


Instruction manual for SAB 110

Screw compressor and unit may differ in equipment depending on their function and requirements.

Some of these variants are treated in this

instruction manual although they may **not** be fitted on your particular unit.

In the below table the x-mark indicates which variants are fitted on your unit with shop no. stated below.

Type of drive	Male drive <input type="checkbox"/>	Female drive <input type="checkbox"/>	SM <input type="checkbox"/>	SF <input type="checkbox"/>
	LM <input type="checkbox"/>	LF <input type="checkbox"/>		
Refrigerant	R717 <input type="checkbox"/>	R22 <input type="checkbox"/>	Other _____	
Shop no.				
Instrumentation	Instrument panel and manual regulation of V _i -slide			
	UNISAB II and manual regulating of V _i -slide			
Oil cooling	Water-cooled oil cooler		OWSG/OWRG	
	Water-cooled oil cooler		Type B	
	Refrigerant-cooled oil cooler		OOSI	
	Refrigerant injection in the compressor		HLI	
Economizer system (ECO-system)	Vessel type		HESS	
	Closed system and vessel type		EOSE	
	Open system and vessel type		SVER	
Ex-execution	Compressor and unit are  safeguarded			
Capacity indicator	A Visual capacity indicator			
	B Capacity indicator with position transmitter			

Preface

The aim of this instruction manual is to provide the operators with a thorough knowledge of the compressor and the unit and at the same time provide information about:

- the function and maintenance of the individual components;
- service schedules;
- procedure for dismantling and reassembling of the compressor.

This instruction manual draws attention to typical errors which may occur during operations. The manual states causes of error and explains what should be done to rectify the errors in question.

It is imperative that the operators familiarize themselves thoroughly with the contents of

this instruction manual to ensure a safe, reliable and efficient operation of the product as YORK Refrigeration is unable to provide a guarantee against damage of the product occurring during the warranty period as a result of incorrect operation.

Dismantling and assembly of compressors and components should only be carried out by authorized personnel to prevent accidents.

The contents of this instruction manual must not be copied or passed on to any unauthorized person without YORK Refrigeration's permission.

YORK Refrigeration's *General Conditions for the Supply of Components and Spare Parts* will apply.

In the space below you can enter the name and address of your local YORK Refrigeration Representative:

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First Aid for accidents with Ammonia

(Chemical formula: NH_3 - refrigerant no.: R717)

General

Ammonia is not a cumulative poison. It has a distinctive, pungent odour that even at very low, harmless concentrations is detectable by most persons. Since ammonia is self-alarming, it serves at its own warning agent, so that no person will voluntarily remain in concentrations which are hazardous. Since ammonia is lighter than air, adequate ventilation is the best means of preventing an accumulation.

Experience has shown that ammonia is extremely hard to ignite and under normal conditions is a very stable compound. Under extremely high, though limited concentrations, ammonia can form ignitable mixtures with air and oxygen, and should be treated with respect.

Basic rules for first aid

1. **Call a doctor immediately.**
2. **Be prepared:** Keep an irrigation bottle available, containing a sterile isotonic (0.9%) NaCl-solution (salt water).
3. A shower bath or water tank should be available near all bulk installations with ammonia.
4. When applying first aid, the persons assisting should be duly protected to avoid further injury.

Inhalation

1. Move affected personnel into fresh air immediately, and loosen clothing restricting breathing.
2. **Call a doctor/ambulance with oxygen equipment immediately**
3. Keep the patient still and warmly wrapped in blankets.
4. If mouth and throat are burnt (freeze or acid burn), let the conscious patient drink water, taking small mouthfuls.
5. If conscious and the mouth is not burnt, give hot, sweet tea or coffee (never feed an unconscious person).
6. Oxygen may be administered, but **only** when authorized by a doctor.
7. If breathing fails, apply artificial respiration.

Eye injuries from liquid splashes or concentrated vapour

1. Force the eyelids open and rinse eyes immediately for at least 30 minutes with the salt water solution just mentioned
2. **Call a doctor immediately.**

Skin burns from liquid splashes or concentrated vapour

1. Wash immediately with large quantities of water and continue for at least 15 minutes, removing contaminated clothing carefully while washing.
2. Call a doctor immediately.
3. After washing, apply wet compresses (wetted with a sterile isotonic (0.9%) NaCl-solution (salt water)) to affected areas until medical advice is available.

**No plant can ever be said to be too safe.
Safety is a way of life.**

First aid for accidents with HFC/HCFC

Refrigerant no.: R134a - R404A - R410A - R505A - R507 - R22, etc

General

HFC/HCFC form colourless and invisible gasses which are heavier than air and smell faintly of chloroform at high concentrations only. They are non-toxic, non-inflammable, non-explosive and non-corrosive under normal operating conditions. When heated to above approx. 300°C they break down into toxic, acid gas components, which are strongly irritating and aggressive to nose, eyes and skin and generally corrosive. Besides the obvious risk of unnoticeable, heavy gases displacing the atmospheric oxygen, inhalation of larger concentrations may have an accumulating, anaesthetic effect which may not be immediately apparent. 24 hours medical observation is, therefore, recommended.

Basic rules for first aid

1. When moving affected persons from low-lying or poorly ventilated rooms where high gas concentrations are suspected, the rescuer must be wearing a lifeline, and be under continuous observation from an assistant outside the room.
2. Adrenalin or similar heart stimuli must not be used.

Inhalation

1. Move affected person into fresh air immediately. Keep the patient still and warm and loosen clothing restricting breathing.
2. If unconscious, call a doctor/ambulance with oxygen equipment immediately.
3. Give artificial respiration until a doctor authorizes other treatment.

Eye injuries

1. Force eyelids open and rinse with a sterile isotonic (0.9%) NaCl-solution (salt water) or pure running water continuously for 30 minutes.
2. Contact a doctor, or get the patient to a hospital immediately for medical advice.

Skin injuries - Freeze burns

1. Wash immediately with large quantities of luke warm water to reheat the skin. Continue for at least 15 minutes, removing contaminated clothing carefully while washing.
2. Treat exactly like heat burns and seek medical advice.
3. Avoid direct contact with contaminated oil/refrigerant mixtures from electrically burnt-out hermetic compressors.

**No plant can ever be said to be too safe.
Safety is a way of life.**

Protecting the environment

Increasing industrialisation threatens our environment. It is therefore absolutely imperative that we protect nature against pollution.

To this end, many countries have passed legislation in an effort to reduce pollution and preserve the environment. These laws apply to all fields of industry, including refrigeration, and must be complied with.

Be especially careful with the following substances:

- refrigerants
- cooling media (brines etc)
- lubricating oils.

Refrigerants usually have a natural boiling point which lies a good deal below 0°C. This means that liquid refrigerants can be extremely harmful if they come into contact with skin or eyes.

High concentrations of refrigerant vapours are suffocating when they displace air; if high

concentrations of refrigerant vapours are inhaled they attack the human nerve system.

When halogenated gasses come into contact with open flame or hot surfaces (over approx. 300°C) they decompose to produce poisonous chemicals, which have a very pungent odour, warning you of their presence.

In high concentrations, R717 causes respiratory problems, and when ammonia vapour and air mix 15 to 28 vol. %, the combination is explosive and can be ignited by an electric spark or open flame.

Oil vapour in the ammonia vapour increases this risk significantly as the point of ignition falls below that of the mixture ratio stated.

Usually the strong smell of ammonia will give ample warning of its presence before concentrations become dangerous.

The following table shows the values for refrigerant content in air, measured in volume %. Certain countries may, however, have an official limit which differs from those stated.

		Halogenated refrigerants					Ammonia	
		HFC					HCFC	
		R134a	R404A	R407C	R410A	R507	R22	R717
TWA Time weighted average during a week	Unit							
	vol. %	0,1	0,1	0,1	0,1	0,1	0,1	0,005
Warning smell	vol. %		0,2					0,002

Further comments on refrigerants:

- If released to the atmosphere, halogenated refrigerants of the type HCFC (e.g. R22) may cause a depletion of the ozone layer in the stratosphere. The ozone layer protects the earth from the ultraviolet rays of the sun. Refrigerants of the types HFC and HCFC are greenhouse gases with contribute to an intensification of the greenhouse effect. They must, therefore, **never** be released to the atmosphere. Use a separate compressor to draw the refrigerant into the plant condenser/receiver or into separate refrigerant cylinders.
- Most halogenated refrigerants are miscible with oil. Oil drained from a refrigeration plant will often contain significant amounts of refrigerant. Therefore, reduce the pressure in the vessel or compressor as much as possible before draining the oil.
- Ammonia is easily absorbed by water:
At 15°C, 1 litre of water can absorb approx. 0,5 kg liquid ammonia (or approx. 700 litres ammonia vapour).
- Even small amounts of ammonia in water (2-5 mg per litre) are enough to wreak havoc with marine life if allowed to pollute waterways and lakes.
- As ammonia is alkaline it will damage plant life if released to the atmosphere in large quantities.

Refrigerant evacuated from a refrigerant plant shall be charged into refrigerant cylinders intended for this specific refrigerant.

If the refrigerant is not to be reused, **return** it to the supplier or to an authorized incinerating plant.

Halogenated refrigerants must never be mixed. Nor must R717 ever be mixed with halogenated refrigerants.

Purging a refrigeration plant

If it is necessary to **purge** air from a refrigeration plant, make sure you observe the following:

- Refrigerants must not be released to the atmosphere.
- When purging an R717 plant, use an approved air purger. The purged air must pass through an open container of water so that any R717 refrigerant remaining can be absorbed. The water mixture must be sent to an authorized incinerating plant.
- Halogenated refrigerants can **not** be absorbed by water. An approved air purger must be fitted to the plant. This must be checked regularly using a leak detector.

Cooling media

Salt solutions (brines) of calcium chloride (CaCl₂) or sodium chloride (NaCl) are often used.

In recent years alcohol, glycol and halogenated compounds have been used in the brine production.

In general, all brines must be considered as harmful to nature and must be used with caution. Be very careful when charging or purging a refrigeration plant.

Never empty brines down a sewer or into the environment.

The brine must be collected in suitable containers, clearly marked with the contents, and sent to an approved incinerating plant.

Lubricating oils

Refrigeration compressors are lubricated by one of the following oil types, depending on the refrigerant, plant type and operating conditions.

- mineral oil
- semi-synthetic oil

- alkyl benzene-based synthetic oil
- polyalphaolefine-based synthetic oil
- glycol-based synthetic oil.

When you change the oil in the compressor or drain oil from the refrigeration plant's vessels, always collect the used oil in containers marked "waste oil" and send them to an approved incinerating plant.

Note

This instruction provides only general information. The owner of the refrigeration plant is responsible for ensuring that all by-laws are complied with.

Description of compressor SAB 110

The SAB 110 is a screw compressor with oil injection and capacity regulating, from approx. 25% to 100%.

Existing types of SAB 110:

	L/D	Form/types of coupling
SAB 110S	1.2	M
SAB 110L	1.5	M
SAB 110S	1.2	F
SAB 110L	1.5	F

L/D indicates the ratio between the rotor lengths L and outer diameter D = 110 mm.

SAB 110 operates on either R717 or R22 refrigerants within the following operational limits:

Max. operational pressure: 25 bar

Max. differential pressure: 20 bar

Highest condensation temperature:

R717 +53°C

R22 +55°C

Highest evaporation temperature:

R717 and R22 +15°C

Lowest evaporation temperature:

R717 and R22 -55°C

- The electric motor is flanged directly to compressor, thus ensuring alignment to the compressor. The motor will not be part of the refrigerant circuit as with semihermetic compressor types. In this way the compressor can also be used for R717.

The electric motor is coupled to the rotor by means of a flexible coupling which can be connected to either **male rotor** (coupl-

ing form M) or **female rotor** (coupling form F).

For each of the two types of coupling there are two rotor sets:

Type S with L/D = 1.2 or type L with L/D = 1.5 respectively, corresponding to a total of 4 rotor sets.

Using **female drive** the compressor yields a 50% higher capacity and requires a correspondingly higher motor power than when using **male drive**.

- The rotors are designed with a so-called D-profile acc. to SRM licence, and with a ratio of 4+6. This means that the male rotor has 4 profile lobes and the female rotor 6 ones.

At the suction end the rotors are provided with roller bearings, while the bearings at the discharge end consist of a combined set of roller bearings which assimilate the radial load, and ball-bearings assimilating the axial load. The axial forces are partly equalized by rotating balance pistons mounted on the rotors.

- The compressor is equipped with a large built-in suction filter, effectively preventing dirt from the plant being carried along with the suction gas into the compressor. Further, the compressor has a combined suction pressure regulator and a non-return valve ensuring that the compressor always operates at a differential pressure between its discharge and suction side. Hereby an effective lubrication of the compressor is secured both on start-up and during operation.

At the same time the suction pressure regulator acts as non-return valve, preventing the rotors from running in reverse when current to the drive motor is switched off.

- The rotor shaft, to which the motor is connected is equipped with a shaft seal of the slide ring type. It consists of a stationary sealing ring, made of special carbon, fitted in the end cover of the compressor and sealed against same by means of an O-ring.

Fastened to the rotor shaft and pressed against the carbon ring by a spring system. A rotating cast iron ring seals against the carbon ring. The shaft seal is of the **balanced type**, which means reduced slide surface pressure and consequently prolonged life.

- The compressor capacity is regulated by means of the **regulating slide** valve underneath the rotors.

When the regulating slide valve moves away from its end stop in its 100% position, capacity is reduced steplessly, as part of the suction gas, between rotors, is not compressed.

The regulating slide valve is moved by a piston which via two solenoid valves is activated by the oil pressure in the unit. When in open position, one of the solenoid valves, **closed** at dead coil, adds oil pressure to the piston, hereby moving the regulating the slide valve towards a higher capacity.

The other solenoid valve, **open** at dead coil, carries, when open, oil from piston (cylinder) back to suction side of compressor. The result is that when the compressor is stopped and the two solenoid valves are dead, the regulating slide valve is moved to lowest capacity position by means of the built-in spring and the pressure behind the piston.

In this way the compressor is unloaded before next start-up.

- SAB 110 has a built-in regulating system by which the compressor volume ratio V_i can be adjusted manually. With the **V_i -system** the compression ratio of the compressor can be adjusted according to the plant pressures, before and after the compressor.

In this way over and under compression is avoided and the lowest possible energy consumption achieved.

- Further, the SAB 110 compressor has a built-in **combined oil filter** which, by means of a filter cartridge retains all particles bigger than 10 micron, and a magnetic filter in which any small iron particles are collected.

In connection with filter housing a **float valve** is built in, ensuring a constant oil flow to the compressor.

Likewise, a built-in **safety valve** safeguards the compressor against unacceptably high differential pressures from discharge to suction side.

Sound data for reciprocating and screw compressor units - all types of compressors

In the following tables the noise data of the compressors is stated in:

- A-weighted sound power level **LW**
(Sound Power Level)
- A-weighted sound pressure level **LP**
(Sound Pressure level)

The values for LW constitute an average of a large number of measurements on various units. The measurements have been carried out in accordance with ISO 9614-2.

The values are further stated as **average sound pressure in a free field above a reflecting plane** at a distance of **1 meter** from a fictional frame around the unit. See fig. 1.

Normally, the **immediate sound pressure** lies between the LW and LP values and can be calculated provided that the acoustic data of the **machine room** is known.

For **screw compressors** the average values are indicated in the tables for the following components.

- **SAB 128, SAB 163, SAB 202, SV and FV:**
Compressor block + IP23 special motor + oil separator.
- **SAB 110:**
Compressor block + IP23 standard motor + oil separator

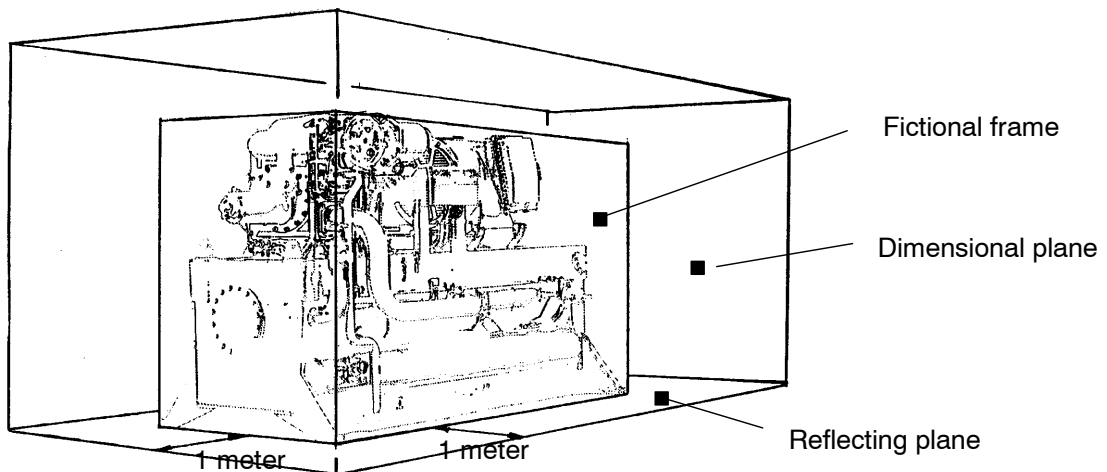
Dimensional tolerances are:

- ± 3 dB for SAB, SV and FV screw compressors
- ± 5 dB for VMY screw compressors

As to the **reciprocating compressors** the values are stated for the compressor block only.

The dimensional values are stated for 100% capacity.

Fig. 1



Note the following, however:

- at part load or if the compressor works with a wrongly set V_i the sound level can sometimes be a little higher than the one indicated in the tables.
- additional equipment such as heat exchangers, pipes, valves etc. as well as the choice of a different motor type can increase the noise level in the machine room.
- as already mentioned, the stated sound pressures are only average values above a fictional frame around the noise source. Thus, it is sometimes possible to measure higher values in local areas than the ones stated - for inst. near the compressor and motor.
- the acoustics is another factor that can change the sound level in a room. Please note that the sound conditions of the site have not been included in the stated dimensional values.
- by contacting SABROE you can have sound data calculated for other operating conditions.

The tables have been divided into reciprocating and screw compressors, respectively. The reciprocating compressors are further divided into one- and two-stage compressors as well as in a heat pump. In each table the operating conditions of the compressor during noise measuring have been stated, just as the refrigerant used has been mentioned.

