or even serious damages which often lead to expensive repairs.
The perfect starting and permanent functioning of an air conditioning system requires accurate and professional work right from the beginning:

- adequate storing and keeping all components closed until they are used
- professional mounting and repairs
- through leak tests, evacuation, cleaning, filling and starting of the air conditioning or refrigeration system.

Moreover, the workmanlike and careful handling of refrigeration tools, vacuum pump, gauge manifold etc. will ensure reliable and professional work for a long time.

The Leak Test

Every air conditioning or refrigeration unit has to be checked for leaks after first installation or repair. Leaks not only result in reduced cooling capacity due to loss of refrigerant, they also enable humidity to enter the system which may cause failures.
Before installing new units or carrying out extensive repairs a pressure test has to be made. The test has to be performed with dried nitrogen 4.6 or 5.0 (on bottles written as OFN) with max. 25 bar. The advantage of this measure is that bigger leaks or loose screw connections may be recognized without losing refrigerant. The fact that the pressure does not decrease in a closed system indicates that there are no leaks. Another advantage of using nitrogen 4.6 is that the unit is already rinsed and pre-dried during the pressure test.

Ø *Do not mix additives with oil or refrigerant in the system for leak testing !*

Caution

Using only nitrogen to carry out the leak test takes a long time (8-12 hours) if you want to detect also small leaks. If there are leaks, nitrogen cannot be detected by leak detectors. The only way to find leaks is then to carry out a soap bubble test. If a leaks that has been determined by decreasing pressure cannot be localized by means of a soap solution, it has to be detected with the help of R134a and an electronic leak detector.
Make sure that the used leak detector is appropriate for R134a.

If subsequent work or repairs have to be carried out due to leakage, another leak test has to be performed after having finished these works.

Evacuation

The purpose of evacuating air conditioning and refrigeration units is to:

- remove air
- remove humidity
- remove foreign gases

For the evacuation of a unit, you need a vacuum pump that has the capacity to reach a level of 1 mbar. Only a high vacuum level ensures that air and foreign gases are permanently sucked off the system. Besides, the lowering of pressure down to 1 mbar (1000 micron) has the effect that the temperature of ebullition of the water is reduced to approx. 0°C, which causes humidity inside the system to evaporate. The steam will also be sucked off together with the air and foreign gases.

Why is it necessary to remove humidity?

- Because refrigerants can only absorb small amounts of humidity and larger amounts of humidity may cause failures.
- To avoid that refrigerant, oil and sealing material decompose.

Why is it necessary to remove air and foreign gases?

Because larger amounts of air and foreign gases inside the refrigerant cycle may cause failures.
Air and foreign gases do not condense and thus will not combine with the refrigerant. This may cause the following failures:

- Increased condensation pressure
- Oxidation and corrosion
- Oxidation of the oil
- Overheating of compressor

Evacuation procedure

1. Connect pressure gauge manifold.
2. Check vacuum pump (oil level, function).
3. Install yellow working hose between gauge manifold and vacuum pump. Make sure that connections are tight.
4. Start vacuum pump.
5. Open working valves at gauge manifold completely.
6. Observe the pressure and evacuate for at least 6 - 8 hours after having reached a vacuum level of 1 mbar.
7. After 6 - 8 hours close both working valves at gauge manifold.
8. Observe the pressure. If the pressure does not increase again, switch off the vacuum pump.
   If the pressure rises again, humidity is still evaporating. In this case evacuation shall be continued or the system has to be rinsed with refrigerant. Anyway, step 5 – 8 have to be repeated.
9. Detach yellow working hose from vacuum pump. The unit is now ready for charging.

Charging the unit with refrigerant

The following procedure may only be carried out if the unit has been checked for leaks and evacuated.

There are two possibilities to determine the required amount of refrigerant:

- If the exact filling amount is known, the unit has to be charged according to the weight indicated on the type plate.
- If the filling amount is not known, the unit has to be charged with the help of the sight glass. In this case, make sure that the ambient temperature is approx. 30°C and the temperature inside the passenger compartment is at least 25 °C.

Charging procedure for an evacuated system

1. Install yellow working hose between gauge manifold and refrigerant cylinder.
2. Open shut-off valve of refrigerant cylinder completely (gaseous).
3. Remove air from yellow working hose by shortly loosening the connection of yellow working hose.
4. Set refrigerant cylinder to “liquid”:
   - If refrigerant cylinder is big and has a dip tube: Close “vapor” valve and open “liquid” valve.
   - If refrigerant cylinder is small and has no dip tube: Put cylinder upside-down.
5. Pre-charging the unit with liquid refrigerant (pressure side). Charge the unit with liquid refrigerant by opening the red, high pressure side working valve at gauge manifold - at switched-off compressor - until pressure compensation is reached at both high and low pressure gauge of gauge manifold.

Caution: - Do not charge liquid refrigerant while compressor is running.

- Small air conditioning or refrigeration units and big refrigerant cylinders should be charged slowly as otherwise the unit would already be overcharged at pre-charging.
- If the required amount of refrigerant is known, place the refrigerant cylinder on a scale and observe the charged amount.

6. Close working valve at high pressure side of gauge manifold.

7. Start up compressor. Fix engine speed at 1.000 to 1.500 RPM/ standard maximum speed of semi hermetic screw compressor.

Caution: To make sure that there is no liquid refrigerant in the compressor, race the compressor 1 or 2 times manually before starting it.

8. Check if the sight glass still shows bubbles.
Observe high and low pressure level in the unit.

9. Prepare refrigerant cylinder for supply of vaporous refrigerant.

10. If sight glass still shows bubbles, open blue working valve (suction side) at gauge manifold and let vaporous refrigerant in to unit.

11. Close blue working valve (suction side) at gauge manifold as soon as sight glass is free of bubbles.

12. Continue to observe sight glass. If it shows no bubbles, charging is completed. If it still shows bubbles, repeat step 10 and 11.

13. Check working pressures and high and low pressure.

14. Check oil level of compressor.

15. Check functioning of high and low pressure switch.

16. If all above mentioned steps have been carried out properly, the unit is now completely charged and may be put into operation.

17. Disconnect gauge manifold.

Checking the Pressure Switches

Checking the high pressure switch

1. Connect pressure gauge manifold to the compressor.
Close shut-off valve with the help of a ratchet spanner by 1-½ clockwise turn.

2. Start air conditioning unit.

3. Interrupt condenser fans or cover condenser coil to prevent air from flowing through the condenser.
The pressure rises up. At apprx.23,5 bar magnetic clutch must cut off, high pressure switch is correctly adjusted.
The pressure falls down.
The magnetic clutch/ air conditioning must be starts again of a pressure at apprx.16,6 bar.

4. If high pressure switch does not react at the prescribed pressures, high pressure switch is defective and has to be replaced.

Caution: If high pressure switch does not work, cut off the unit and compressor resp. at apprx.24,5 bar, immediate access to stop it manually.

Checking the low pressure switch

1. Connect pressure gauge manifold to the compressor.
Close shut-off valve with the help of a ratchet spanner by 1-½ clockwise turn.

2. Start air conditioning unit.

3. Slowly close service valve clockwise with the help of a ratchet spanner until intake pressure decreases.
At apprx.0,35 bar the magnetic clutch must be disengaged. Stop closing the service valve as soon as the magnetic clutch is disengaged.
Pressure builds up again.
The magnetic clutch/ air conditioning must be starts again automatically at apprx.2,1 bar.

4. If low pressure switch does not react at the prescribed pressures, low pressure switch is defective and has to be replaced.

Caution: If low pressure switch does not work, stop unit and compressors resp. at apprx.0,25 bar, immediate access to stop it manually.