RECIPROCATING COMPRESSORS

One-stage

Evaporating temperature = -15°C
 Condensing temperature = +35°C
 Refrigerant = R22/R717
 Number of revolutions = **1450 rpm.**

Compressor block	LW	LP
CMO 24	84	69
CMO 26	86	71
CMO 28	87	72
SMC 104 S	95	79
SMC 106 S	96	80
SMC 108 S	97	81
SMC 112 S	99	82
SMC 116 S	100	83
SMC 104 L	96	80
SMC 106 L	97	81
SMC 108 L	98	82
SMC 112 L	100	83
SMC 116 L	101	84
SMC 104 E	96	80
SMC 106 E	97	81
SMC 108 E	98	82
SMC 112 E	100	83
SMC 116 E	101	84

Evaporating temperature = -15°C
 Condensing temperature = +35°C
 Refrigerant = R22/R717
 Number of revolutions = **900 rpm.**

Compressor block	LW	LP
SMC 186	101	83
SMC 188	102	84

Two-stage

Evaporating temperature = -35°C
 Condensing temperature = +35°C
 Refrigerant = R22/R717
 Number of revolutions = **1450 rpm.**

Compressor block	LW	LP
TCMO 28	81	66
TSMC 108 S	95	79
TSMC 116 S	97	81
TSMC 108 L	96	80
TSMC 116 L	98	82
TSMC 108 E	96	80
TSMC 116 E	98	82

Evaporating temperature = -35°C
 Condensing temperature = +35°C
 Refrigerant = R22/R717
 Number of revolutions = **900 rpm.**

Compressor block	LW	LP
TSMC 188	100	82

Heat pump

Evaporating temperature = +20°C
 Condensing temperature = +70°C
 Refrigerant = R22/R717
 Number of revolutions = **1450 rpm.**

Compressor block	LW	LP
HPO 24	91	76
HPO 26	93	78
HPO 28	94	79
HPC 104	97	81
HPC 106	98	82
HPC 108	99	84

SCREW COMPRESSORS

Evaporating temperature = -15°C
 Condensing temperature = +35°C
 Refrigerant = R22/R717
 Number of revolutions = **2950 rpm.**
 *Number of revolutions = **6000 rpm.**

Compressor block	LW	LP
SAB 110 SM	98	81
SAB 110 SF	98	81
SAB 110 LM	98	81
SAB 110 LF	98	81
SAB 128 HM Mk2	102	84
SAB 128 HF Mk2	106	88
SAB 128 HM Mk3	101	84
SAB 128 HF Mk3	104	86
SAB 163 HM Mk2	105	86
SAB 163 HF Mk2	109	90
SAB 163 HM Mk3	103	86
SAB 163 HF Mk3	106	87
SAB 202 SM	104	85
SAB 202 SF	105	86
SAB 202 LM	104	85
SAB 202 LF	105	86
SV 17	100	83
SV 19	101	84
FV 19*	101	86
SV 24	103	85
FV 24*	104	86
SV 26	103	85
FV 26*	107	85
SAB 81	101	86
SAB 83	102	85
SAB 85	103	86
SV 87	105	86
SV 89	108	85

Evaporating temperature = -35°C
 Condensing temperature = -5°C
 Refrigerant = R22/R717
 Number of revolutions = **2950 rpm.**

Compressor unit	LW	LP
SAB 163 BM	106	88
SAB 163 BF	110	92

Evaporating temperature = -15°C
 Condensing temperature = +35°C
 Refrigerant = R22/R717
 Number of revolutions = **2950 rpm.**

Compressor block	LW	LP
VMY 347 H	97	82
VMY 447 H	100	85
VMY 536 H	104	88

Evaporating temperature = 0°C
 Condensing temperature = +35°C
 Refrigerant = R22/R717
 Number of revolutions = **2950 rpm.**

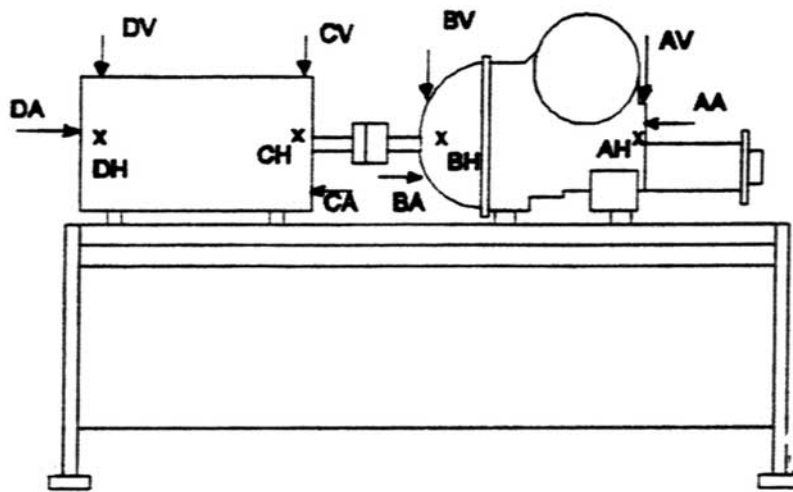
Compressor block	LW	LP
VMY 347 M	99	84
VMY 447 M	101	86
VMY 536 M	105	89

Vibration Data for Compressors - All Compressor Types

Vibration data for YORK Refrigeration's Sabroe **reciprocating** compressors complies with: **the ISO 10816, standard, Part 6, Annex A, group 4, AB**, which fixes max. permissible operating vibrations at 17.8 mm/s.

Vibration for YORK Refrigeration's Sabroe **screw** compressors complies with: **ISO 10816 standard, part 1, Annex B, Class III, C**, which fixes max. permissible operating vibrations at 11.2 mm/s.

The measurements are made as illustrated in the figure below (points A-D).



Pay attention to the following, however:

- Motors comply with EN 60034-14 (CEI/IEC 34-14) Class N.
- When placing the unit on the vibration dampers delivered by YORK Refrigeration (additional), the vibrations against the foundation are reduced by:
 - 85-95% for screw compressor units
 - 80% for recip. compressor units
- However, a higher vibration level may occur if:
 - motor and compressor have not been aligned as described in the Instruction Manual.
 - the compressor runs at a wrong V_i ratio. This applies to screw compressors.
 - the piping connections have been executed in a way that makes them force pull or push powers on the compressor unit or transfer vibrations to the unit caused by natural vibrations or connected machinery.
 - the vibration dampers have not been fitted or loaded correctly as indicated in the foundation drawing delivered together with the order.

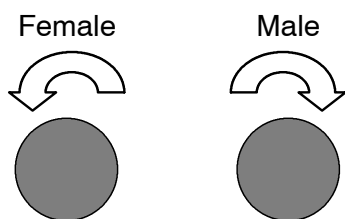
Handling of the compressor, areas of application, safety equipment etc.

Direction of rotation

In order to reduce the noise level from the electric motors these are often made with specially shaped fan wings, thus determining a particular direction of rotation.

Consequently, it is essential that the motor is ordered with the correct direction of rotation made for the compressor.

The direction of rotation of the compressor is indicated by an arrow cast into the compressor cover as shown on the following sketch. Please, notice that **male and female drive have different directions of rotation.**



Seen towards shaft ends

Handling of compressor and unit

For lifting of the compressor it has been equipped with a threaded hole for mounting of the lifting eye. As to the weight of the compressor, see table on **compressor data**.

Note:

The compressor block alone may be lifted in the lifting eye. The same applies to the motor.

The **unit** is lifted by catching the lifting eyes welded onto the unit frame. These have been clearly marked with red paint. The **weight** of the unit is stated on the package as well as in the shipping documents.

During transportation and handling care should be taken not to damage any of the components, pipe or wiring connections.

Areas of application of the screw compressors

Compressor types:

**SAB 110 SM/SF, SAB 110 LM/LF,
SAB 128 HM/HF,
SAB 163 HM/HF,
SAB 202 SM/SF, SAB 202 LM/LF,
VMY 536 M/B**

Application

In view of preventing an unintended application of the compressor, which could cause injuries to the operating staff or lead to technical damage, the compressors may only be applied for the following purposes:

- As a refrigeration compressor with a number of revolutions and with operating limits as indicated in this manual or according to a written agreement with SABROE.
- With the following refrigerants:
R717 - R22 - R134a - R404A - R507 - R600 - R600A - R290 - LPG
Other HFC refrigerants in accordance with SABROE's instructions.
All other types of gas may only be used following a written approval from SABROE.
- In an explosion-prone environment, provided the compressor is fitted with approved explosion-proof equipment.

The compressor must NOT be used:

- For evacuating the refrigeration plant of air and moisture,

- For putting the refrigeration plant under air pressure in view of a pressure testing,
- As an air compressor.

Emergency device

The compressor control system must be equipped with an emergency device.

In case the compressor is delivered with a SABROE-control system this emergency device is found as an integrated part of the control.

The emergency device must be executed in a way to make it stay in its stopped position, following a stop instruction, until it is deliberately set back again.

It must not be possible to block the emergency stop without a stop instruction being released.

It should only be possible to set back the emergency device by a deliberate act, and this set back must not cause the compressor to start operating. It should only make it possible to restart it.

Other demands to the emergency device:

- It must be possible to operate it by means of an easily recognizable and visible manual handle, to which there is free access.
- It must be able to stop any dangerous situation, which may occur, as quickly as possible without this leading to any further danger.

Combustion motors

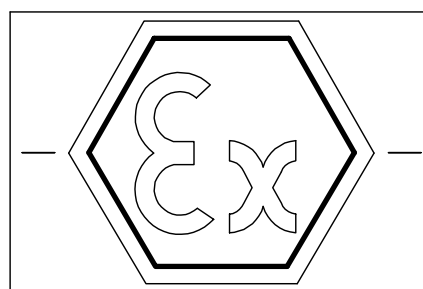
If combustion motors are installed in rooms containing refrigeration machinery or rooms where there are pipes and components containing refrigerant, you must make sure that the combustion air for the motor is derived from an area in which there is no refrigerant gas, in case of leakage.

Failure to do so will involve a risk of the lubricating oil from the combustion motor mixing with the refrigerant; at worst, this may give rise to corrosion and damage the motor.

Explosion-proof electrical execution

If the compressor is delivered in an explosion-proof electrical execution, this is stated in the table on page 1 of this instruction manual.

Likewise, the compressor will, besides the SABROE name plate, be equipped with an Ex-name plate like the one illustrated below.



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The temperature of tangible surfaces

When a compressor is working, the surfaces that are in contact with the warm discharge gas also get warm. However, the temperature depends on which refrigerants and under which operating conditions the compressor is working. Often, it exceeds 70°C which for metal surfaces may cause your skin to be burnt even at a light touch.

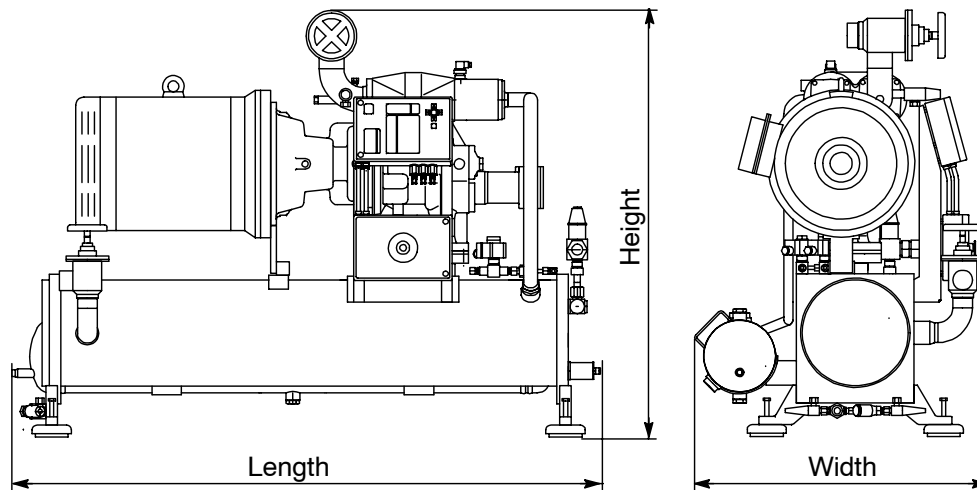
Consequently, the compressors will be equipped with **yellow warning signs** informing you that pipes, vessels and machine parts

close to the warning signs during operation are so hot that your skin may be burnt from 1 second's touch or longer.



Technical data for compressor & unit SAB 110

Dimensions and weight (without economizer)



T4840097_0

Compressor type	Refrigerant	Oil cooling system ¹⁾	Max. dimensions			Max. weight net Kg. ⁴⁾
			Width mm ²⁾	Length mm	Height mm ³⁾	
SAB 110	R22	Without oil cooler	750	1700	1310	400
		HLI				410
		B				415
		OOSI	800			490
	R717	HLI	750	1900		410
		OOSI	800			490
		OWSG	950			520

- 1) HLI = High stage liquid injection in the compressor (High stage Liquid Injection)
 B = Plate heat exchanger (water)
 OOSI = Shell and tube exchanger (refrigerant)
 OWSG = Shell and tube exchanger (water)

- 2) Incl. motor IEC 200
 3) Excl. vibration dampers
 4) Excl. motor, oil cooling system, oil, water and refrigerant

Compressor data SAB 110

Compressor type	Rotor drive	L/D 1)	Rotor Dia. ratio mm	Internal volume V_i	ΔP max. 2) bar	Motor at 2950 0/min		Motor at 3550 0/min	
						Male rotor 0/min	suct. vol. m^3/t	Male rotor 0/min	suct. vol. m^3/t
SAB 110 S-M	M	1.2	110	1.8 to 4.5	20	2950	140	3550	168
SAB 110 S-F	F					4425	209	5325	252
SAB 110 L-M	M	1.5				2950	175	3550	210
SAB 110 L-F	F					4425	262	5325	315

1) L/D =Rotor length divided by rotor diameter 2) Discharge pressure minus suction pressure

See permissible operating limits, however, in the following Operating Limits Diagrams

	Block weight without motor Kg
SAB 110 S SAB 110 L	150

Nominal capacity R22

Compressor type	Rotor drive	L/D	Motor at 2950 rpm		
			-40/-10°C kW ¹⁾	-40/35°C kW ²⁾	-10/35°C kW ²⁾
SAB 110 S-M	M	1.2	33.0	21.4	81.1
SAB 110 S-F	F		50.0	33.5	126
SAB 110 L-M	M	1.5	41.7	27.1	102
SAB 110 L-F	F		63.2	42.3	159

Nominal capacity R717

Compressor type	Rotor drive	L/D	Motor at 2950 rpm		
			-40/-10°C kW ¹⁾	-40/35°C kW ²⁾	-10/35°C kW ²⁾
SAB 110 S-M	M	1.2	24.2	19.2	78.0
SAB 110 S-F	F		36.5	29.9	121
SAB 110 L-M	M	1.5	30.5	24.3	98.6
SAB 110 L-F	F		46.2	37.9	153

Based upon: Suction gas overheating 10 K

Above performance values apply for standard units

Liquid undercooling:

1) 0 K for Booster operation

2) 5 K for high pressure operation

Operating limits, general

The recommended operating limits for the compressor when using R717, R22, R134a, R404A/R507 and R407C are illustrated in the following diagrams.

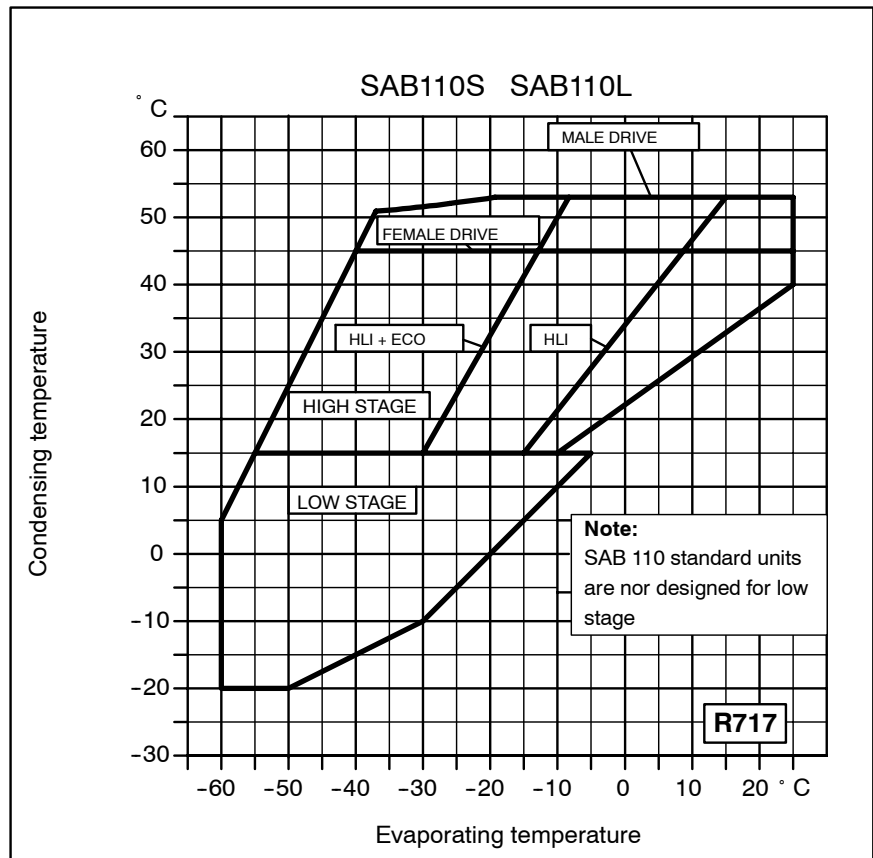
With respect to the graphs, please note the following:

- The upper operating limits apply to **Male** and **Female Drive** as appropriate (please

refer to page 1 for your particular compressor type) .

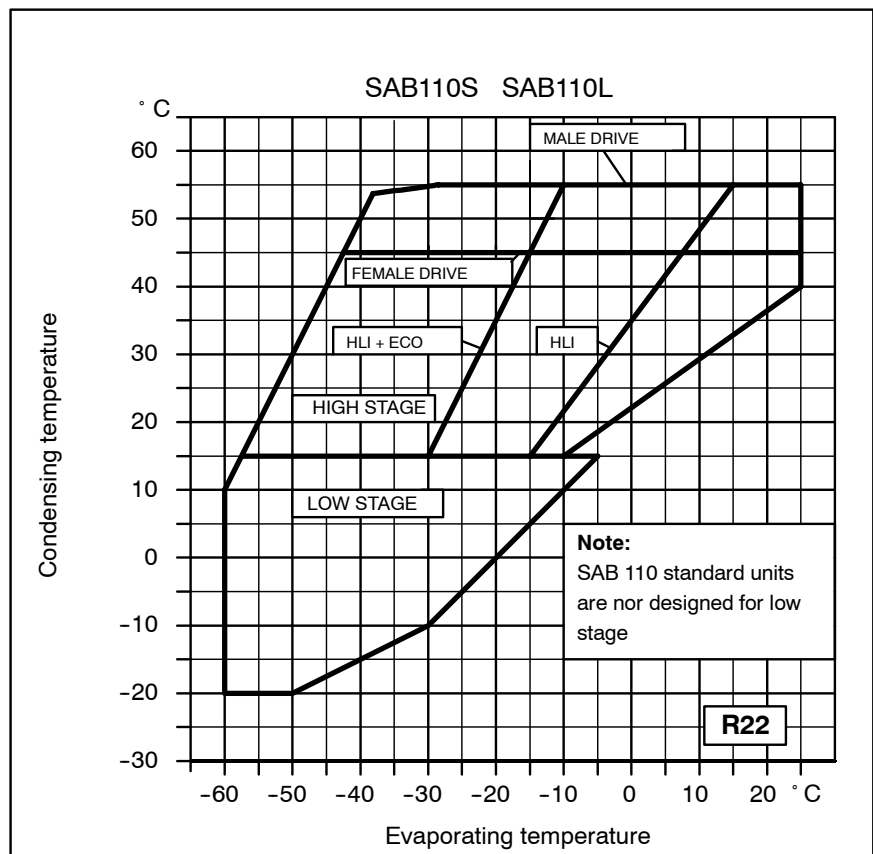
- Note extended operating limits if the compressor is provided with the following extra equipment:
 - HLI (**H**igh stage **L**iquid **I**njection)
 - HLI + economizer together
- Economizers can be used within the entire operating area in which the compressor is permitted to work.