The FK 50 – Series

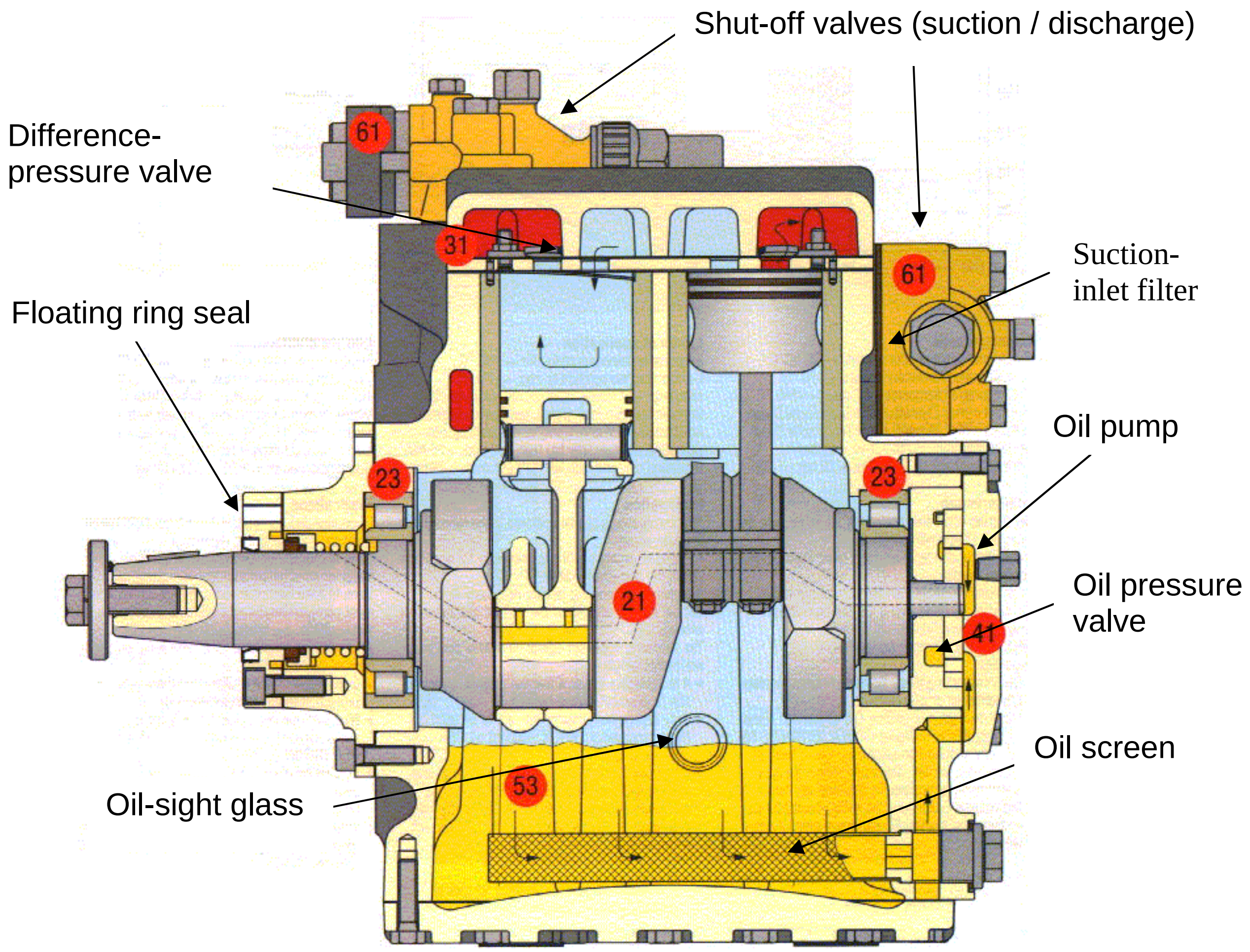
Type Code

Example: FK X 50/660 K

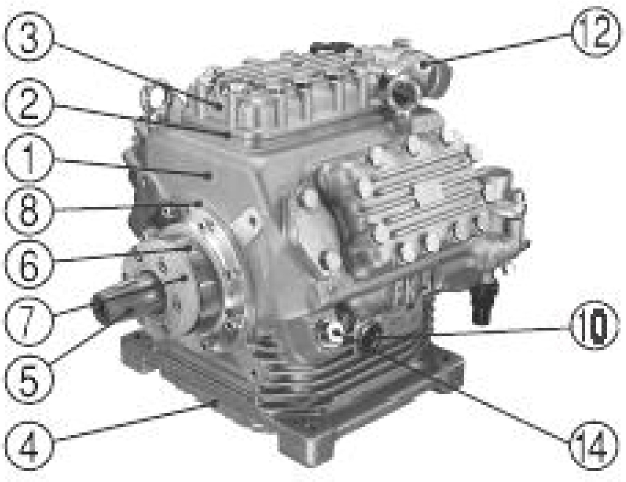
Series (compressor)
Index for diester oil filling
Size
Code (geom. working volume in cm³)

Type of valve plate
N = Standard / Refrigeration
K = Klima / Air condition

Sectional Drawing of Compressor



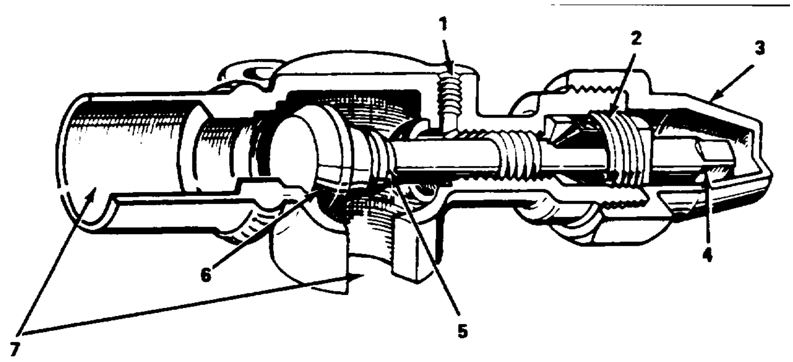
Construction



1. Compressor housing
2. Valve plate
3. Cylinder cover
4. Base plate
5. Shaft end
6. Axial face seal
7. Floating ring seal/ integrated leakage oil collector
8. Seat for magnetic clutch
9. Oil pump
10. Oil sight glasses
11. Suction shut-off valve
12. Discharge shut-off valve
13. Oil drain plug/ oil screen
14. Oil filler plug
15. Connection for heat protection thermostat

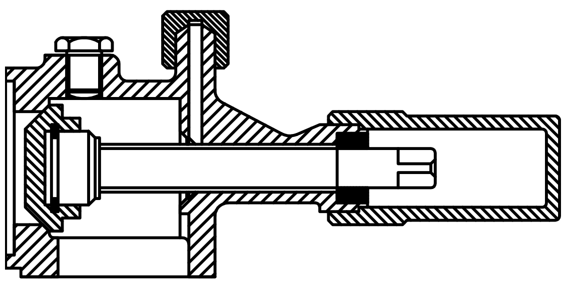
Shut-off Valves

Compressors are equipped with a service valve both on the high and low pressure side. These valves can be connected to the gauge manifold.



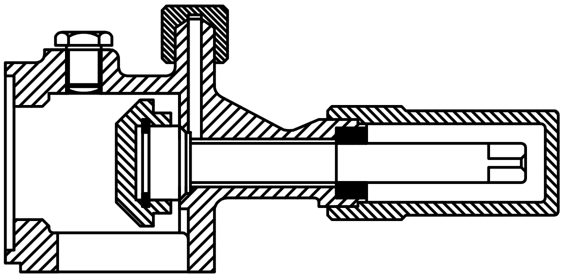
The service valve has 3 positions: needle inside, needle outside, needle half inside

Needle in inside position (closed - turn clockwise)



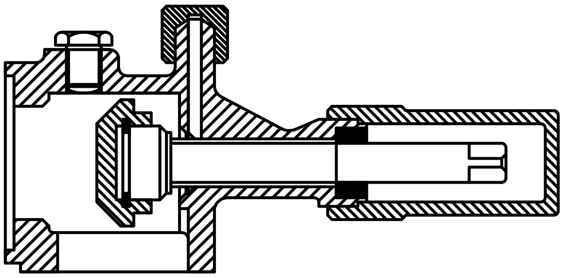
When the needle is in closed position, the refrigerant cycle is interrupted. Now the compressor may be replaced; evacuation may be carried out through the service connection UNF 7/16”, which is in contact with the compressor.

Needle in outside position (open – turn counter-clockwise)



This is the normal working position. When the needle is in open position, the refrigerant cycle is not interrupted. There is no connection to the gauge manifold.

Needle in half inside position:



This position may be considered the service position. In this case there is a connection between gauge manifold and refrigerant cycle.

Oil Inside the Compressor

The compressor oil level may be checked with the help of an oil sight glass, which can be found at the bottom side of the compressor housing. Normally the refrigerant cycle does not consume oil. The only reasons to recharge oil is, when a big leak has been detected, or when a considerable amount of oil was lost during replacement of a large component (condenser, evaporator).

Only use oil that is appropriate for the used refrigerant.

Never charge used oil.

Do not overcharge the refrigerant cycle with oil. An excessive proportion of oil may cause serious damages and has a negative effect on the cooling capacity.

Detecting oil leaks

First of all you should check visually whether oil can be found on the fittings, the flexible hoses or the crank shaft.
If this should be the case, clean the relevant spots to detect the leak.

Controlling the amount of oil inside the compressor

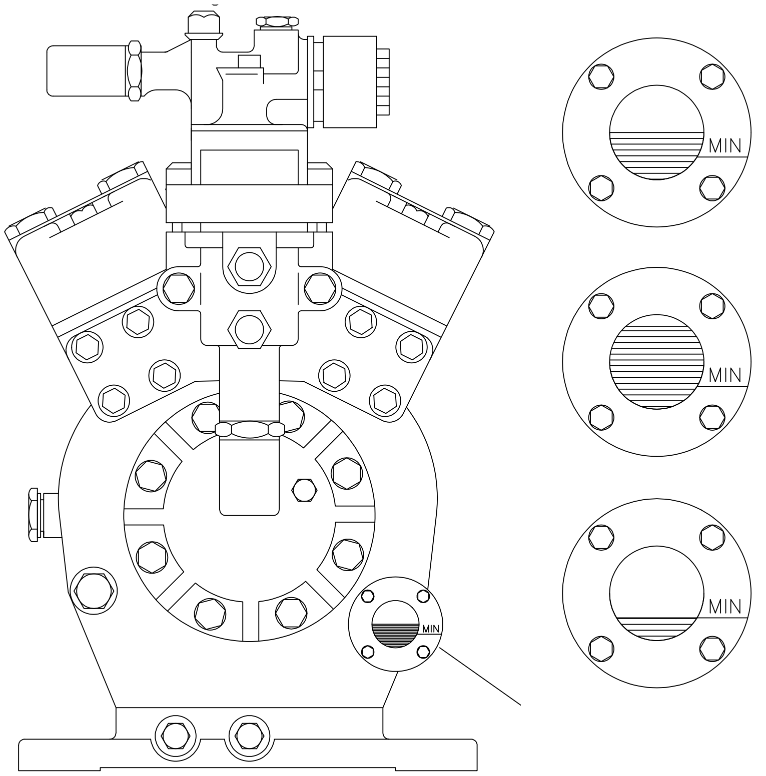
During operation, the oil-sight glass should be half-filled with oil.

The following conditions must be given when checking the oil-level:

- Compressor should be running for at least 20 minutes
- Vehicle engine should run at 2/3 of its maximum speed
- Inside temperature should be between 22 and 30°C
- Outside temperature should be between 20 and 40°C
- It is possible, the compressor should be in horizontal position

The oil level shown in the oil-sight glass is only meaningful, if the above conditions are given.

When the oil level is too low, check the amount of refrigerant inside the cycle.. A leak in the refrigerant cycle may lead to a low oil-level. If the amount of refrigerant proves to be too low, recharge and check the oil-level again.
If the oil-level is still low, the reason may be that the oil is dislocated.
Never deposit too much oil in a high position, as this may cause severe damages (the deposited oil is being entrained in one jolt and causes damages to the compressor).