**Operating limits
R717**



(T250839_0)

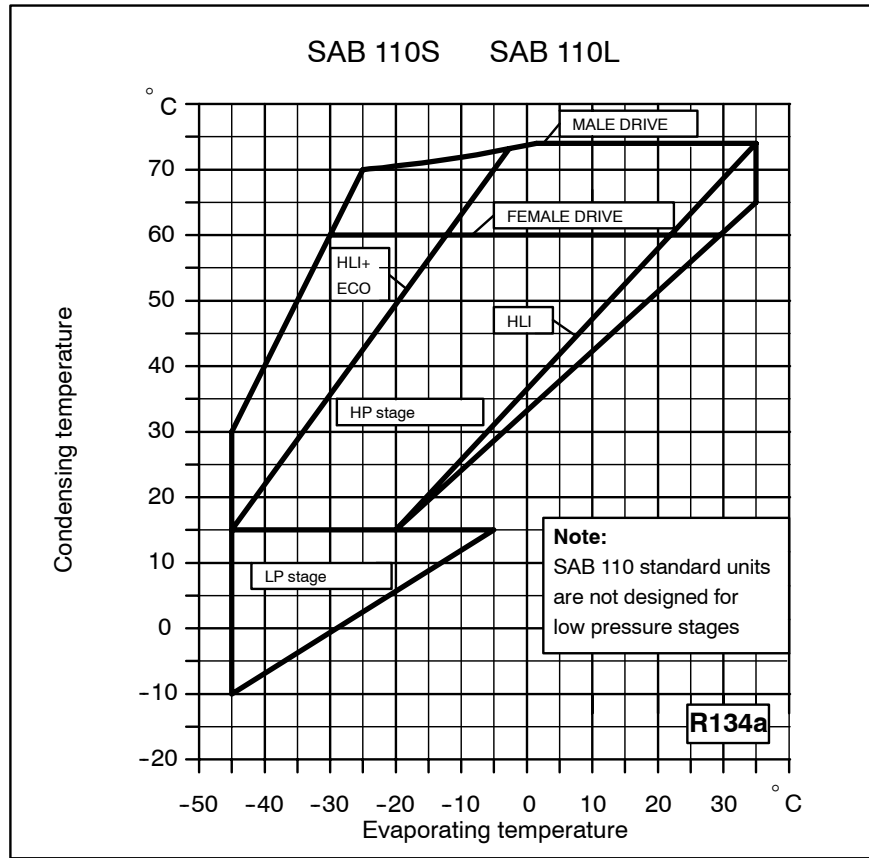
**Operating limits
R22**



(T250837_0)

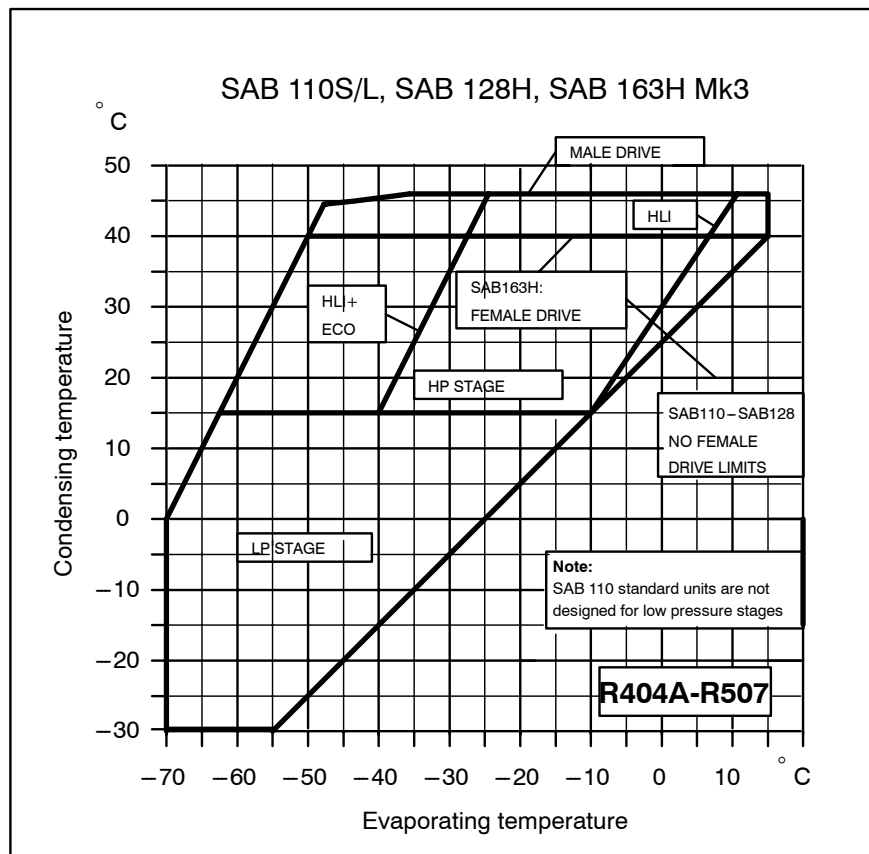
**Operating limits
R134a**

(T250820_1)

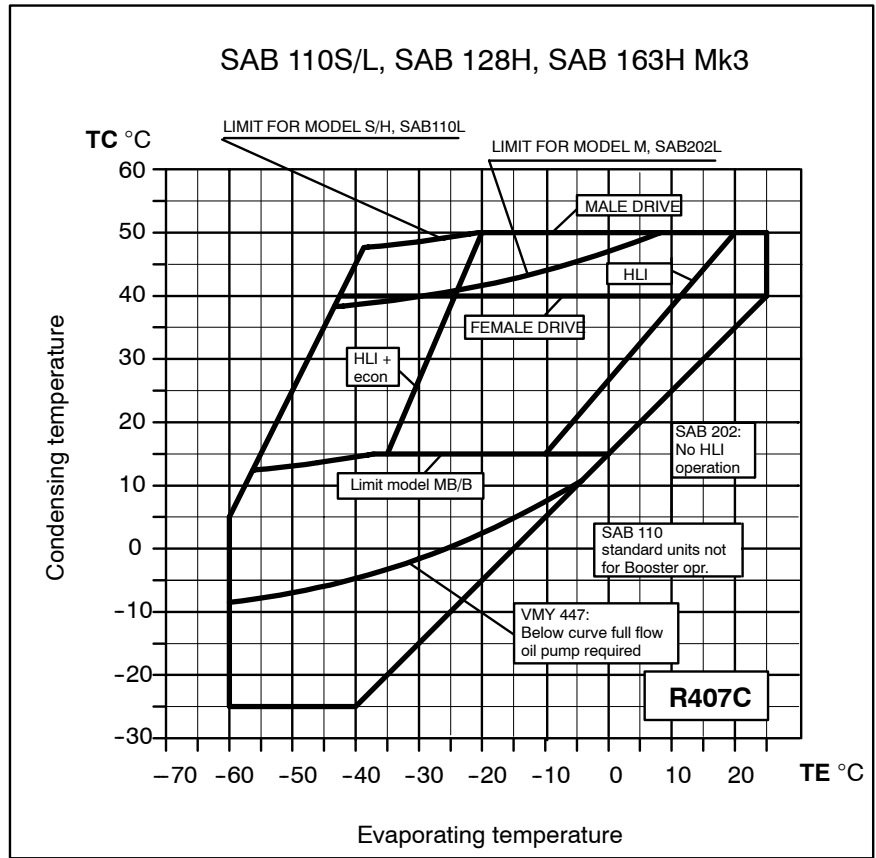


**Operating limits
R404A - R507**

(T250829_2)



**Operating
limits
R407C**



(T250133_1)

Compressor and unit operation SAB 110

During operation of compressor, below points must be observed. These are described in detail in the following sections.

1. Preparations before starting up.
2. Initial start.
3. Normal start.
4. Current control conditions at normal operation (only for units with **instrument panel**).
5. Normal stop.
6. Emergency stop or incorrect settings.
7. Preparations before a lengthy standstill period.

1. Preparations before starting up

After installing compressor unit in its final place and after establishing all connections for refrigerant, water and electricity, instruments and safety switches, the following must be carried out:

- a) Check that rotating direction of motor is correct. The rotating direction is marked with an arrow on the suction cover of the compressor and depends on whether the motor is connected to **male** or **female** rotor.

Check rotating direction of motor by dismantling end cover of motor so that the fan becomes visible.

By briefly supplying electricity to the motor the rotating direction is observed.

- b) For units with **instrument panel** check function of safety switches in order to ensure that they can stop the motor. Ad-settings for the safety switches appear

from the table on *Temperature and pressure Settings*.

- c) Connect a vacuum pump to valve Pos. 24 and evacuate unit to a vacuum of approx. 4-5 mm Hg. If necessary, use a thermostatic vacuum gauge for measuring of pressure, and charge **dry air** or **nitrogen** until pressure reaches 1 bar. Then evacuate again to 4-5 mm Hg.
- d) Charge with new oil of a quality prescribed in the oil instruction. Connect oil hose to valve Pos. 47. Charge new oil until oil level becomes visible in the upper part of the top sight glass. The amount of oil appears from the table on *Oil charges*. With the compressor in operation, **recharging** of oil may be done through valve pos. 62, positioned between suction stop valve pos. 20 and the compressor. By throttling the suction stop valve pos. 20 to e.g. 0.5 atm. and by connecting valve pos. 62 to the oil tin with a hose, the oil can be sucked into the compressor with valve pos. 62 open. **Take care** not to drain the oil tin completely, or air will be sucked into the plant.
- e) Open all internal valves.
- f) Carefully open suction stop valve thus admitting refrigerant gas from suction side into the unit. Make sure that rotors are kept still during the gas flow.
- g) Once the pressure in the unit is equal to pressure on suction side, open suction valve completely and also open discharge stop valve, after which the unit is ready for start-up.

During the whole procedure watch out for leakages.

2. Initial start-up

- a) If the compressor is not started within a period of 3 months after having been tested at SABROE, the shaft seal **must** be taken apart and lubricated with refrigeration oil. This eliminates the risk of leakage at the O-rings and to damage the slide surfaces.
- b) Check oil level in oil separator.
- c) Open suction stop valve/discharge stop valve completely. Open all other internal valves.
- d) Check free access for cooling water to oil cooler, if any.
- e) Check for power to the compressor control- and security systems.
- f) On units with instrument panel, reset buttons must be depressed for all safety switches and all control lamps must indicate that everything is in order.
- g) For units with instrument panel and minimum switch, check that capacity regulation is in "minimum" position and that the minimum switch is activated.
- h) Check position of V_i -slide in accordance with the desired operating conditions the and diagram in this instruction manual.
- i) Set change-over switch to manual and activate starter switch.
- j) Check for abnormal sounds. If nothing abnormal is noticeable, allow the compressor to run at normal operating pressure and set capacity regulation to the desired capacity value or to automatic operation. Keep a constant check on pressures, temperatures and power consumption.
- k) Do not leave compressor for the first 15 minutes.

3. Normal start-up

- a) Check oil level.
- b) Open suction and discharge stop valves.
- c) Set cooling to oil cooler, if any.
- d) Switch on current to unit.
- e) Reset all pressure controls and thermostats for units with instrument panel.
- f) Start compressor.
- g) Check all pressure and temperature measuring devices for units with instrument panel.
- h) Once the compressor has reached the desired operating conditions, capacity regulation may be set on **automatic operation** or **manual operation** so that capacity of the compressor corresponds to the actual capacity of the plant.
- i) Do not leave compressor for the first 15 minutes.

4. Current control at normal operation

For units with **instrument panel** the following should be noted daily:

- suction pressure (bar)
- suction temperature (°C)
- discharge pressure (bar)
- discharge pipe temperature (°C)
- oil temperature (°C)
- current consumption (amp.)
- number of service hours
- position of V_i -slide
- Oil level

5. Normal stop

- regulate compressor down to minimum capacity
- set change-over switch to stop
- shut off oil cooling.

6. Emergency stop or incorrect setting

Units with instrument panel

Safety switches, pressure controls and thermostats are fitted in order to stop the compressor in case of malfunctioning.

The unit can be equipped with the following safety equipment, depending on order specification:

High pressure cut-out KP5 with reset.

Low pressure cut-out KP1 possibly with reset (additional equipment)

- Oil thermostat KP79 with reset (to be applied only in connection with oil cooler types: OWSG/OWRG, type B or OOSI)
- Discharge pipe thermostat KP 79 for HLI cooling. Discharge pipe thermostat KP 81 for units fitted with oil cooler types OWSG/OWRG, type B or OOSI.
- Differential oil pressure cut-out type Arlon for measuring of pressure drop through the oil filter.
- Oil flow switch built into compressor block.

All these devices will stop the compressor whenever their set value is exceeded.

Do not restart compressor until the cause of the stoppage has been found and any malfunction has been rectified.

Units with UNISAB II control:

Consult separate instruction manual for this control system.

7. Preparations before a lengthy stand-still period

- Close main stop valve after receiver and evacuate evaporators. If necessary, adjust low pressure cut-out of unit to stop compressor at a lower pressure.
- Allow temperature in evaporators to rise and repeat evacuation.
- Once the suction pressure has been reduced to slightly above atmospheric pressure, stop compressor and close suction and discharge stop valves.
- Shut off oil and condenser cooling. If a risk of freezing exists drain off cooling water.
- Disconnect power supply to master and control circuits.

Pressure testing of the refrigeration plant

Before charging refrigerant to plant it **must** be pressure tested and evacuated.

Pressure test the plant using:

- **Dry** air. - pressurized cylinder containing dry atmospheric air may be used. - **Never** oxygen cylinders.
- air compressor for high pressure.
- nitrogen

Important

Do not use the plant's compressors for pressurizing plant. Do not use water or any other fluids for pressure testing.

In case nitrogen is employed, it is important to place a reduction valve with pressure

gauge between the nitrogen cylinder and the plant.

During pressure testing, it is important that pressure transducers and other control equipment are not exposed to the testing pressure. Likewise, compressor stop valves must be closed during pressure testing.

Plant safety valves must normally be blanked off during pressure testing as their opening pressure is lower than the testing pressure.

Important

During this pressure testing, no persons are allowed in the rooms with plant components or in the vicinity of the plant outside the rooms.

- The entire plant should be strength tested according to the local rules for pressure testing.

Attention is drawn to the fact that the compressor is strength tested to a maximum of **21 bar** in the compressor house.

- Then reduce the pressure to **10 bar** for **24 hours** - as an initial leak testing - as a tight plant will maintain the same pressure throughout this period.

During the leak testing, people are allowed to enter the rooms and approach the plant.

- As second leak test, examine all weldings, flange joints etc. for leakages by applying soapy water, while at the same time maintaining the 10 bar pressure.

Make a pressure test report on the pressure testing with the following minimum content:

- date of pressure testing
- who carried out the testing

- comments

Evacuation of refrigeration plant

After pressure testing the refrigeration plant must be evacuated in order to remove atmospheric air and moisture. Evacuation must be carried out on all types of refrigeration plant regardless of type of refrigerant to be charged into the plant.

The boiling point of a liquid is defined as the temperature at which the steam pressure is equal to atmospheric pressure.

The boiling point of water is 100°C. If the pressure is lowered, so is the boiling point of the water.

The below table indicates the boiling points of water at very low pressures:

Boiling point of water °C	At pressure mm HG
5	6,63
10	9,14
15	12,73
20	17,80

For evacuation, use a vacuum pump which bleeds the plant of both air and moisture.

The vacuum pump must be able to lower the pressure to approx. 0.1 mm Hg (mercury column) and it must be equipped with gas ballast valve. Use this valve to the greatest extent possible in order to prevent condensation of moisture in the vacuum pump.

Important

Never use refrigerating compressor to evacuate the plant.

In order that an evacuation may be satisfactory, the final pressure must be below 5 mm Hg. Please, observe that there is a risk of

any water left in the plant freezing in case the ambient temperatures are lower than 10°C. In such case, it is necessary to admit heat to the ambience of the components as evaporation of any ice formation can be difficult.

It is recommended that evacuation be carried out as follows:

- Evacuate to a pressure below 5 mm Hg.
- Then blow dry air or nitrogen into the system to reach a pressure corresponding to atmospheric pressure

Never use oxygen bottles

- Evacuate again to a pressure below 5 mm Hg.
- Shut off the vacuum pump from the refrigeration plant and check that pressure

does not rise within the next few hours. If water is still present in the system, it will evaporate and cause a pressure rise. In that case evacuation will be unsatisfactory and must be repeated.

Operating log

For regular checking of operating status of compressor and refrigeration plant, it is recommended to keep an operating log.

This operating log should be kept regularly and may contain useful information about the cause of any unwanted changes in operating conditions.

The following table is an example of an operating log and must as a minimum contain the following:

Observation	Place of measuring	Measuring unit
Time	<ul style="list-style-type: none"> Hour counter/Clock 	Date and hour
Suction pressure	<ul style="list-style-type: none"> Compressor manometer UNISAB II 	°C or bar
Discharge pressure	<ul style="list-style-type: none"> Compressor manometer UNISAB II 	°C or bar
Pressure fall through oil filter	<ul style="list-style-type: none"> For compressor with manometer an indicator is fitted on compressor UNISAB II 	bar
Oil temperature	<ul style="list-style-type: none"> Thermometer UNISAB II 	°C
Suction gas temp.	<ul style="list-style-type: none"> Thermometer in suction line just before the compressor (Additional equipment) UNISAB II 	°C
Discharge gas temp.	<ul style="list-style-type: none"> Thermometer on the oil separator UNISAB II 	°C
Oil level	<ul style="list-style-type: none"> Oil level glasses on oil separator 	Must be visible in oil level glasses
Recharging of oil to compressor	<ul style="list-style-type: none"> Please refer to the section <i>Oil charges</i> 	number of litres
Ampere consumption of compressor motor	<ul style="list-style-type: none"> Electric board UNISAB II (additional equipment) 	Amp.

At the same time attention should be drawn to the following
(could be checked off in the log):

- whether the cooling system of the compressor works properly
- whether there is any unusual noise coming from the compressor
- whether there are any unusual vibrations in the compressor

Service Schedules for screw compressors

SAB 110, 128/163 Mk3, 202 & VMY

Good and careful servicing of the compressor and the unit is of great importance for their proper functioning and service life.

It is therefore recommended that these service instructions be followed; based on the number of operating hours, they indicate the service tasks to be carried out.

Preparations before compressor inspection

Before dismantling any part of the compressor or unit for inspection or repair, **the pressure must be reduced to atmospheric pressure**. This is done as follows:

- Regulate the compressor down to its lowest capacity stage and stop it.
- Now close all stop valves in the pipe connections to the unit except for the suction stop valve pos. 20, which remains open until the pressure in the unit has been equalized to the suction pressure. This is described in the passage called *The non-return valve*.
- Close suction stop valve pos. 20.
- Any excess pressure in the unit is equalized to atmospheric through stop valve pos. 24. See the "Key to Piping Diagrams" and the chapter on: *Protecting the Environment*.

The heating element in the oil separator must remain connected until the pressure is completely equalized, thus *boiling* the refrigerant out of the oil.

- Remove **main fuses** for the compressor motor in order to prevent it from starting inadvertently.

Compressor and unit are now ready for inspection and dismantling, if required.

Replacement of oil filter

In case only the oil filter has to be replaced, follow below procedure depending on the type of your compressor:

SAB 110, SAB/163 and SAB 202

Above-mentioned compressors all have built-in oil filters.

Follow the procedure described in the previous passage: *Preparations before compressor inspection*.

Remove oil filter as described in section: *Maintenance of the compressor*.

VMY with external oil filter

As the units may be fitted with one or two oil filters (mounted in parallel) apply procedures **A** or **B**.

A: Units with one oil filter only

- Bring compressor to minimum capacity, and stop it.
- When pressure in unit is equalized to suction pressure, close stop valves **before** and **after** oil filter.
- Any over pressure in filter housing is equalized to atmospheric pressure through the evacuation valve on filter housing.
- Cover on filter housing can now be dismantled, as described in section *Oil filter*.

B: Units with two parallel oil filters

- While the compressor is operating, the stop valves **before** and **after** one of the oil filters must be closed.
- Over pressure in filter housing is equalized to atmospheric pressure through evacuation valve on filter housing.
- Cover on filter housing can now be dismantled, as described in section *Oil filter*.

Cleansing of oil in the unit

The most critical time for an oil filter is, however, right after initial start-up of compressor.

Although an effort should be made to keep the plant free of any impurities when assembled, experience shows that it may be difficult to avoid impurities in tubes and vessels.