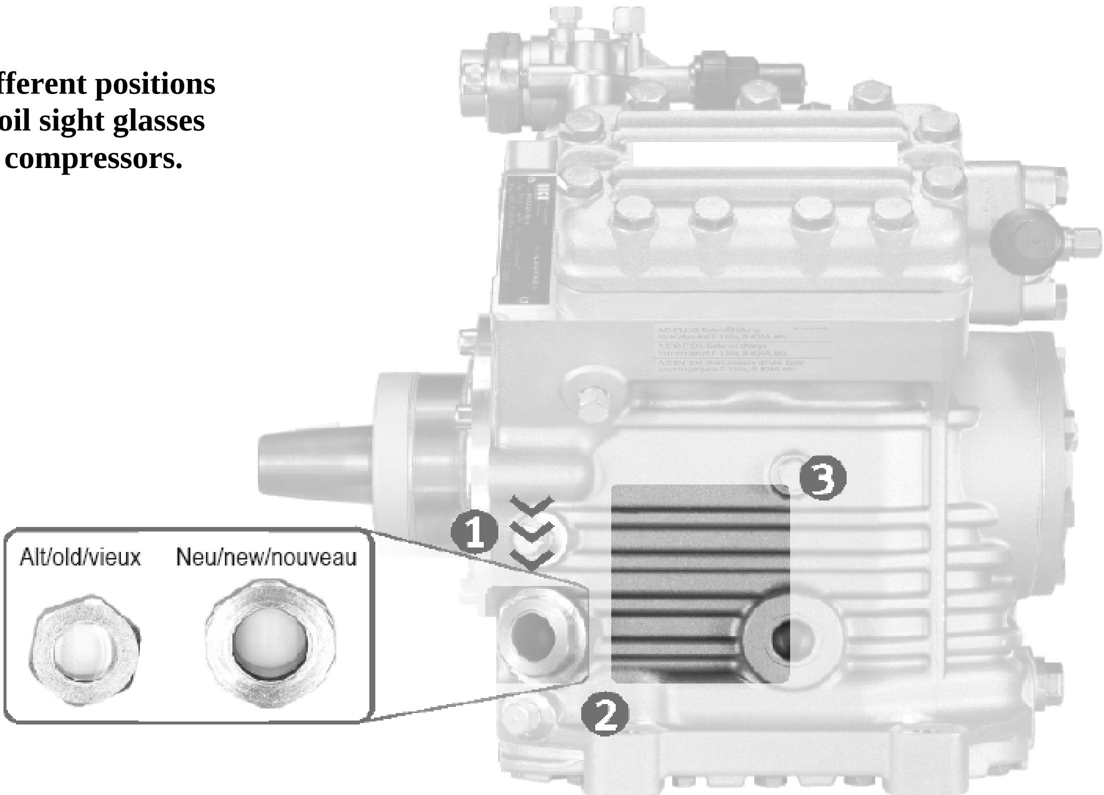


Normal oil-level

Oil-level too high.
Drain oil.

Oil-level too low.
Recharge oil.

Different positions of oil sight glasses on compressors.



Draining Oil

1. Close service valves of suction and pressure side (turn clockwise) with the help of a refrigeration ratchet.

2. Install the suction station and suck off the remaining refrigerant within the compressor.

3. Slightly release waste oil screw. *THERE IS NO NEED TO REMOVE THE SCREW*. Drain as much oil as is necessary.

4. Re-tighten waste oil screw.

5. Start evacuation of compressor.

6. Open service valves of suction and pressure side (turn counter-clockwise) with the help of a refrigeration ratchet.

7. Start the air conditioning unit and check it again in accordance with the above described conditions.

Note: If it is not possible to drain the oil properly (lack of space), the compressor must be removed. In this case the regulations for changing a compressor will apply.

Charging Oil

1. Close service valves of suction and pressure side (turn clockwise) with the help of a refrigeration ratchet.

2. Install the suction station and suck off the remaining refrigerant within the compressor.

3. Connect a hose with one end to the service connection of the compressor oil filler plug, and dip the other end into the oil receptacle. Connect another hose or manifold gauge with pipes to the suction side near the shut-off valve, and a vacum pump. Know succ oil with the vacum pump into the filler plug to the compressor.

4. Connect the vacuum pump to the service connection of the pressure side. Start evacuation to draw oil into the compressor.

5. Open service valves of suction and pressure side (turn counter-clockwise) with the help of a refrigeration ratchet, as soon as there is enough oil in the compressor.

Oil Change

The compressor has to be removed to change the oil. This is the only way to make sure that the oil inside the compressor is completely removed.