These impurities will be conveyed by the suction gas to the suction filter, where large-sized impurities are intercepted. Smaller impurities will pass through the filter and be conveyed to the oil separator, where they are suspended in the oil. From here they are tak-

en to the lubricating system of the unit and absorbed by the oil filter.

These impurities may result in a need to change the oil filter cartridge shortly after initial start-up.

It is equally important to check the oil at regular intervals as specified in the sections *Checking the oil* and *Assessing the oil*.

Purification of the oil may be done by means of a 3 micron filter in a **closed system**.

During this process, the oil must not come into contact with the oxygen and moisture in the air.

In addition, it is important that all pressures and temperatures be kept within the specified values and that filters be kept clean; provided inspection is carried out to the schedules prescribed below, compressor and unit will work efficiently and achieve a long service life.

The following charts indicate the schedules for **checking the oil** in the compressor unit and a more detailed description of the operations to be performed during scheduled service inspections.

Checking the oil

Operating hours between main inspections See chart for main inspections						Service schedules Number of operating hours from initial start-up and after each main inspection (see footnote)
20000h		30000h		40000h		
*	R717	*	R717	*	R717	
						50
•	•	•	•	•	•	200
•	•	•	•	•	•	1000
•	•	•	•	•	•	2500
•	•	•	•	•	•	5000
•	×	•	×	•	×	10000
×	•	×	•	×	•	15000
⊕	⊕	•	×	•	×	20000
		•	•	•	•	25000
		⊕	⊕	×	×	30000
				•	•	35000
				⊕	⊕	40000

- It is advisable to assess the oil as described in the following chart.
 - ×
 - ⊕ The oil charge must be replaced with fresh oil.
 - ▨ Service schedules after initial start-up of compressor.
 - ▩ Service schedules after each main inspection.
- If this assessment is not made, the oil charge **must** be replaced with fresh oil.

NB:

It is not advisable to reuse oil drawn from compressor or plant. This oil has absorbed the moisture in the air and is likely to cause operating problems.

Always turn off the power to the heating rod before draining off the oil.

Activities during a service inspection

	Periodic service	Activity
1	Daily	1.1 External inspection and leak check. 1.2 Check the oil level in the oil separator. 1.3 Check pressures and temperatures. 1.4 Check for unusual vibrations or noise. 1.5 Record operating data in the log book.
2	After 50 hours' operation	2.1 Clean the suction filter.
3	After 200 hours' operation	3.1 Clean the compressor suction filter. 3.2 Take an oil sample from the oil separator and appraise it visually, or send the sample to a laboratory for analysis. Both methods are described in the section entitled <i>Assessing the oil</i> . 3.3 Replace the filter cartridge in the oil filter, unless it has been replaced earlier. 3.4 Clean all other oil filters and connections to and from the compressor. 3.5 Check the coupling and its alignment (SAB 110*) 3.6 Check that all screws and nuts have the correct torque.
4	After 1000 hours' operation	4.1 Clean the compressor suction filter. 4.2 Take an oil sample from the oil separator and appraise it visually, or send the sample to a laboratory for analysis. Both methods are described in the section entitled <i>Assessing the oil</i> .
5	After 2500 hours' operation	5.1 Clean the compressor suction filter. 5.2 Take an oil sample from the oil separator and send it to a laboratory for analysis, as described in <i>Assessing the oil</i> . 5.3 Fit a new oil filter cartridge. 5.4 Clean all other oil filters and connections to and from the compressor. 5.5 Check the coupling and its alignment (SAB 110*) 5.6 Check that the pressure switches and thermostats function correctly (refer to the set values in the instruction book). If UNISAB II computerized control is fitted, check the transducers (see the instruction manual for UNISAB II)

* Check the elastic intermediate part to see whether there are any visible oblique cracks in the rubber part. If such cracks are observed, replace the intermediate part.

Periodic service		Activity
6	<p>After 5000 hours. operation</p> <p>This service should be repeated after every 5000 hours of operation</p>	<p>6.1 Clean the compressor suction filter.</p> <p>6.2 Fit a new oil filter cartridge.</p> <p>6.3 Clean all other oil filters and connections to and from the compressor.</p> <p>6.4 Check the coupling and its alignment (SAB 110*)</p> <p>6.5 Check that the pressure switches and thermostats function correctly (refer to the set values in the instruction manual). If UNISAB II computerized control is fitted, check the transducers (see the instruction manual for UNISAB II)</p> <p>6.6 Take an oil sample from the oil separator and send the sample to a laboratory for analysis, as described in the section entitled <i>Assessing the oil</i>. Please also refer to the table entitled <i>Checking the oil</i>.</p>
7	<p>Major service</p> <p>Carried out as specified for the individual screw compressor type. (See the diagram for major service)</p>	<p>7.1 Total overhaul of the compressor, including fitting new gaskets. As the compressor is already open, inspect the bearings and, if necessary, fit new ones. Check the regulating system.</p> <p>7.2 Overhaul and clean the compressor motor. N.B. <i>Follow the service schedule specified by the motor manufacturer.</i></p> <p>7.3 Fit a new oil filter cartridge.</p> <p>7.4 Drain off the compressor oil and charge with new, fresh oil.</p> <p>7.5 Check the coupling and its alignment (SAB 110*)</p> <p>7.6 Check that the pressure switches and thermostats function correctly (refer to the set values in the instruction book). If UNISAB II computerized control is fitted, check the transducers (see the instruction manual for UNISAB II)</p>

* Check the elastic intermediate part to see whether there are any visible oblique cracks in the rubber part. If such cracks are observed, replace the intermediate part.

Assessing the oil

Oil in refrigeration plants is a vital part of the compressor, as it not only lubricates and cools the movable parts of the compressor, it also prevents abrasive particles from entering the bearings.

An analysis of the oil can give important information on how the compressor is running. We would, therefore, advise that the **oil analyses** be carried out at the intervals prescribed.

An oil sample must be drawn off while the compressor is in operation, which gives a **representative** sample. Before taking the sample, clean the drain valve and tap a little oil off, to prevent any impurities which may have accumulated in the valve or the piping from mixing with the sample.

Visual assessment

If you pour the sample into a clean, transparent glass bottle or a test-tube and hold it up to a clear light source, it will be easy to assess the quality. You can also compare the sample with the fresh oil of the same make and grade.

An oil which you approve on the grounds of a visual assessment must:

- be clear and shiny
- not contain any visible particles
- feel viscous, smooth and greasy when a drop is rubbed between two fingers.

If you don't feel that you can approve the oil by visual assessment, charge with new oil or send a sample to a laboratory for **analysis**.

Warning

If the oil sample is poured into a glass bottle, this must not be hermetically sealed until all the refrigerant in the oil sample has evaporated. Refrigerant in the oil may produce excess pressure in the bottle with subsequent risks of explosion. Never fill a bottle up completely. Do not send glass bottles through the postal service - use purpose-made plastic bottles. Please see below.

Analytical evaluation

Naturally, the oil sample can be analysed by the oil company which supplies the oil.

As a **special offer to our customers**

YORK Refrigeration has developed an analytical concept, which is able to analyse all oil makes. This will mean a uniform reporting of the results.

The analysis allows the following to be determined:

- Whether or not the oil is still usable, if necessary after filtering.
- Whether solid particles possibly present in the oil originate from the bearings or other components exposed to wear and tear in which case the compressor must be inspected.
- Each report will include the corresponding measuring results from **the previous 3 oil analyses**. In this way you will be able to follow up on the state of both the oil and the compressor from one analysis to the next.

Procedure

- A form set with a plastic sampling bottle and a dispatching envelope can be requested from the local YORK Refrigeration representative.
- The oil sample must be drained from the cleaned oil drain valve into the sample bottle. Screw the lid loosely on and let the bottle stand for a few hours to enable refrigerant contained in the oil sample to evaporate before sending it to the laboratory.
Do not fill the bottle completely.

- Please follow the *Sampling and Shipping Instructions* enclosed in the form set in which the address of the laboratory in Holland are also mentioned.

Analysing the oil

The following table states some average values that can be applied in practice. However, you should be on the alert whenever the results of the analyses approach these values. In some cases the water content of 100 ppm in HCFC plants may be too much and thus lead to Cu-plating in the shaft seal.

Limiting values

Parameter	Unit	Metode	Sabroe Olie PAO 68			Sabroe Olie AP 68			Sabroe Olie A 100		
			Spec. Værdi	Max.	Min.	Spec. Værdi	Max.	Min.	Spec. Værdi	Max.	Min.
Viskositet @ 40°C	cSt	ASTM D 445	66	76	53	64	74	51	100	115	80
TAN *1)	mg KOH/g	ASTM D 664	0,03	0,2	-	0,01	0,2	-	0,05	0,2	-
SAN * 2)	mg KOH/g	ASTM D 665	-	0	-	-	0	-	-	0	-
Vand	ppm	Karl Fisher	-	100	-	-	100	-	-	100	-
Udseende	-	-	rapport			rapport			rapport		
Farve	-	ASTM D 1500	rapport			rapport			rapport		
Uopløseligt Pentan	W%	MM 490 (5µm)	-	0,05	-	-	0,05	-	-	0,05	-
Oxidering	abs/cm	IR,1700-1720 /cm	-	5	-	-	5	-	-	5	-
Nitrering	abs/cm	IR,1627-1637 /cm	-	5	-	-	5	-	-	5	-
Kvælstofforbindelser	abs/cm	IR,1547-1557 /cm	-	0,5	-	-	0,5	-	-	0,5	-
Max. værdier for metalindhold i olien											
Bly	ppm	ICP	-	10	-	-	10	-	-	10	-
Kobber	ppm	ICP	-	10	-	-	10	-	-	10	-
Silicium	ppm	ICP	-	25	-	-	25	-	-	25	-
Jern	ppm	ICP	-	100	-	-	100	-	-	100	-
Krom	ppm	ICP	-	5	-	-	5	-	-	5	-
Aluminium	ppm	ICP	-	10	-	-	10	-	-	10	-
Tin	ppm	ICP	-	10	-	-	10	-	-	10	-

1): TAN (Total Acid Number/ Total Syretal) rapporteres kun for
2): SAN (Strong Acid Number/Stærk Syretal) rapporteres kun

for anlæg, hvor ammoniak ikke anvendes anlæg, hvor ammoniak ikke anvendes

A report is drawn up for every sample received. This report concludes:

- Whether the oil can still be used - without taking any further action.
- Whether the oil can be used after it has been filtered through a very fine filter. If this is necessary, the oil must be pumped directly from the compressor unit through a 3 micron filter and back to the unit. The

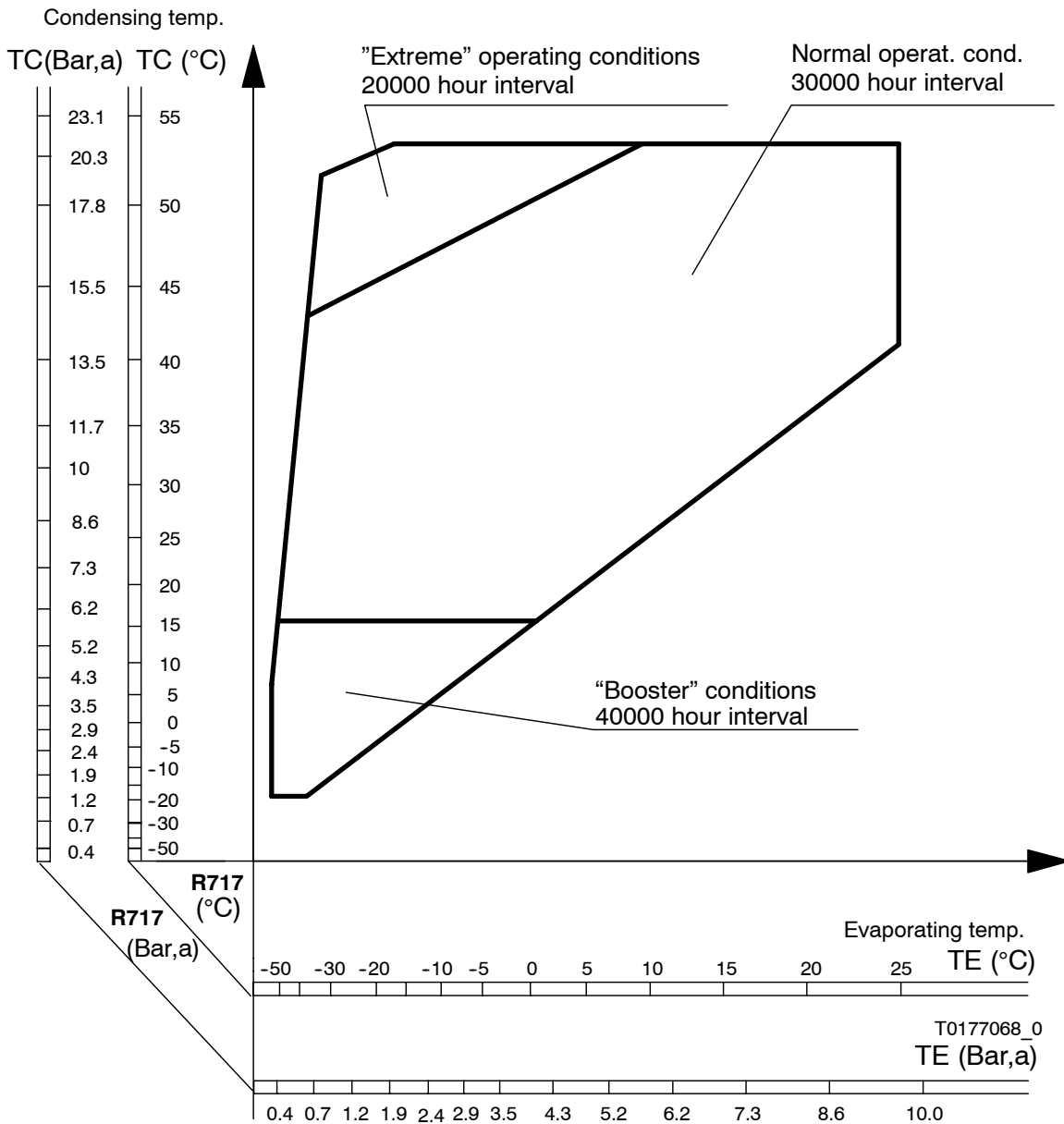
system must be completely closed, to prevent the oil being affected by moisture in the air.

- Whether the oil is no longer fit for use.

The report will always be sent to the address stated on the sample label included in the form set. A copy will be sent to YORK Refrigeration so that we are in a position to advise you, if required.

Major Service Intervals

SAB 110, SAB 128/163 Mk3, SAB 202



0178-030-EN 95.10

Oil charges, Weights and Shipping Volumes SAB 110

Oil charge (Oil level visible in the middle of the upper sight glass during operation)

Shipping Volume (incl. motor IEC 225M)

Oil cooler	Oil Separator Liter	Compr. Liter	Oil filter Liter	Oil cooler Liter	Tubing Liter	Unit total Liter
OOSI 1614	OHU 3015: 38	2	3	8	2	53
OOSI 2114	OHU 3015: 38			15		60
OWSG 1615	OHU 3015: 38			17		62
OWSG 2115	OHU 3015: 38			28		73
B 25	OHU 3015: 38			1		46
HLI	OHU 3015: 38			0		45

Compressor type	Unit with oil separator M ³
SAB 110	OHU 3015
	2.5

Weight (excl. motor, refrigerant, oil and water)

Oil cooler	Oil separator Kg	Compr.. Kg	Fittings Kg	Oil cooler Kg	Unit total Kg
OOSI 1614	OHU 3015:200	150	100	95	545
OOSI 2114	OHU 3015:200			150	600
OWSG 1615	OHU 3015:200			120	570
OWSG 2115	OHU 3015:200			185	635
B 25	OHU 3015:200			15	465
HLI	OHU 3015:200			20	470

Economizer HESS	Weight Kg
131746	64
161736	103

0177-134-EN 90.02

Tegn. nr. 4840-071

Temperature and Pressure Settings SAB 110

For Compressor units with UNISAB II Control, the limits for set pressures and temperatures are programmed in the UNISAB II system.

Please refer to the separate instruction manual for UNISAB II.

For compressor units with instrument panels, use the following table:

OWSG= Water-cooled oil cooler	HLI = High-stage liquid injection (Refrigerant injection into the compressor)
OOSI = Refrigerant-cooled oil cooler	B = Water cooled oil cooler

Pos.	Type	Usage	B OWSG OOSI	Oil cooling	
				R717	R22*
1	KP1	Low-pressure cut-out °C	TE-5	TE-5	TE-5
2	KP5	High-pressure cut-out bar	17	17	17
3	A12	Differential pressure across oil filter bar	0.7	0.7	0.7
5		Thermometer in discharge pipe max. °C	100	50	TC+30
6		Thermometer in oil distr. pipe min. °C	40	40	TC+25
		Thermometer in distr. pipe max. °C	55	55	TC+40
7		Thermometer in suction pipe	individual		
11	MP55	Oil pressure cut-out bar	2.5	2.5	2.5
12	KP79	Oil thermostat max. °C	60	60	TC+45
13	KP81/KP79	Discharge pipe temperature max. °C	100	60	TC+45
14	KP77	Solenoid valve opens at: °C	-	35	35
15		Suction pipe pressure gauge	individual		
16		Pressure gauge for cond. pressure (intermediate pressure) max. bar	17	15	17
28		Safety valve on oil separator bar	25 ***	25 ***	25 ***
83	TEAT	Injection valve	- ***	**	**

TE = Evaporating temp.

TC = Condensing temp.

* If you have HLI cooling with R12, the oil and the discharge pipe temperatures must be 30°C higher than the condensing temperature (TC) to prevent the oil from losing its lubricating ability due to the refrigerant dissolved in the oil. Due to the higher temperature, a special synthetic oil (SHC) must be used under most operating conditions.

** The TEAT valve should be finely adjusted to the required oil temperature.

*** A lower temperature setting is permitted, if prescribed by the local authorities.

HLI cooling when the unit is operating with R717

Max. condensing temperature TC = 40°C.

The values stated in this table must not be exceeded, especially when using mineral oil.

Use the Oil Recommendation to select a suitable oil.

Servicing the Refrigeration Plant

Both during start-up and operation it must be made sure that the plant is working correctly.

Compressor and condenser must be able to work satisfactorily, safety devices must be intact and the evaporator must function under load. i.e.:

- the desired temperatures are observed,
- the oil pressure and discharge pipe temperature on the compressor are correct,

- the condenser pressure is not excessively high and

- the plant works as it is supposed to.

The service instructions outline some general guidelines for servicing the refrigeration plant with some references to the instruction manual. The service instructions should therefore be read and followed carefully.

	Check	Interval	Activity
Pressure and temp.	Condensing pressure	Daily	Excessively high pressure may be due to: <ul style="list-style-type: none"> • reduced cooling effect • air in the condenser. Too low condensing pressure implies a risk of restricting the refrigerant supply to the evaporator.
	Discharge pipe temperature		Normal discharge pipe temperature according to instructions.
Filters	Filter in <ul style="list-style-type: none"> - liquid line - thermostatic valve - suction line - oil return 	Clean when required	Accumulated dirt causes reduced refrigerant supply to the evaporator. If a filter has a hot inflow and cold discharge, this may be due to clogging of the component.
Dehumidifier	Moisture in the sight glass (on HFC/HCFC installations)	When required	Some installations are provided with a sight-glass featuring moisture indicator. If the indicator colour switches from green to yellow, there is moisture in the refrigerant. Change the drying filter regularly.

	Check	Interval	Activity
Refrigerant	Refrigerant charge	Periodically	Inadequate charge results in reduced plant capacity and often leads to an excessively high discharge pipe temperature.
	Leak detection		The plant must be searched regularly for leaks. Flanges and joints <i>settle</i> during the initial operation period of the plant. They must therefore be tightened and checked.
Automatic controls	Safety pressure controls Automatic operating controls Alarms	Periodically	Adjust operating point and check the function. Replace switch system if sticking.
Electric motor	Lubrication of electric motors	Periodically	Clean and lubricate according to supplier's instructions. At temperatures lower than -25°C, use special lubricant.
	Alignment of coupling V-belt drive		Check in accordance with the instructions of the instruction manual. Tighten loose V-belts, if any, or replace with new ones.
Condenser	Corrosion	Periodically - normally min. 4 times a year	Marine condensers are normally protected against galvanic corrosion by the mounting of corrosion plugs in the condenser covers. Metallic contact between corrosion plug and cover is essential to proper functioning.
Evaporator	Frosting-up	When required	Unproblematic operation is conditional on the evaporator being kept free of ice. Defrost as and when required.
	Oil draining (ammonia plant)	Periodically	Check evaporator, intermediate cooler, receiver, etc. for oil accumulation. Exercise caution; use a gas mask

Maintenance of compressor SAB 110

Dismantling and assembly

This instruction contains a description of how to dismantle and assemble a SAB 110 compressor.

Such work must only be carried out by a technically skilled staff on the basis of this instruction. This is to prevent break-down and risk of casualties during work and in the operating period that follows.

Therefore, before starting out read this section very carefully.

When dismantling and assembling of SAB 110 the following points must be observed:

- When dismantling parts make sure they are marked so that they can be remounted in the same position as before.
- **Torque moments for screws and bolts** must always comply with the table of the instruction manual. Please, see table of contents.
- As the o-ring gaskets tend to become too big when exposed to oil and refrigerants, it is expedient to keep a set of gaskets ready before starting out. See list of sets of spare parts at the end of this instruction manual.
- When working on the compressor the power to the compressor motor must be cut off and safeguarded in such a way to prevent the compressor from starting up inadvertently. (Main fuses may be removed).

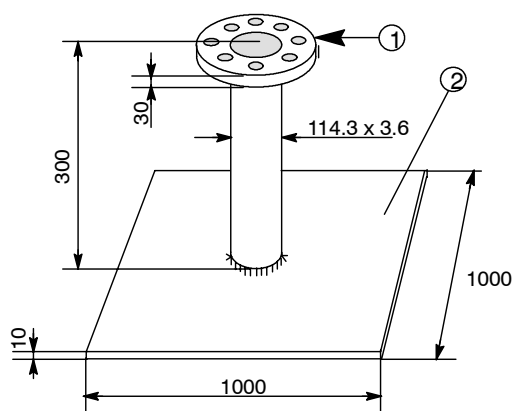
- When cleaning and wiping compressor parts do **not** use twist or any other fluffy cloth.

Preparations before dismantling

It is possible to make a partial dismantling and inspection while the compressor is still clamped on oil separator. In case of total dismantling, however, the compressor must be lifted off.

In the latter case it is recommended to clamp the compressor on a frame as shown on the below sketch:

Fig. 1

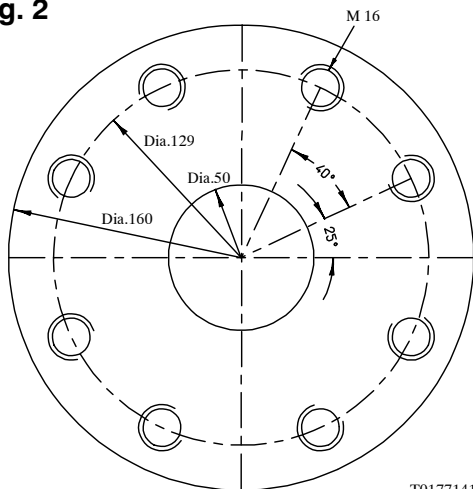


The flange pos. 1 fits the discharge flange of the compressor and is shown on fig. 2.

The base frame pos. 2 may be smaller if it is securely fixed to the floor.

It is recommended to dismantle motor before clamping compressor on the frame.

Fig. 2



Tools

For dismantling and assembling of compressor use both standard tools and special-purpose tools. The necessary tools are specified in the *List of tools* in this manual.

Removal of refrigerant gas

After having closed suction and discharge stop valves on compressor and unit as well as blocked any other pipe connections to the unit, remove refrigerant from unit as described in the section on *Protecting the Environment*.

Removing compressor from oil separator

Before removing compressor from oil separator proceed as follows:

- dismantle cable connections to motor
- dismantle motor at flange connection between motor and bearing cover pos. 20. Please refer to section 13. *Dismantling and assembly of motor and coupling*.
- close all valves in piping between refrigeration plant and compressor unit and

equalize pressure in compressor unit to atmospheric pressure as described in section on *Protecting the Environment*.

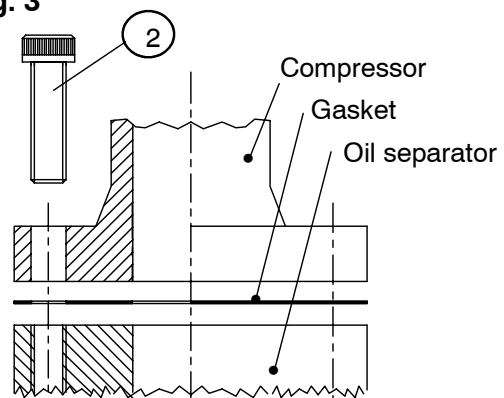
- dismantle pipe connections and wiring connections to compressor block. Wrap up dismantled pipes while stored to keep them clean and undamaged.
- fix a soft lifting sling under the compressor on both sides of the discharge flange. Tighten lifting sling to make it support the compressor block and next dismantle bolts pos. 2 at flange joint against oil separator. (See fig. 3)

Make sure that the lifting sling is fastened so that it prevents the compressor from rolling over.

In case the compressor is equipped with a lifting eye, use this instead.

Note: *Lifting of the whole unit in the lifting eye is not permitted, however.*

Fig. 3



By lifting the compressor slightly up from flange on oil separator the compressor can be carefully pulled away from flange pos. 253, where screws pos. 23 should be dismantled (see spare parts dwg.).

Next, lift compressor away from oil separator.

Note that oil may be leaking from the compressor block when lifted away from oil separator.

Dismantling of compressor

Dismantling of compressor can normally take place while it is still mounted on the oil separator.

By major operations - e.g. overhauls - it may be expedient to move compressor block away from oil separator in order to obtain more space. See section on *Preparations before Dismantling*.

The dismantling of the compressor has been divided into the following sections:

	Section
Suction filter	1
Suction pressure regulator and non return valve	2
Safety valve	3
Oil filter	4
Float switch	5
Regulating cylinder for capacity slide	6
Capacity slide	7
Shaft seal and balance piston	8
Capacity indicator	9
Bearing cover, rotors and bearings	10
Adjustment of rotors	11
Slide stop for Vi-regulation	12
Dismantling and assembly of motor and coupling	13

In the following the position numbers in the text refer to the spare parts lists and the blue spare parts drawings at the end of this instruction manual.

Assembling of compressor

Before assembling the compressor give all parts a thorough cleaning. Look out for any damage or wear and tear. Replace defective or worn parts with new ones. Check all gaskets for possible reuse. In case of doubt, replace by new ones.

Before reassembling lubricate all parts, including screws and bolts, with clean new refrigerating machine oil.

1. Suction filter

Suction filter is built into the compressor frame above the rotors.

Its purpose is to collect all impurities carried with the suction gas from evaporator system.

Experience shows that a good deal of impurities are collected in the filter during the initial period following start-up of a new refrigeration plant.

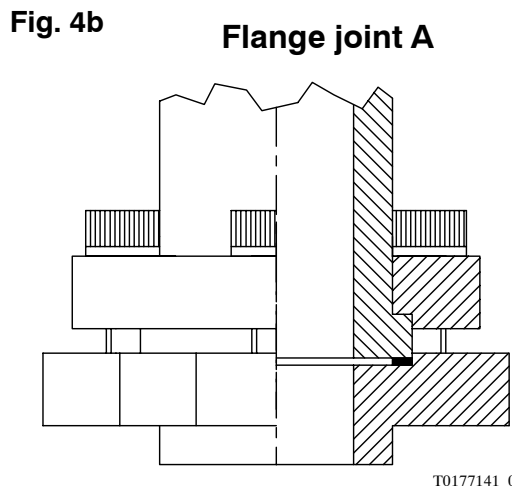
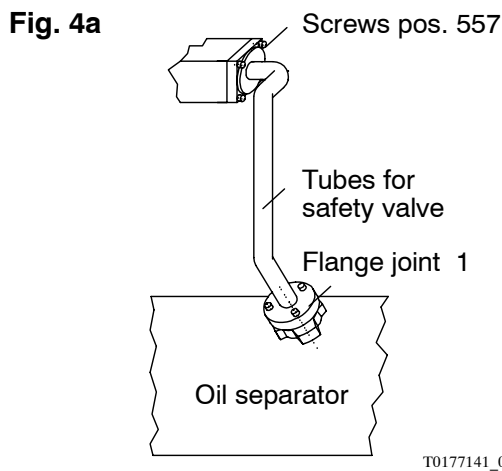
It is important, therefore, to clean the suction filter when the compressor has operated for 200 hours after initial start-up.

If the suction filter is not taken out and cleaned, there is a risk of it bursting as a result of too high differential pressure across the filter.

Removal and cleaning of suction filter

When the pressure in the compressor unit is equal to atmospheric pressure, dismantle pipes pos. 320, which are connected to the cylinder pos. 270.

- Dismantle screws at flange joint A as shown on fig. 4a and 4b.



- By dismantling the four long screws pos. 557 the **tubes for safety valve** can be removed. Pay attention to O-ring pos. 555 and gasket at flange joint A.
- Now pull out the complete suction pressure regulator with the cylinder pos. 270 by hand. Make sure that non-return valve pos. 260 comes out with the suction pressure regulator. Remove suction filter pos. 170 by hand taking care that no dirt falls into the compressor and that the filter texture is left intact.

Clean suction filter in an oil solvent and blow it dry and clean with compressed air.

Mounting

After cleaning the suction filter, check it to see if any damage has been done to the wire mesh.

- Insert the suction filter in the filter housing as shown on the drawing.
- Put the complete suction pressure regulator including non-return valve pos. 260 and spring pos. 261 carefully into place. Pay attention to O-ring pos. 252.
- Now mount **pipe for safety valve** and fasten this and suction pressure regulator with long screws pos. 557. Notice O-ring pos. 555.
- Tighten flange joint A. Take care not to damage the gasket.
- Mount pipes pos. 320.

2. Suction pressure regulator and non-return valve

Suction pressure regulator is mounted in cylinder pos. 270 and placed in suction chamber. The purpose of this regulator is to maintain a **differential pressure** from pressure to suction side of the compressor thus acting as driving pressure for the lubricant to the bearings and rotors.

At compressor stand-still the regulator is closed by means of spring pos. 272 as shown on spare parts dwg.

At the same time the cone of non-return valve pos. 260 is closed against seat pos. 253 by spring pos. 261.

When the compressor is started, the non-return valve opens to allow sufficient suction

gas into the compressor in order to build up pressure in oil separator.

As this pressure rises the regulator is opened by the entire piston pos. 271 moving into cylinder pos. 270.

In case the differential pressure falls during operation - so that the oil pressure may not be maintained - the regulator closes modulatingly and maintains the necessary differential pressure.

When the compressor stops the regulator closes instantly, thereby preventing rotors from rotating backwards.

Dismantling of suction pressure regulator

- Dismount pipes pos. 320 and screwed connections that are fixed on the cylinder pos. 270.
- Dismount **pipes for safety valve** and suction pressure regulator pos. 270 as described in section on *Removal and Cleaning of Suction Filter*.

On the work table, dismantle the following parts in below order:

- Pull out manually non-return valve pos. 260 from piston pos. 271 and remove spring pos. 261.
- During dismantling of screws pos. 554, hold safety valve pos. 550 by hand against cylinder pos. 270 to counteract the force of spring pos. 272.
- Take out safety valve pos. 550 and spring pos. 272.
- Now remove pin bushing pos. 551 from cylinder pos. 270 by means of piston pos. 271 and the entire suction pressure regulator is dismantled.

- Dismantle O-ring pos. 552.

Normally, it is not necessary to dismantle the non-return valve. If need be, the outer locking ring pos. 262 can be removed after which piston pos. 260 and guide rod pos. 263 can be dismantled by hand.

Assembling of suction pressure regulator

Before assembling make sure that piston pos. 271 runs smoothly in cylinder pos. 270. Further, lubricate all parts with refrigerating machine oil.

Assemble suction pressure regulator in reverse order to the one described for dismantling. However, observe the following:

- Pay attention to O-rings pos. 552 and 553.
- When mounting screws pos. 554 press safety valve pos. 550 against the pressure from spring pos. 272.
- Check that the piston moves freely back and forth in the cylinder.
- After mounting of spring pos. 261 and the complete non-return valve, check the free movement back and forth of the non-return valve. Mount the complete suction pressure regulator in the compressor as described in the section on *Removal and Cleaning of Suction Filter*.

3. Safety valve

Safety valve pos. 550 is a sealed unit that should not be opened for inspection. The valve is set by SABROE to open at a prefixed differential pressure between compressor pressure and suction sides.

The differential pressure is indicated on the name plate pos. 558 at the end of the safety valve.

Dismantling and mounting of the safety valve is described in section 2, *Suction pressure regulator and non-return valve*.

4. Oil filter

The oil filter is one of the most vital parts of the compressor lubrication system, protecting the bearings against particles causing wear and tear.

The oil flows through flange pos. 450, meeting first, the magnetic rod pos. 459/460, which filters off all magnetic particles. From here, it passes through filter cartridge pos. 470 that filters off all particles bigger than 10 micron. The filter cartridge cannot be cleaned but must be replaced as soon as its filtering capacity is used up.

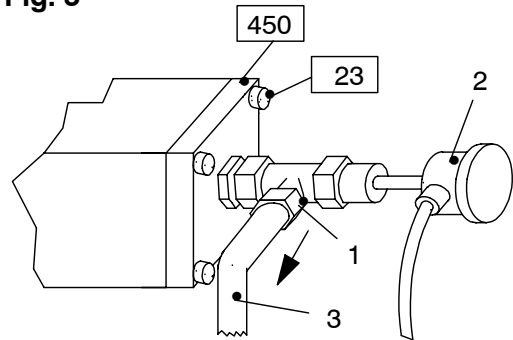
Normally, the filter cartridge is changed at the servicing intervals indicated in section on *Servicing Intervals for screw compressors*, but at initial start-up and after any major repair work on the refrigeration plant, more frequent replacements of filter cartridges may prove necessary.

Replacing oil filter

Once the pressure in the compressor unit has been equalized to atmospheric pressure, proceed as follows:

- Remove thermo sensor or thermostat item 2, see fig. 5, from sensor pocket.
- Loosen flange pos. 450 by removing the four screws pos. 23.
- By disassembling pipe joint item 1 flange pos. 450 can now be dismantled as pipe item 3 is pushed in the arrow direction.

Fig. 5



T0177141_0/V5

- Take out filter cartridge with magnetic filter by hand.
- Take out magnetic filter from filter cartridge by dismantling:
 - Screw pos. 455
 - Washers pos. 456
 - Spring pos. 461

Do not further dismantle magnetic filter but clean it in a detergent and dry it with a cloth or use compressed air.

Mounting of oil filter

Mounting takes place in the reverse order to the one described in the previous section.

However, note the following:

- Make sure that an O-ring is fitted in the hole of the oil filter. The oil filter is delivered with inserted O-ring.
- Spring pos. 462 must be in place.
- O-rings pos. 451 and 502 must be fitted.

5. Float switch

In order to protect the movable parts of the compressor against break-down in case of failing oil supply to the compressor, a float switch pos. 500 has been built into the internal oil system of the compressor.

The float switch works as follows (fig. 6):

- The illustrated float (ball) surrounds a closed stainless steel tube along which it moves up and down. The float contains a permanent magnet which activates a reed switch inside the tube.

If during operation, the housing is filled with oil, the float will be in top position and the reed switch is **connected**.

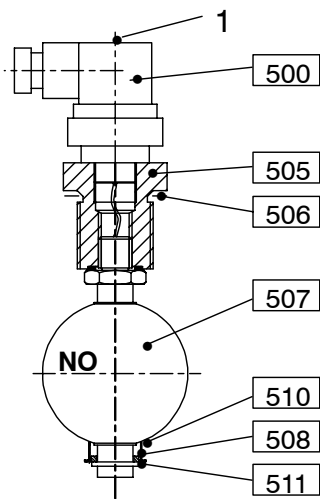
If the oil level in the housing drops during operation as a sign of failing oil flow, the float will sink to bottom position and thereby disconnect the reed switch. When the compressor is standing still, the float switch housing is emptied of oil and the reed switch thus disconnected.

If the reed switch is disconnected during operation, the UNISAB S-Control will stop the compressor after expiry of the time lag encoded in the control system. For details, refer to the UNISAB S-Control instruction manual.

By relay control this time lag is 10 sec.

Note: It is imperative that the "NO" inscription on the float points in the direction shown on fig. 6.

Fig. 6



Dismantling of float switch

- Dismantle the two pipe connections to float switch pos. 501.
- Dismantle the electric wiring connection by loosening screw, point 1. See fig. 6.
- By dismantling the four screws pos. 23 it is possible to pull the float housing out of the frame by hand.

Float switch pos. 500 is dismantled as follows:

- Using a big locking ring plier, remove **locking ring** pos. 504 and **guide for oil filter** pos. 503 can be removed.
- By removing circlip pos. 511, washer pos. 508 can be dismantled, see fig. 6. Next, the threaded nipple pos. 505 with float switch pos. 500 can be unscrewed from float housing pos. 501. Spring pos. 510 and float pos. 507 can now be removed from the float housing.

Mounting the float switch

For mounting of the complete float switch - which is done in the reverse order to the one described above - attention is drawn to the following:

- While fixing the threaded nipple pos. 505 with the float switch pos. 500 in the float housing pos. 501, position float pos. 507 and spring pos. 510.

REMEMBER:

- To mount gasket pos. 506
- To position float with the **NO** as shown on fig. 6.
- To mount washer pos. 508 and circlip pos. 511.
- For fitting of locking ring pos. 504 push it right up against oil filter pos. 503.

- Pay attention to O-ring pos. 502 and gasket pos. 506.

6. Regulating cylinder for capacity slide

The purpose of the regulating cylinder pos. 50, the built-in piston system and the capacity slide pos. 200 is to adapt the compressor capacity to the immediate refrigeration requirements of the plant.

The system functions as follows: piston with sealing ring pos. 204 hydraulically moves capacity slide back and forth. Hereby a modulating opening takes place for an internal bypass channel, which - when piston is to the far right on the draft - is as open as can be. The compressor is now running at its lowest capacity.

Dismantling

- By dismantling screws pos. 73 it is possible to remove the following parts:
 - Cover pos. 72
 - Indicator glass pos. 75
 - O-ring pos. 74
 - Supporting ring pos. 224
- Dismantle indicator dial pos. 221 by removing screw pos. 223.
- Dismantle indicator housing pos. 70 by removing screws pos. 71.
- After dismantling of screws pos. 62 it is possible to pull cover pos. 60 out of the cylinder pos. 50 by dismounting 2 screws No. 22.2 from the tools kit in the threaded holes of the flange.

Watch out for oil in the cylinder !
- Remove cover pos. 60 together with capacity indicator as one unit. Pull the whole

thing **straight out** in order to avoid damaging spindle pos. 210 and its engagement with the piston. See disassembly of the indicator in section 9.