1. Close service valves of suction and pressure side (turn clockwise) with the help of a refrigeration ratchet.

2. Install the suction station and suck off the remaining refrigerant within the compressor.

3. Remove the compressor and change oil.

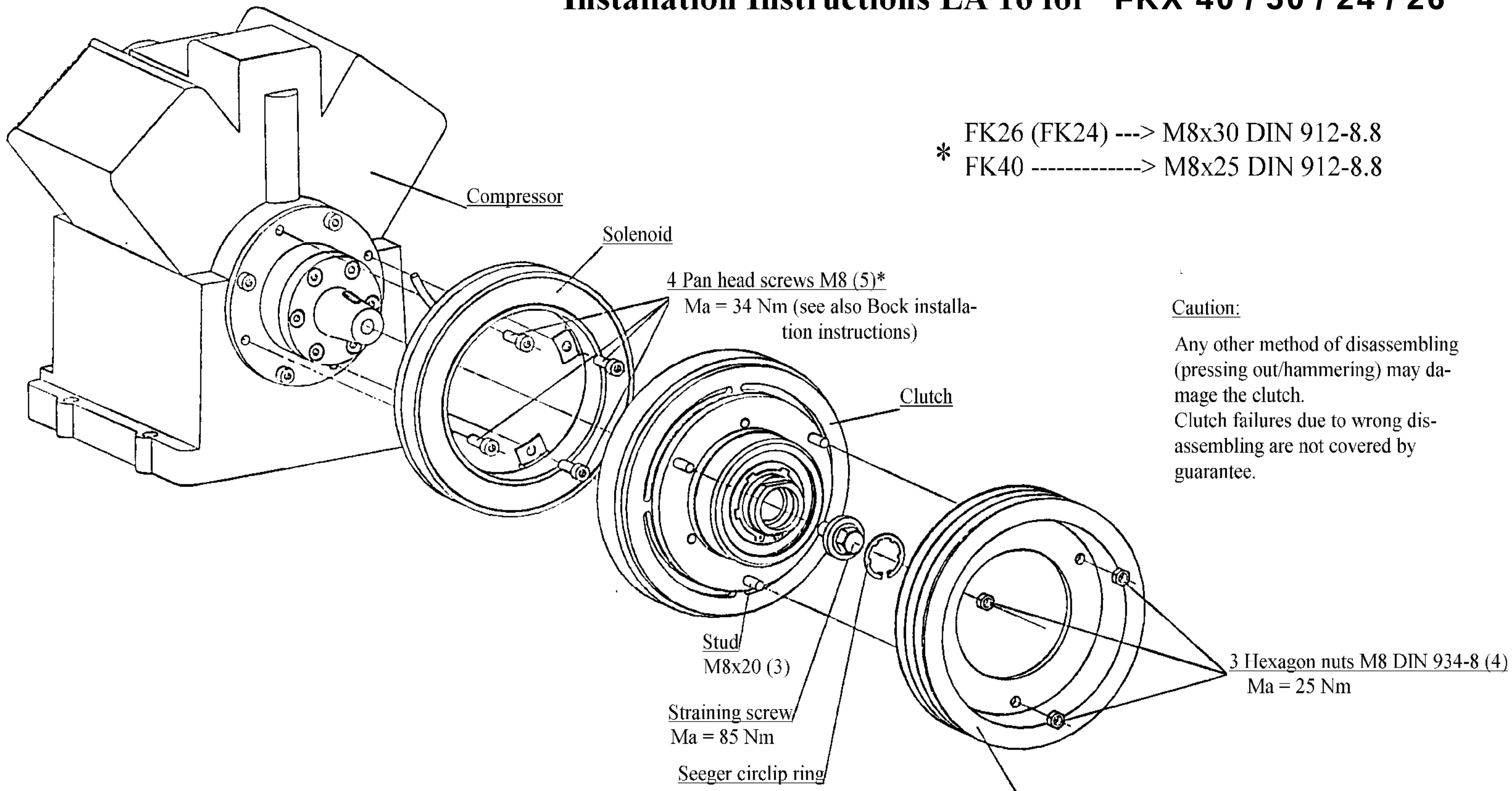
4. Re-install compressor.

5. Start evacuation of compressor.

6. Open service valves of suction and pressure side (turn counter-clockwise) with the help of a refrigeration ratchet.

7. Start the air conditioning unit and check it again.

Installation Instructions LA 16 for **FKX 40 / 50 / 24 / 26**



* FK26 (FK24) ---> M8x30 DIN 912-8.8
FK40 -------------> M8x25 DIN 912-8.8

Caution:

Any other method of disassembling (pressing out/hammering) may damage the clutch.
Clutch failures due to wrong disassembling are not covered by guarantee.

Installation Instructions:

of electro-magnetic clutches of series LA 16 for compressors FKX 40 / 50 / 24 / 26.

1. Dismount 4 pan head screws M8 (5)* from bearing flange.
Caution: When dismounting the bearing flange screws, observe installation instructions for compressors !

2. Fasten the magnet with the 4 pan head screws M8 (5)* to the bearing flange. Arrange the cable in a way that it does not touch hot parts. t_{max} = 105°C.

3. Remove the Seeger circlip ring and the straining screw from the rotor assembly and slide the rotor assembly onto the compressor shaft. Make sure that curved washer fits the rotor slot correctly. The rotor must not touch the magnet when being revolved manually. Observe control mark! Insert and tighten straining screw (torque wrench Ma=85 Nm). Insert Seeger circlip ring.

4. Slide pulley onto the studs (3) and tighten with nuts M8 DIN 934-8 (4).

5. Connect the cable. Polarization is not required. Voltage +/- 10% of nominal voltage.

6. When disassembling, lubricate Seeger circlip ring and release straining screw anticlockwise.

Installing the Thermal Expansion Valve

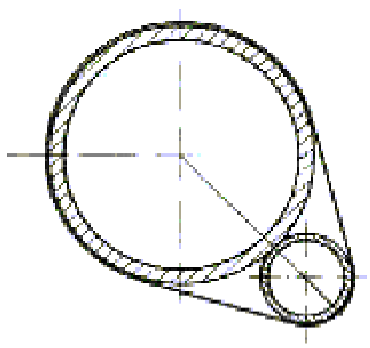
Checking the components of the TEV

Check whether the nozzle still operates.
Check whether capillaries are undamaged.