- For dismantling of piston pos. 201, first remove locking nut pos. 206 and locking plate pos. 208.
- Before further dismantling adjust the Vi-slide to its **min. position** by unscrewing adjusting screw pos. 180 as far out as possible, i.e. to max. **X** length. See section on *Manual adjustment of the Vi-slide stop*.
- Remove screws pos. 52 and pull cylinder pos. 50 straight out. By this movement the two washers pos. 201 of the piston are released from slide rod pos. 207.
- Piston with sealing ring pos. 204 can now be pulled out of the cylinder by hand.

Notice that spring pos. 191 will press capacity slide pos. 200 out against the regulating cylinder.

7. Capacity slide

Capacity slide pos. 200 can now carefully be pulled out of the compressor by hand.

Disassembly, if need be, of slide rod pos. 207 and capacity slide can be carried out by removing screw pos. 311.

Mounting

Mounting takes place in the reverse order to the one described above. Note the following, however:

- On mounting capacity slide pos. 200 spring pos. 191 must be in place as shown on drawing and pin pos. 205 must be in place and in order.
- On mounting cylinder pos. 50 press it against spring pos. 191 while at the same time fitting screws pos. 52. Pay attention

to O-ring pos. 51.

Tighten screws pos. 52 with 75 Nm.

- For mounting of piston first assemble the two washers pos. 201 with sealing ring pos. 204 in between. Next, insert the entire unit in cylinder pos. 50 until it touches recess on slide rod pos. 207.

Observe the following:

- Lubricate thoroughly with refrigerant machine oil. Take care not to damage sealing ring pos. 204 when mounting it in the cylinder.
- Place sealing ring correctly as shown on drawing.
- Check that O-ring pos. 203 is in place.
- Mount locking plate pos. 208 and locking nut pos. 206. Text on nut must face outwards and the locking plate must be bent so that it firmly locks the nut.
- When mounting cover pos. 60, make sure that spindle pos. 210 engages slide rod pos. 207 and catches pin pos. 205. Pay attention to O-ring pos. 61.

Dismantling and assembly of capacity indicator

- **Dismantle** the parts in below sequence:

- Screw pos. 223

- Indicator dial pos. 221

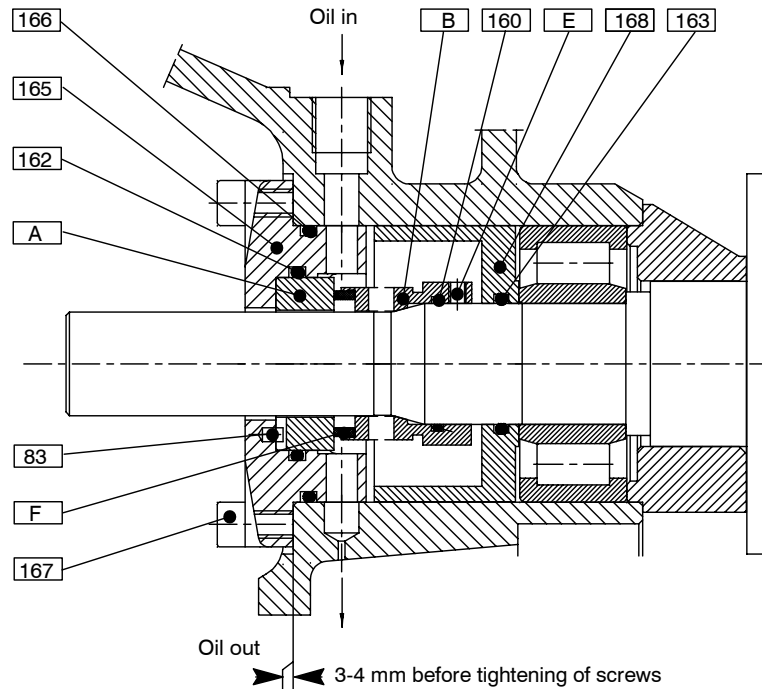
- Nuts pos. 342

- Cam disks pos. 341 if fitted on your compressor

- Dismantle locking ring pos. 213 and next press out spindle pos. 210 and ball bearing pos. 211.
- After dismantling of locking ring pos. 214, pull ball bearing pos. 211 off the spindle.
- Dismantle spacer ring pos. 215 and sealing ring pos. 212.
- **Assembly** of parts takes place in reverse order while observing the following :
 - Insert sealing ring pos. 212 on spindle together with spacer ring Ppos 215. Take care not to damage the sealing ring and that it is positioned with the opening facing the spacer ring.
 - Fit spindle pos. 201 with bearing pos. 211 and locking ring pos. 214 as well as the sealing ring as one unit in flange pos. 60. Also here take care not to damage sealing ring.
 - Remember to fit locking ring pos. 213.

8. Shaft seal type 680

Fig. 1



T264107_1

Designation	Pos. No.
Cast iron seat	A
Rotating part with carbon face	B
Outer O-ring	162
Inner O-ring	160
O-ring for cover	166
Pointed screws, 3	E
Carbon slide ring	F

The seal is a slide ring type, consisting of a stationary cast-iron seat pos. A which is positioned in the shaft seal cover pos. 165. Rotation is prevented by a pin pos. 83.

The end face of the cast-iron seat is lapped to ensure that the slide face seals tightly. The O-ring pos. 162 seals against the shaft seal cover pos. 165.

The shaft seal must ensure complete tightness between the compressor shaft and the compressor housing, so that the inside of the compressor is completely sealed off from the atmosphere.

The rotating part of the shaft seal, in which the carbon face pos. F is fitted, is fastened on the rotor shaft by means of the three pointed screws pos. E and tighten by means of the static O-ring pos.160.

The shaft seal type 680 has a built-in metal bellow in its rotating part which, apart from ensuring tightness, also assimilates axial displacement and provides the necessary compressive force between the two slide faces mentioned below.

Please be extremely careful with the lapped surfaces of the cast-iron seat and the carbon face. The slightest scratch will impair the sealing effect.

Removing the shaft seal

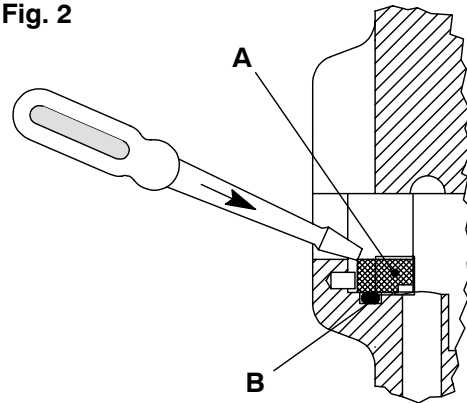
Before taking out the shaft seal, dismantle the motor as described in section 13, *Dismantling and Assembly of Motor and Coupling*.

- Take the pressure off the compressor - as described in the instruction manual - and dismantle the coupling.
- Remove all screws pos. 167. The shaft seal cover pos. 165 can then be pulled out over the shaft. If the cover sticks, so that it is not possible to remove it manually, use two cover screws pos. 167 fitted in the threaded holes of the flange to ease it off.

The cast-iron seat pos. A will come out

together with the cover. It can now be pushed out as shown in fig. 2.

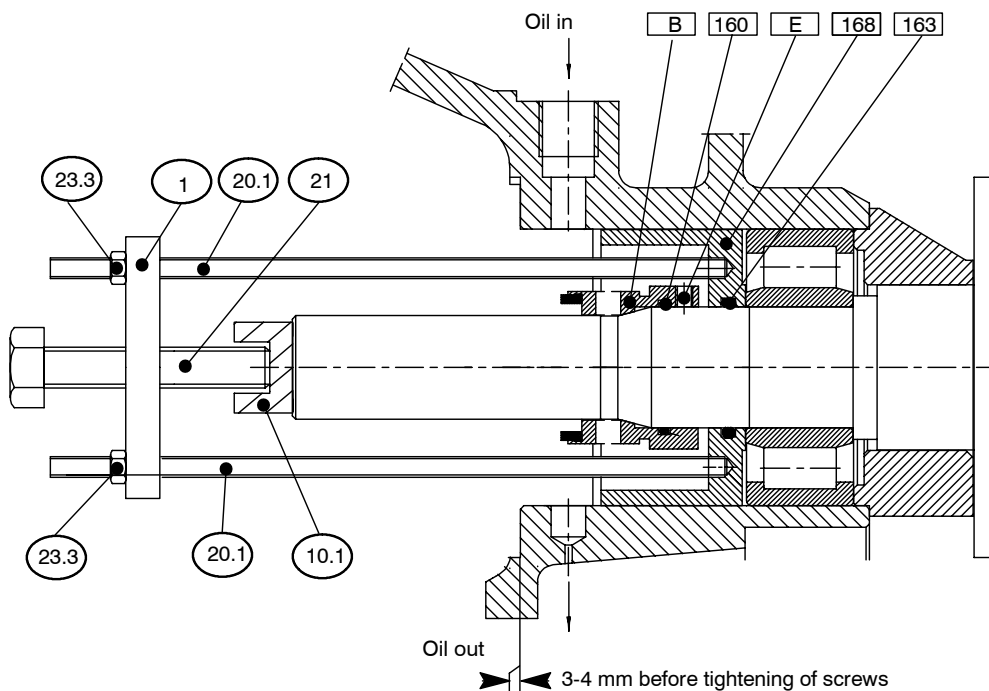
Fig. 2



T0177141_0/V15

- By means of the dismantling tool, as illustrated in fig. 3, pull the rotating part of the shaft seal out of the compressor. **Remember** first to loosen the three pointed screws pos. E.

Fig. 3



T264107_1+

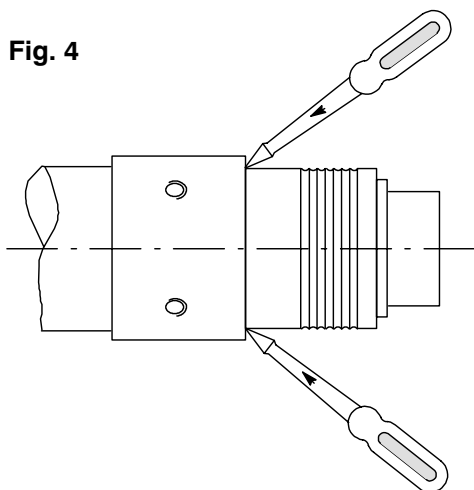
Fitting the shaft seal

- Clean the shaft seal cover pos. 165 and the rotor shaft thoroughly. Check the shaft for scratches and marks that might cause leaks.

Oil the shaft and shaft seal parts with the same type of refrigeration oil as the one used in the compressor.

- Press the rotating part carefully in over the rotor shaft until it touches the recess on the rotor shaft as shown in fig. 1. Do not press the carbon ring but use two screw drivers as illustrated by fig. 4. In this way you avoid twisting the bellows in the shaft seal.

Fig. 4



- Then tighten the 3 pointed screws pos. E alternately with the supplied 3 mm Allen key.
- Mount the cast-iron seat pos. A and the O-ring pos. 162 in the shaft seal cover and make sure that the pin pos. 83 catches the slot in the seat pos. A.
- Carefully ease the shaft seal cover in over the shaft until it meets resistance from the rotating part. Before screw pos.167 has been tightened, there will be a gap of 3 to 4 mm between the two flanges, as shown in fig. 1. Check to ensure that O-ring pos. 166 is correctly placed.
- Tighten screws pos. 167 alternately - take care not to damage the shaft seal by tightening unevenly. Tighten the screws with the torque indicated in the instruction manual.
- Fit the coupling as described in the Instruction Manual and turn the shaft (by hand) to check that it rotates freely.
- Remember first to loosening the 3 pointed screws pos. E.

9. Capacity indicator

Dismantling and assembly

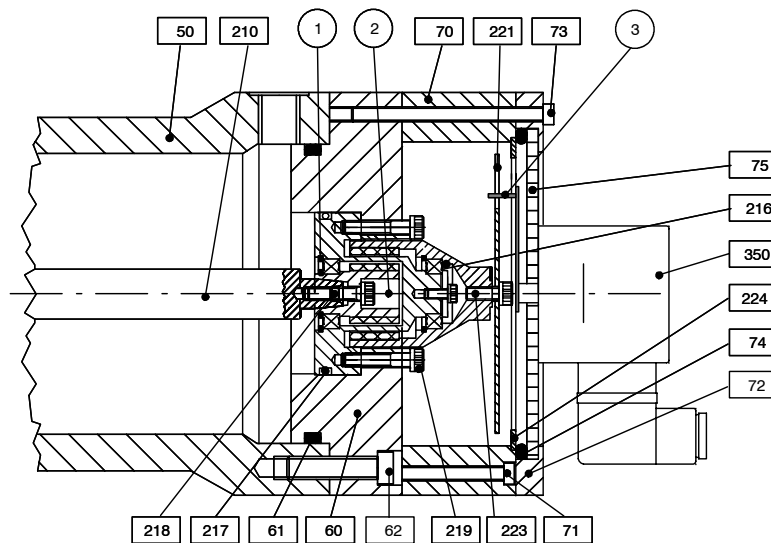
As it appears from the spare parts drawing, the following two types of standard systems for capacity indication can be mounted.

A: Visual capacity indicator

B: Capacity indicator with position transmitter.

Look at page 1 to see which system your compressor is using.

Fig. 9.1 Magnetic coupling pos. 216



T0177135_0/V23

Magnetic coupling for capacity indication type A and B

The rotating movement from spindle, pos. 210, see fig. 9.1, is transferred to the transmitter pos. 350 through a magnetic coupling, pos. 216, which is completely tight to both oil and refrigerant.

Dismantling

- By removing screws, pos. 73, the following parts are taken apart:
 - Flange pos. 72
 - Sight glass, pos. 75, available in two different designs, either for visual indication or for mounting of transmitter.

- O-ring pos. 74
- Supporting ring pos. 224

- Remove screws, pos. 71, and indicator housing, pos. 70, can be taken down.
- Dismantle the screws, pos. 62, whereupon the flange, pos. 60, and the spindle, pos. 210, can be pulled out gently.
- Dismantle indicator dial, pos. 221, by loosening screw, pos. 223.
- By removing screws, pos. 219, the entire magnetic coupling, pos. 216, can be pressed out of the flange, pos. 60, by hand.

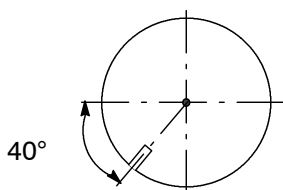
- By dismantling circlip no. 1 the inner magnet retainer no. 2 and spindle, pos. 210, can be pulled out against the magnetic force.
- Dismantle spindle, pos. 210, by loosening screw, pos. 218.

Assembly

Assembly of the complete unit is carried out in reverse order to the dismantling.

Pay attention to the following, however:

- On mounting of the magnetic coupling in cover, pos. 60, O-ring, pos. 217, must be fitted.
- Before fastening indicator dial, pos. 221, with screw, pos. 223, it should be positioned so that the slot points to the left and 40° below horizontal. See sketch.



- On mounting of sight glass, pos. 75, it should be positioned so that the 0% mark is right above the slot in the indicator dial, pos. 221.

Position transmitter

Usage:

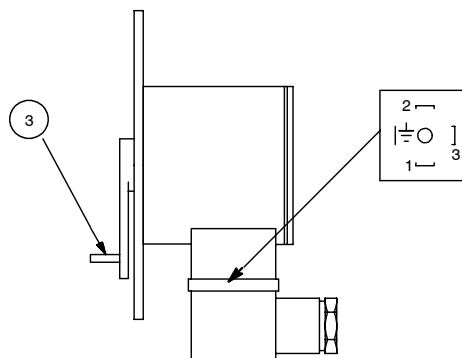
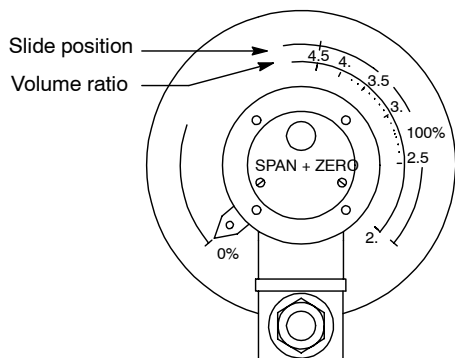
The position transmitter is used for remote indication of compressor capacity. By integrating electronic limit switches into the control, max. and min. compressor capacity can be signalled, for instance.

The indicator disc rotates the position transmitter arm by using pin **no 3**, which engages with the slit of the disc.

Assembly

- The position transmitter, pos. 350, must be fitted on the sight glass, pos. 75, in such a way that the electric socket is turning downwards when the 0% mark on the sight glass is opposite the slit in the indicator disc as described above.
- The retaining pin no. 3 of the transmitter must engage in the slot in indicator washer, pos. 221, on mounting sight glass, pos. 75.

Position transmitter



T0177063 0

Connect the position transmitter to the control system according to the following diagram:

Terminal	Used for
1	Signal 0 - 20 mA
2	Voltage supply 24 V DC +/-20%
3	Frame OV
\perp	Not used

Adjustment:

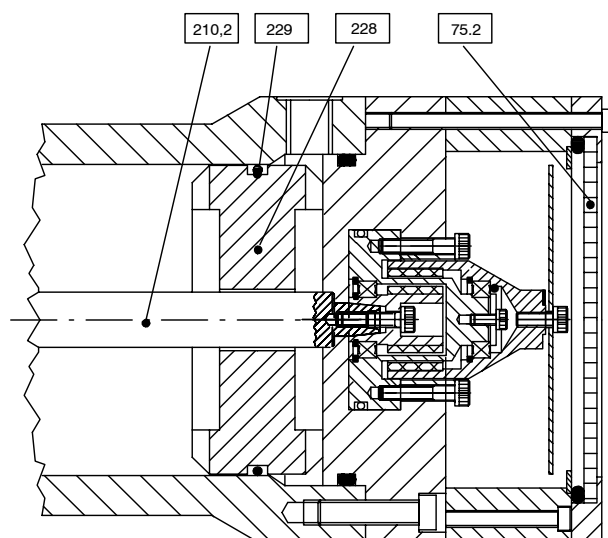
- Turn the transmitter shaft until the output signal is approx. 4mA. On UNISAB II the display shows 0%. Secure the arm opposite the 0% mark on the sight glass. Fit sight glass with transmitter on the compressor. Make sure that the pin GT8.1 catches the slot on the indicator dial!

- Turn the sight glass until the 0% mark aligns with the indicator dial with the capacity slide in its minimum position.
- With the Zero screw adjust to the desired minimum signal. With controls supplied by SABROE, adjust to 4mA signal. One turn with the ZERO screw changes the signal to 2mA.
- With the capacity slide in maximum position, adjust the output signal to 20mA on the SPAN screw. One turn changes the signal to 1mA.

Note:

The adjustment of the slide will affect the max. position of the capacity slide. The max. signal of the position transmitter must therefore be adjusted on the SPAN screw after adjustment of the V_i slide.

Limiting the minimum capacity of the screw compressor - SAB 110 S/L



T0177135_0/V23

The above mentioned screw compressors, which are used at evaporating temperatures below -20°C for refrigerant R717 or R22, are fitted with a **spacer ring pos. 228** which changes the minimum capacity of the compressor from normally approx. 10% to:

SAB 110 S	ca. 50 %
SAB 110 L	ca. 35 %

The limitation eliminates undesirable noise in the compressor in the start and stop periods.

Each individual part in the system is shown on the above drawing. Reference is made to the *List of Parts* at the end of this instruction manual.

Pos. 228	Spacer ring
Pos. 229	O-ring
Pos. 210.2	Spindle
Pos 75.2	Glass for indicator

Dismantling and assembly

The system is dismantled and assembled as described in section 9 *Capacity indicator*, and the spacer ring pos. 228 can be removed by hand by catching the hole in the middle. When the spacer ring is mounted it can be positioned arbitrarily.

10. Bearing cover, rotors and bearings

Dismantling and assembly

This section describes how bearing cover pos. 20, rotors pos. 110, and the bearings are dismantled and assembled in the compressor.

Before dismantling the parts mentioned, carry out the following:

- Dismantle **motor** and **coupling** as described in section 13.
- Dismantle **shaft seal** as described in section 8.

Dismantling of bearing cover pos. 20:

- 10.1 Dismantle the attachment of the bearing cover to the oil separator.
- 10.2 Unscrew adjusting screw pos. 180 for the V_i -slide stop to its extreme position by turning it **anticlock-wise**.
- 10.3 The capacity slide system as described in section 7 is not necessarily disassembled but can be pulled slightly out of the compressor in order to remove the spring pressure from spring pos. 191.
This is done by dismantling screws pos. 52 and the pipe connection to the capacity cylinder pos. 50.
Pull the capacity cylinder approx. 100 mm out of the compressor frame, letting it stick to the capacity slide. Pay attention to the spring pressure and hold back the cylinder, while at the same time dismantling screws pos. 52.
- 10.4 Knock out the two cylindrical guide pins pos. 22 using punch No 56 and Hammer No 55.1.

Before knocking out the guide pins the pipe joints on the side of the compressor must be dismantled first in order to save space.

Pay attention to the nozzle in the pipe joint to the rotor injection.

- 10.5 Dismantle screws pos. 23 and threaded plug pos. 24.
- 10.6 By means of screws No 22.2 from the tools kit, which are fitted in the threaded holes in the flange on the bearing cover pos. 20, this can now be pushed away from the compressor housing pos. 10 until loose. Then lift it away. Support bearing cover during the dismantling.

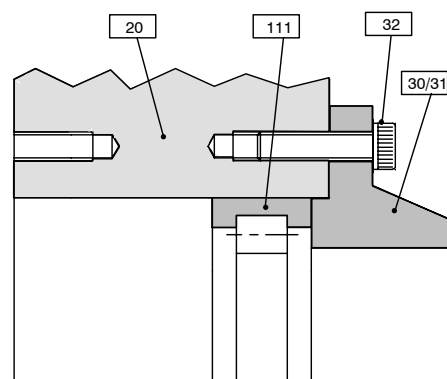
Now the two main bearings pos. 111 can be dismantled as described in the following section as well as the V_i -slide stop pos. 190, described in section 12.

Dismantling of main bearings pos. 111 on the suction side

After dismantling of bearing cover pos. 20, the main bearings can be dismantled in the following way:

- 10.7 Dismantle suction port pos. 30/31 by removing screws pos. 32 as shown on fig. 1.

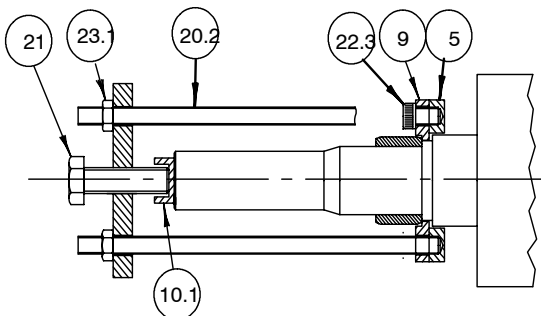
Fig. 1



T0177141_0 V33

- 10.8 **Carefully** knock the **outer rings** of the main bearings out of the bearing cover by means of punch No 56 and hammer No 55.1.
- 10.9 Pull the inner rings of the main bearings off the rotor shafts by means of the tools shown on fig. 2.

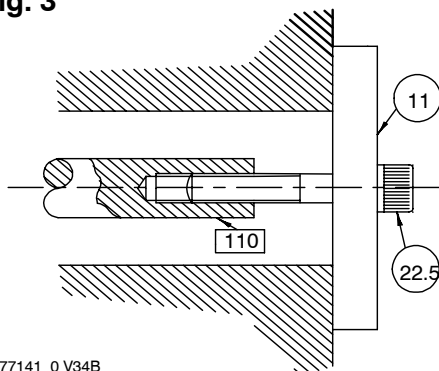
Fig. 2



T0177141_0/V16

In order to prevent the rotors from turning when the inner rings are pulled off, lock the rotors at the opposite end as shown on fig. 3.

Fig. 3



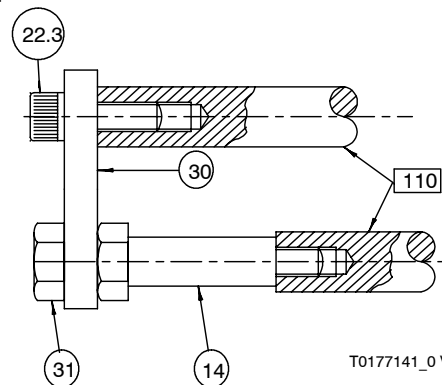
T0177141_0 V34B

Before this tool can be mounted, the parts mentioned in pt. 10.10 to 10.13 must be dismantled.

Dismantle main bearings pos. 111 and axial bearings pos. 132 and take out the rotors.

- 10.10 Loosen the locking screws pos. 45, then loosen the two adjusting screws pos. 44 3-4 turns.
- 10.11 On dismantling the screws pos. 43 it is possible to remove cover pos. 40.
- 10.12 With screw No 22.1 pull out the two covers pos. 153.
- 10.13 Dismantle screws pos. 115 and thrust plates pos. 114.
For this purpose use tools as shown on fig. 4, which are mounted at the other end of the rotors in order to lock the rotors.

Fig. 4

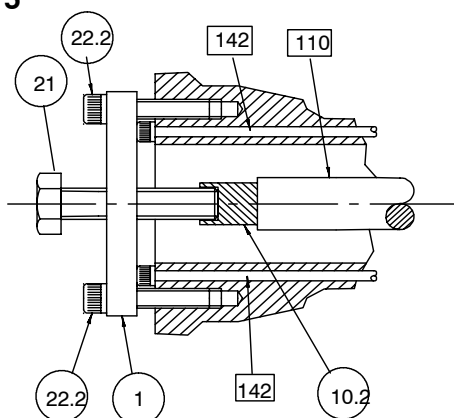


T0177141_0 V34A

Please, notice that the inner rings of the main bearings on the suction side can now be dismantled as described in pt. 10.9.

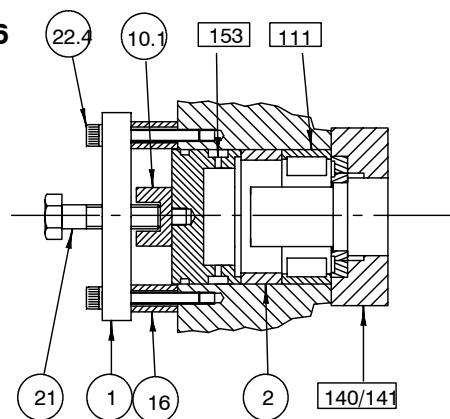
- 10.14 Dismantle all auxiliary tools as mentioned in pt. 10.13.
- 10.15 With tools arrangement fig. 5 press out the rotors, one at a time.

Fig. 5



T0177141_0 V38

Fig. 6



T0177141_0 V37

Make sure in tool No 1 to select the holes for screws No 22.2 that centre No 1 in relation to the rotor shaft. Tighten screws No 22.2 so that No 1 touches the screw heads pos. 142.

- 10.16 Carefully remove the rotors from the compressor, and take out by hand the axial ball bearing pos. 132, the shims pos. 133, the inner rings for main bearings pos. 111 and the balance piston pos. 130.

The axial ball bearings pos. 132 consist of 3 main parts which must be kept together so that they are not interchanged or mixed with parts from the bearing on the other rotor.

- 10.17 After remounting of screws pos. 142 and sealing plates pos. 143, press out the discharge ports pos. 140 and 141 and the main bearings pos. 111 by means of the tools shown on fig. 6.

The discharge ports pos. 140/141 can now be removed by hand and the ring for the balance piston pos. 139 separated from the discharge ports (fig.6)

Mounting of bearing cover, rotors and bearings

Before mounting check that all parts are cleaned and ready for reuse.

It is not recommended, however, to reuse the bearings. Further, make sure that the O-rings and gaskets are OK.

All parts should be lubricated with new refrigerant machine oil of the same type as the one used in the refrigeration plant. Use Molycote grease on pressing the bearings into place as already described.

Tighten the screws with the moments as prescribed in the table on **Torque moments for screws and bolts**, provided that no other moment is stated in the text.

- 10.18 Before mounting of the discharge ports pos. 140 and 141 make sure that these are free of burrs on the edges. Also check that the inner surfaces of the compressor housing are clean so that the discharge ports can be placed right next to the bottom surface of the housing.

Turn discharge ports as shown on the spare parts drawing.

Mount and tighten screws pos. 142.

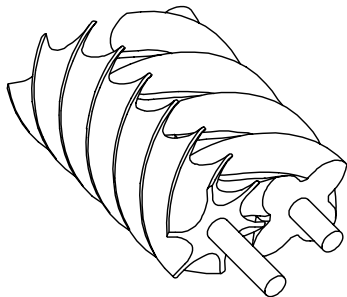
In view of tightness, use new sealing plates pos. 143, and position them so that they centre the screw in the hole.

10.19 Position the two rotors in the compressor housing, one at a time, and place them as shown on fig. 7 for either male or female drive.

Fig. 7



Male drive



Female drive

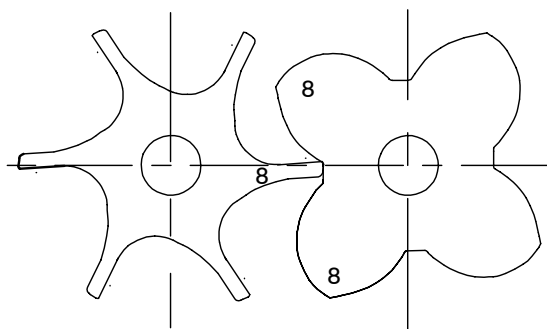
T0177141_0/V19

The rotors are marked with a number on the end surfaces that are turned

towards the suction side of the compressor.

The number has no value in itself but the same number must be on both rotors and **on mounting** the engagement between the rotors must be as shown on fig. 8.

Fig. 8

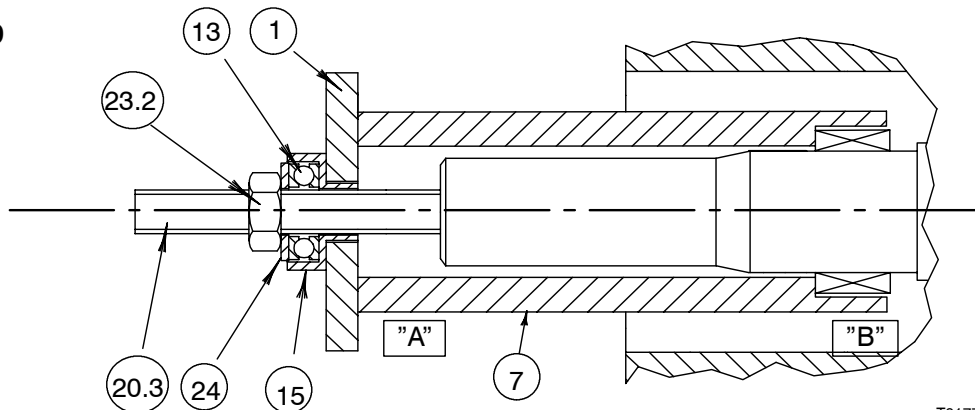


T0177141_0/V20

Now make bearing cover pos. 20 ready for mounting on the compressor housing, but before that mount the inner rings of the main bearings pos. 111 on the suction side.

10.20 Mount the inner rings of the main bearings with tools as shown on fig. 9. Tighten nut No 23.2 with 40 N_m. For locking of the rotors mount tools, fig. 3, at the other end of the rotor.

Fig. 9



T0177141_0 V36

10.21 Position V_i-slide stop pos. 190 in the bearing cover as described in section 12.

10.22 Press the outer rings of the main bearings into place in the bearing cover using the two suction ports pos. 30 and 31 as pressing tools.
Remember to turn the inscription on the bearings so that it faces the bearing cover.

Fix the suction ports by means of screws pos. 32.

Now mount the complete bearing cover pos. 20 on the compressor housing as described in the following:

10.23 Carefully insert bearing cover pos. 20 and mount screws pos. 23 – tighten only slightly.
Pay attention to O-ring pos. 21.

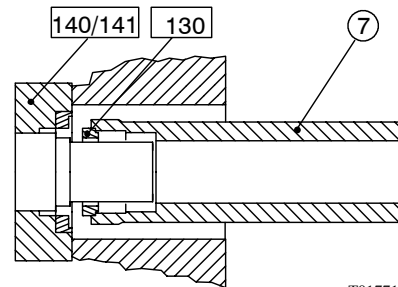
10.24 By means of hammer No 55.1 knock the two cylindrical guide pins into place and mount screws pos. 23.

At the other end of the compressor mount bearings and all other parts as described in the following:

10.25 Mount the outer and inner rings pos. 139 and 130 of the balance piston at both rotors.

For mounting of the inner balance ring it will be an advantage to use tool No 7 as shown on fig. 10 .

Fig. 10



T0177141_0/V21

10.26 Mount the innermost main bearing ring on both rotors with tool arrangement as shown on fig. 9. Tighten nut No 23.2 with 40 N_m and turn the inscription on the bearing ring so that it faces **outwards**.

In order to prevent the rotors from turning they must be locked at the other end with tools shown on fig. 4.

Before mounting lubricate the shaft with Molycote grease.

10.27 Mount the outer rings of the main bearings with tool shown on fig. 6. The inscription on the bearing faces **outwards**.

10.28 Press the innermost inner ring of the ball bearing pos. 132 on both rotors by means of tools shown on fig. 9 and fig. 4.

Make sure that the 3 bearing parts are positioned in the same way as they were in the original packing and that the inscription on the bearing faces **outwards**.

Turn tool No 7 with its smooth end **A** towards the bearing ring. Tighten nut No 23.2 with 40 N_m.

- 10.29 From the set with shims pos. 133 select thickness 0.82 mm, which is inserted in front of the main bearing pos. 111. Now insert the outer ball bearing ring with balls pos. 132 by hand.

Turn the ball bearing in relation to the pressed in inner ring as they were placed in the original packing.

11. Adjusting the rotors

After assembly of the compressor as described in section 10 the position of the two rotors is adjusted, one at a time, **adjusting the driving rotor first**, i.e. the rotor to which the motor is connected.

- 11.1 Mount clamping tool No 8, as shown on fig. 11, and tighten with screw pos. 115.
Tighten with 61 N_m.
- 11.2 Mount thrust cover pos. 153 as shown on spare parts drawing, without the O-ring pos. 154, however. Mount cover pos. 40 and fix with screws pos.

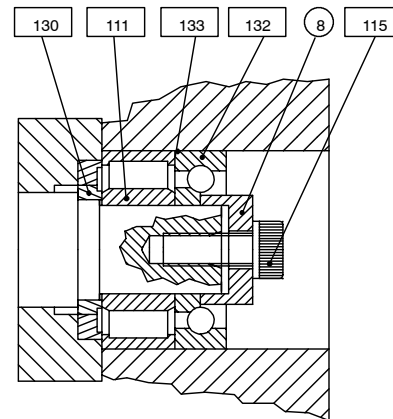
43. Do **not** tighten adjusting screw pos. 44 completely against the thrust cover pos. 153.

- 11.3 At the opposite end, the **suction side**, of the compressor, mount adjusting tools as shown on fig. 12.

Fit tool part No 14 through the hole in bearing cover pos. 20, after removing plug pos. 24.

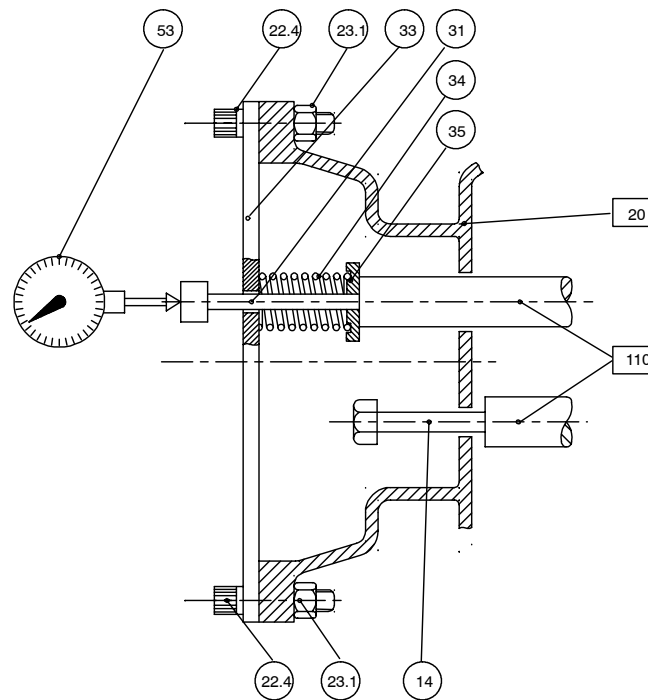
Place the dial meter in front of the rotor that is going to be adjusted.

Fig. 11



T0177141_0/V24

Fig. 12



PO17714-1a

11.4 As it may be seen from fig. 12, spring pos. 34 is going to press the rotor against the discharge port at the other end of the compressor.

Adjusting screw pos. 44 must be loose. Position the dial meter on "0".

11.5 Tighten adjusting screw pos. 44 with **30 N_m** and read the dial meter. The axial displacement of the rotor, the **exact measure**, must be between 0.05 and 0.10 mm by correct adjustment.

By larger axial displacements insert a thicker - or a thinner - adjusting shim pos. 133, see spare parts list, and repeat measuring points 11.4 to 11.5.

11.6 Once correct adjustment has been achieved, the following is done:

- Note down the exact measure to be used in pt. 11.11.
- Dismantle measuring tool shown in fig. 12.
- Loosen adjusting screw pos. 44.

- Dismantle screws pos. 43 and remove cover pos. 40.
- Pull out thrust cover pos. 153 by means of tools screw No 22.1.

11.7 Mount the auxiliary tool at the other end of the rotors as shown in fig. 4, and dismantle clamping tool No 8.

11.8 Dismantle the other inner ring on the ball bearing pos. 132 as described in pt. 10.28.

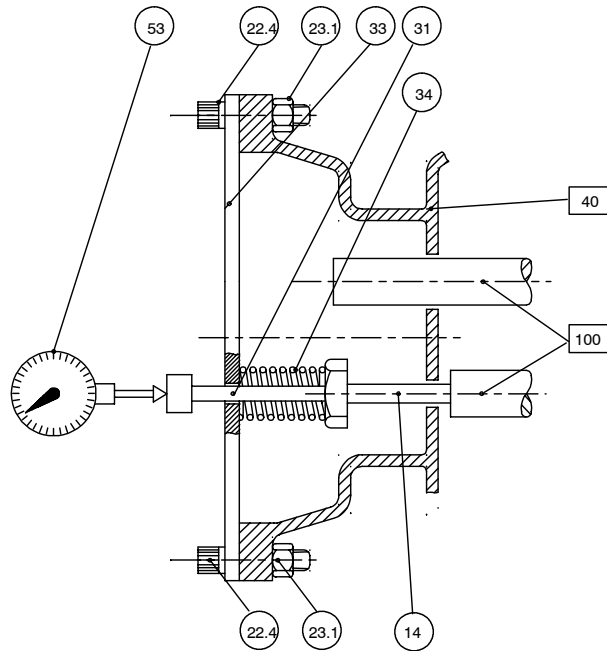
11.9 Fit thrust plate pos. 114 and fasten with screw pos. 115.
Torque: 61 N_m.

11.10 With the O-ring pos. 154 fitted, position thrust covers pos. 153.

The first part of the adjustment of the **driving rotor** is now completed. Repeat the procedure from pt. 11.1 to 11.10 for the other rotor.

Please, notice that the adjusting tools mentioned in pt. 11.3 must be mounted as shown on fig. 13.