When installing the valve, make sure that the pipes are properly connected, as screwed connections tend to be leaky.

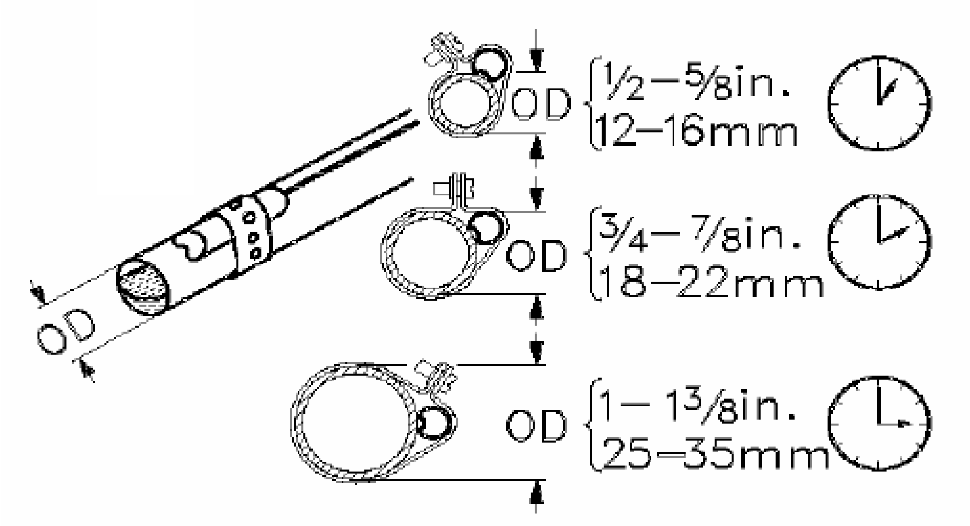
Sensor bulb

The sensor bulb is fixed after evaporator pipe outlet and equalizer line connection.



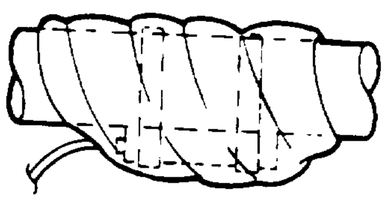
Fix the sensor bulb with a sensor clamp to the side of the horizontal suction line.

Do not install the sensor bulb at the tube leading vertically up or down.



Clean the surface of the pipe to which the sensor bulb is fixed suction line ≥ 22 mm ∅ (preferably use emery paper).

It is absolutely necessary to insulate the sensor bulb. A sensor bulb without insulation will cause severe damages.



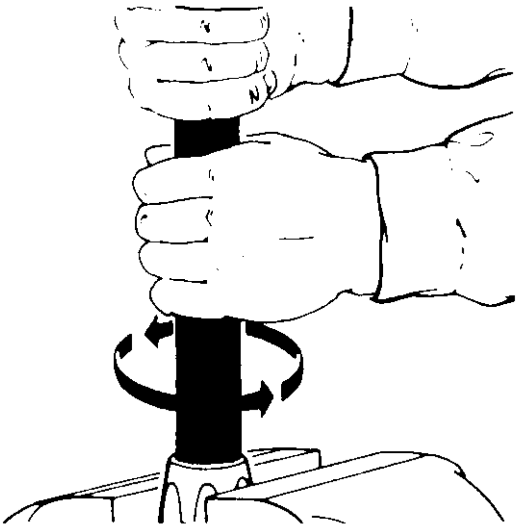
Never tie capillaries up to warm parts or close to blowers (influence of air flow).

Installing Flexible Hoses

Cut the hose square without scratching it.

Use a sharp saw (DO NOT USE EMERY PAPER).

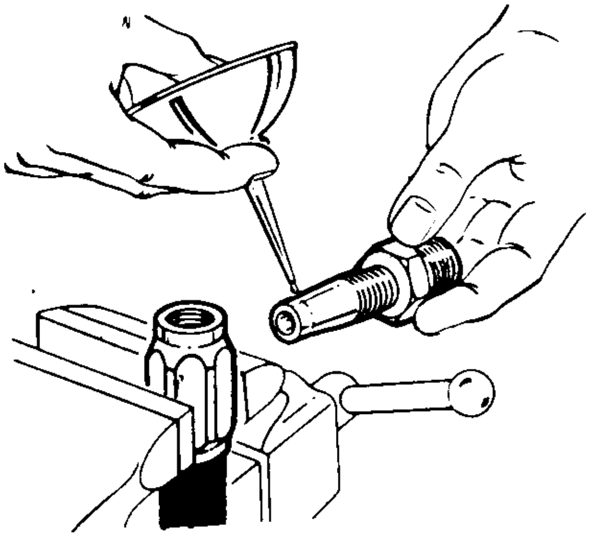
Remove cuttings thoroughly. To blow out the particles after cutting of hoses, use dry nitrogen and never compressed air.



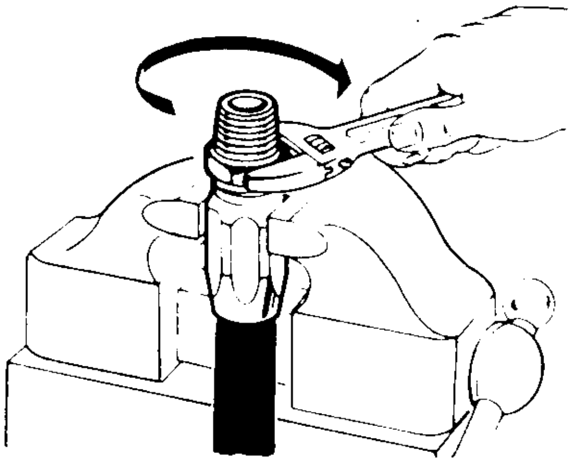
Draw a line with chalk or with a marker close to the end of the locking ring (see below). This simple and efficient trick allows you to see whether the hose is likely to be pulled out while you put the hose together.

Insert the hose into the locking ring by rotating counter-clockwise, until it fits closely. Then release it by a rotation through 90°.

If the hose is very long, rather rotate the locking ring counter-clockwise onto the hose.



Lubricate the thread and the cone with the oil that is used by the unit.



Insert the cone into the hose, force it slightly further with your finger and start rotating the locking ring clockwise.

Take a suitable wrench and continue rotating until the nut will not approach the locking ring, do not slightly touches. It is good to leave a gap of 1- 2 mm for further corrections of the joint position.

Do not tighten too much! Rotation should be even and without interruption.

Maintenance and Service

The efficient performance of the air conditioning unit is dependent upon a proper maintenance and function-tests. A through visual inspection and function test by the driver, before any performance, will avoid expensive repairs. Little faults are often responsible for big repairs. Working reliability of the air-conditioning unit depend upon a regular maintenance chart.
To keep the air conditioning units functional even in periods when it is not used, visual inspection and function tests have to be performed.

- **If the air conditioning units are operated in extreme dusty areas, maintenance intervals have to be adjusted to the needs.**

- **If the air conditioning units are used for long term, for example in the wintertime, the air conditioning units must be operated at least once a month, for a minimum of 30 minutes. This operating prevents gaskets and bearing at the compressor to dry out. Only while the A/C units are in operation, the compressor will be lubricated by it's own oil pump.**

Note

To operate compressor and the unit in the wintertime, the inside temperature has to be higher than 24 °C. (Therefore the passenger compartment has to be heated up if necessary.)

Once a year before the season start, a service inspection by a specialist, is recommended for a reliable operation during the whole season.

The air conditioning system is a closed circuit, that's why total cleanliness must be the aim of service engineer. Once a contaminant enters the system it will remain there, only intervention by a service engineer can remove it.

Contaminants usually react slow. A system may start up initially and run perfectly: a few months later it will be found to be badly damaged, perhaps beyond repairs.

Maintenance Chart

Maintenance:
Weekly or every 50 working hours

a) Clean air filter mats at return air intake and at evaporators. Take out filter mats, flush in hand-warm water under use of fine detergent and shake. Replace damaged filter mats.

b) Check function of evaporator blowers and condenser fans (main rotating direction).

c) Check v-Belt tension at compressor drive. Adjust if necessary. Renew damaged v-belts, use matched sets.

Maintenance:
Monthly or every 200 working hours

a) Check condenser, clean if necessary. Straighten bend fins, reducing the air flow reduces the heat transfer. To clean dusty condenser use compressed air against the usual air flow direction. To remove dirt and foreign objects, steam cleaning and pressure washing are the standard methods for cleaning. Strong caustic soaps and acid methods should be avoid.

b) Check evaporator drain tubes for dirt or restrictions.

c) Check hoses refrigerant lines and wires for leaks, lose connections and wear because of touching sharp edges. Avoid contract with hot parts. Protect electric connections from corrosion.

d) Check all fixing screws, mountings and brackets for tightness and cracks. Tighten loose bolts, replace worn parts and lubricate v-belts tension pulleys and shafts.

e) Check refrigerant filling at sight glass. There for the unit has to run for approx. 10 – 15 minutes at a minimum of 1500 rpm. The sight glass has to appear clear and free of bubbles.

Inspection chart:
Once a year or every 1000 working hours

This inspection must be done by a refrigeration specialist.

Works to be executed:

a) Check refrigeration system for leaks.
b) Check refrigeration lines and connections for tightness, leaks and mountings.
c) Renew contaminated refrigerant and refrigeration oil.
d) Renew filter drier.
e) Check the expansion valve.

f) Check function of high- and low pressure switch.
g) Check compressor for leaks capacity and mounting.
h) Check oil level.
i) Check function of capacity/ cylinder head unloader.
j) Check function and bearing of electro-magnetic-clutch.

k) Check condition of air conditioning housing, seals and locks.
l) Check principle of heating, ventilation, cooling.
m) Check function and condition of electric system.
n) Check function of thermostat and operating control.
o) Check fresh air- and return air-flaps.

p) Check v-belt pulleys, bearings and shaft lubricate.
Check v-belts for adjustment and wear.
q) Check liquid receiver for corrosion.

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