Fig. 13



PO17714-1b

Final adjustment

After both rotors have been adjusted and the exact measures noted down, we are now ready for the **final adjustment** of the rotors.

11.11 The **exact measure** for each of the rotors is compared with the measures in column 1 in the following table. Column 2 provides you with the **final adjusting measure**.

If, for instance, the exact measure is 0.061 mm for the female rotor, it is somewhere between 0.060 and 0.069, which yields a **final adjusting measure** of 0.04 mm according to the table.

Exact measure ¹ between mm	Final ² adjusting measure mm
0,050-0,055	0,040
0,056-0,060	0,045
0,061-0,065	0,050
0,066-0,070	0,055
0,071-0,074	0,060
0,075-0,079	0,065
0,080-0,084	0,070
0,085-0,089	0,075
0,090-0,094	0,080
0,095-0,100	0,085

With the adjusting tools mounted and adjusted as shown on fig. 12 or 13 and with the dial meter positioned on

"0", tighten adjusting screw pos. 44 while at the same time reading the dial meter.

The hand of the dial meter must move **the final adjusting measure**.

- 11.12 After the **final adjustment** lock adjusting screw pos. 44 with pointed screws pos. 45, and the adjustment of the rotor is now completed.
- 11.13 Repeat the final adjustment points 11.11 to 11.12 for the other rotor.
- 11.14 Check that the rotors are easy to turn by hand.

12. Slide stop for V_1 -regulation

The purpose of the V_1 -regulation system is to adjust the built-in volume ratio of the compressor so that the compression ratio of the compressor is the same as the pressure ratio between condensing pressure and evaporation pressure in the refrigeration plant.

The system works as follows:

V_1 -slide pos. 190 is displaced and thus - via the regulating slide pos. 200 - changing the size of compressor discharge port. This modification of the size of discharge port increases - or reduces - the compression chamber, thus regulating the compression ratio.

Adjustment of slide stop is done manually as described in a separate section of this instruction manual. Please, see table of contents.

Dismantling of V_1 -slide stop

- First dismantle bearing cover pos. 20 and next suction port pos. 30 and 31. See section 10.
- After dismantling vent screw pos. 107 and gasket pos. 108, slidestop pos. 190 can be pulled out by hand.
- When dismantling screws pos. 106 it is possible to take out and disassemble piston pos. 103 with sealing ring pos. 101 and retainer pos. 105.
- Check the following:
 - that cylinder in bearing cap pos. 20 is without any scratches or marks that could cause leakage.
 - that sealing ring pos. 101 is flawless.

Mounting of V_1 -slide stop

When mounting - which is to be carried out in reverse order of dismantling - observe the following:

- Turn adjustment screw pos. 180 to minimum position by turning it **anti-clockwise**.
- Lubricate cylinder pos. 20 and sealing ring pos. 101 thoroughly with refrigerating machine oil before fitting them together very carefully.
- Remember to mount vent screw pos. 107 with gasket pos. 108.

13. Dismounting and assembly of motor and coupling

The electric motor is secured to bearing cover pos. 20 by means of M16 screws, and can be dismantled in the following ways:

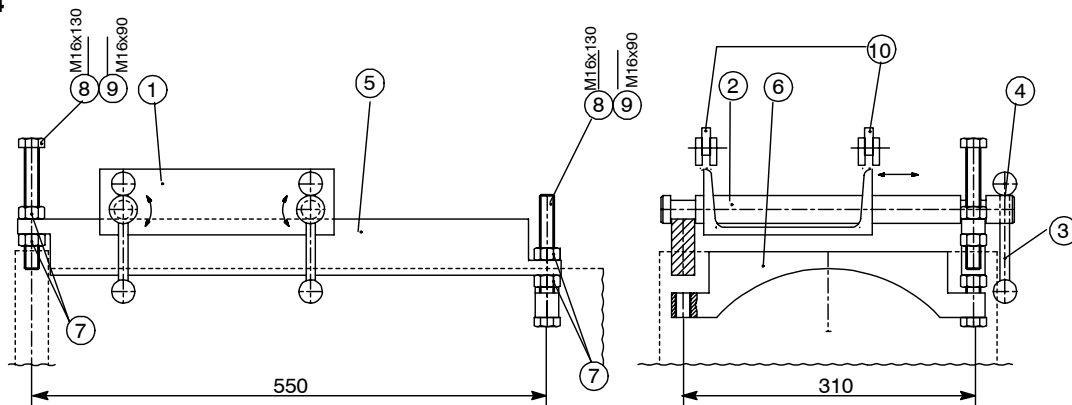
- A:** By means of a **crane** or other **lifting gear** in which the motor is suspended.
- B:** By means of a **sliding tool** mounted on the base frame under the motor.

In the following you will find a description of the two methods:

Dismounting the motor

- A:** If a crane or other lifting gear is available, the following method can be used.
 - A1:** Dismantle electric cable connections in terminal box of motor.
 - A2:** The motor is suspended in a lifting sling fastened to the lifting eye on the motor.
 - A3:** Carefully loosen the screws securing the motor to bearing cover pos. 20 and make sure that the motor is securely suspended in the lifting sling.
 - A4:** Carefully pull motor in its longitudinal direction away from bearing cover hereby splitting coupling between motor and compressor shafts.

Fig. 14



T3083118_0

B: If no lifting gear is available, we recommend that you use a sliding tool which can be supplied by SABROE.

The sliding tool is used in the following way. See Fig. 14 below.

1B: Dismount the electric cable connections in the terminal box of the motor.

2B: Mount the parts Nos 5 to 8 of the sliding tools on the base frame as shown on the drawing. Fit the screws No. 8 into the threaded holes in the lifting eyes of the unit. Place the supporting part No. 6 loosely on the shell of the oil separator.

3B: Screw the bottom nuts No. 7 in so deep that slide No. 1 with spindles No. 2 can be placed under the motor.

4B: By means of screws No. 7 the entire sliding system is elevated, and by shifting slide No. 1 in its longitudinal and transverse direction, it is ensured that it is placed below the centre of gravity of the motor.

5B: The sliding system is elevated so much that it is able to carry the motor when the screws between the motor and the compressor are removed. In connection with direct air-cooled motors, the

sliding system can support the motor directly.

If the motor is equipped with cooling fins on the outside, a supporting plate must be placed between the sliding system and the fins.

6B: When the screws between the motor and the compressor are loosened, it may be necessary to fine adjust the height of the sliding system by means of nuts No. 7. Then counter tighten with the upper nuts No. 7

Please, observe that the sliding system must be parallel with the longitudinal axis of the motor in horizontal plane.

7B: By carefully turning the spindles No. 2 the motor can be rolled away from the compressor. Hereafter, slide No. 1 may be moved sideways in order to obtain more space between the motor and the compressor. For motors with a small outside diameter on the jacket, the two double bars No. 10 can be used during mounting on No. 1.

Note:

On marine plants, the motor must be secured to prevent it from falling off the sliding system in a heavy sea.

Dismantling of coupling

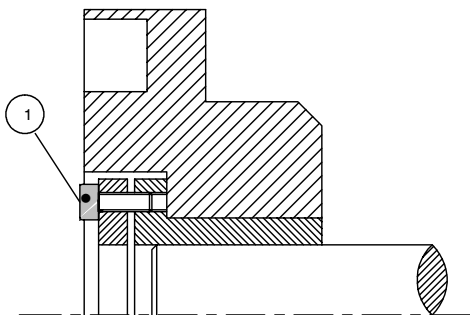
After having carried out **A** or **B** as described above, the coupling can be dismantled.

In the following two sections a description is given of the procedure for couplings type **E128** and type **65 HEW**.

Coupling type E128

Dismantling

Fig. 14.1



T0177141_0/V10

- Coupling flange on compressor can be dismantled by hand (fig. 14.1) - after screws point 1 on the bushing have been loosened a couple of turns. (Fig. 14.1)
- Coupling flange on motor is pressed on and can **if necessary** be pulled off by means of a draw tool. **Observe that pointed screw M10 must be loosened before dismantling!**

Mounting of coupling and motor

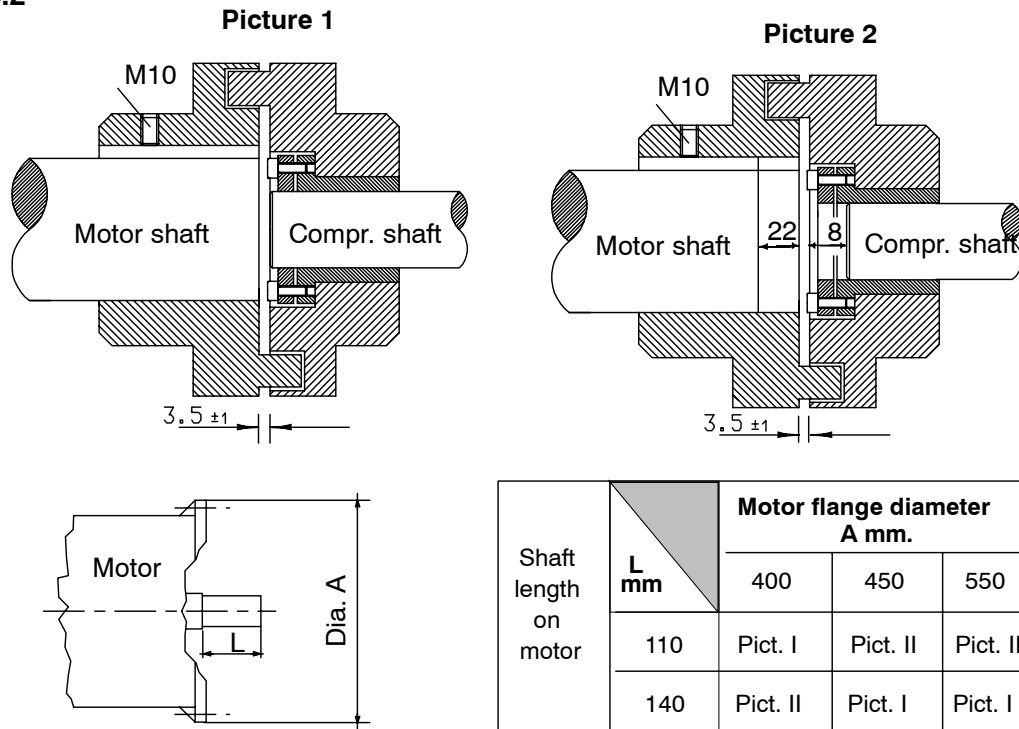
- Before the coupling half-section is mounted on the compressor shaft, **the compressor shaft, the coupling half-section and the bushing must be degreased with an oil solvent**. The coupling half-section on the compressor must be positioned correctly, in accordance with fig. 14.2.
- Depending on motor flange dimension A and length L of shaft, the distance from end surface of coupling flange to end surface of shaft must be as indicated on fig. 14.1, picture 1, i.e. end surfaces must be on the same level or, like in picture 2, with a 22 mm distance.
- After correct positioning of coupling flange, tighten screws pos. 1 (fig. 14.1) in the following way:
First tighten the screws manually, next turn each of them 1/2 a turn at a time **clockwise** until the correct torque moment of **8 Nm** has been obtained for all screws.
- Carefully push motor in its longitudinal direction towards bearing cover pos. 20 making sure that the two coupling flanges engage in each other with the rubber ring in between.

During the mounting check the distance between the two coupling flanges through the inspection hole on the side of the bearing cover. The distance between the end surfaces of the two coupling flanges must be 3.5 ± 1 mm as shown on fig. 14.2.
- Secure motor with screws and fit cable connections.
- Remove the lifting gear or the sliding tool.
- When starting the compressor check rotating direction by looking through the in-

specification hole in bearing cover pos. 20 which is closest to the coupling. At correct

rotating direction, the visible part of the coupling will move **downwards**.

Fig. 14.2

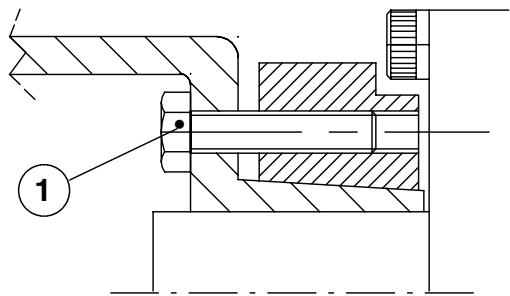


T0177141_0/V11

Coupling type 65 HEW

Dismantling

Fig. 14.3

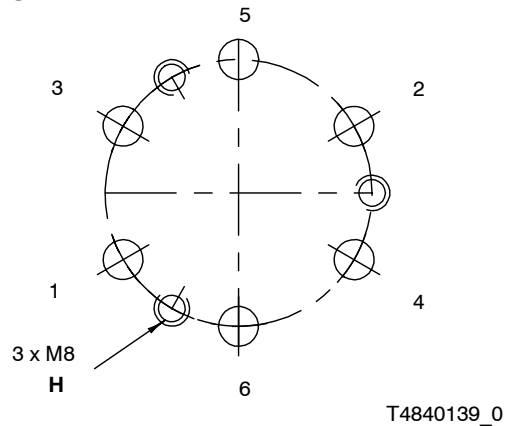


T4840139_0

After removing the motor as described previously, dismantle the coupling in the following way:

- At the coupling flange on the compressor loosen screws pos. 1, fig. 14.3, a few turns. Mount 3 of the loosened screws pos. 1 in the threaded holes pos. H, shown on fig. 14.4, and by tightening them alternately the bushing is loosened. Now take out the coupling flange by hand.

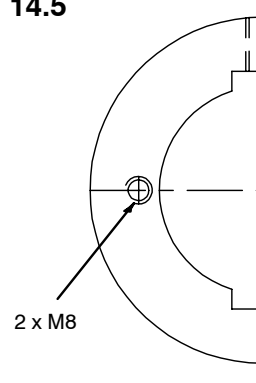
Fig. 14.4



T4840139_0

- At the motor coupling flange, first dismantle the elastic intermediate part pos. 4 by removing screws pos. 5, fig. 14.7. Next, loosen screw pos. 2, fig. 14.8. It is now possible to pull the coupling flange off the shaft by means of the two threaded holes in the flange, as shown on fig. 14.5.

Fig. 14.5



T4840139_0

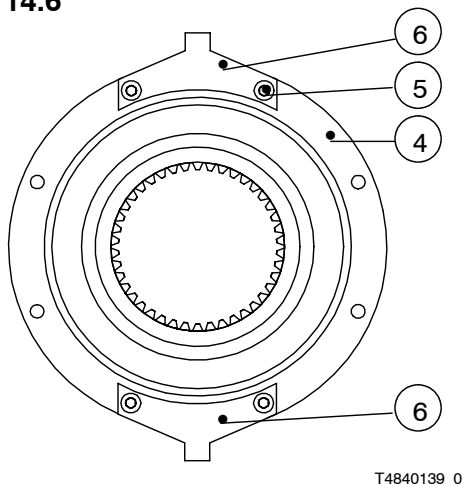
Mounting of coupling and motor

Mount the coupling flange on the compressor and motor as described in the following:

- Before mounting of the coupling flange on the compressor shaft, clean coupling flange, the individual parts in the bushing and the compressor shaft.
Next, lubricate all parts in a little of the refrigerant machine oil. **Do not** lubricate with Molybdändisulfide, high pressure oils or lubricating grease.
- The coupling flange on the compressor must be positioned correctly in accordance with fig. 14.8 so that the distance from shaft end to end surface of the coupling flange constitutes $E = 7 \pm 0.5$ mm.
- After correct positioning of the coupling flange tighten all screws pos. 1 cross-wise like the numbers on fig. 14.4. First tighten with half the torque moment and then tighten with the full torque = **38 Nm**.

On tightening the screws pos. 1 it might be a good idea to use the two tools pos. 6 as shown on fig. 14.6.

Fig. 14.6

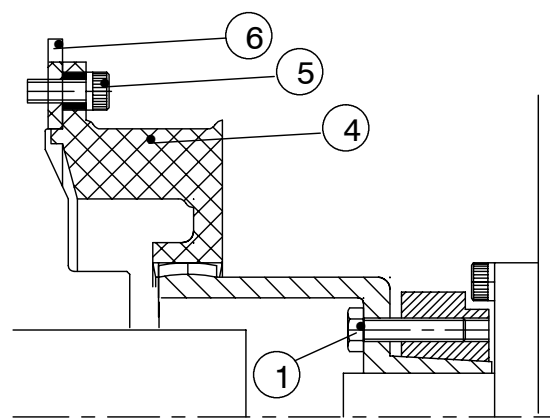


T4840139_0

Secure the tools on the intermediate part pos. 4 with the screws pos. 5 and position the unit on the compressor flange as shown on fig. 14.7.

Hereby the pins on the tools engage the bearing cover pos. 20, thus preventing the coupling flange from rotating during tightening.

Fig. 14.7



T4840139_0

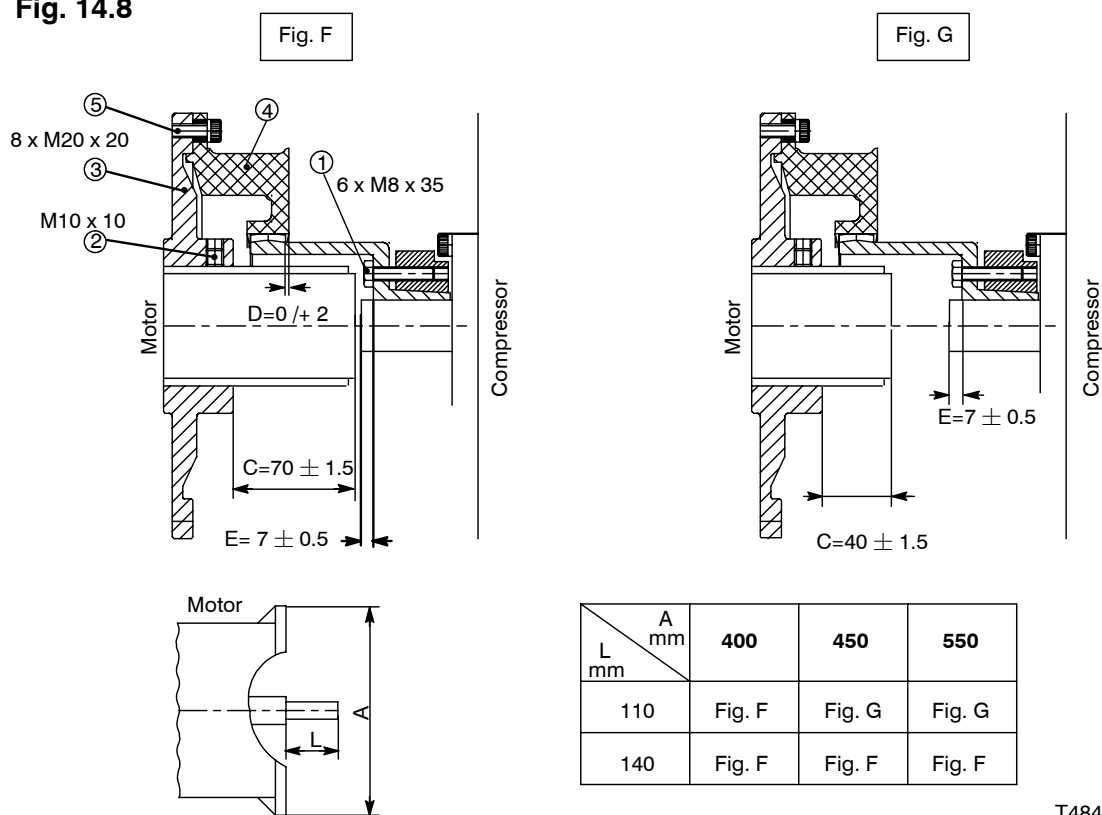
- On mounting the coupling flange pos. 3 on the motor shaft a press tool should be used. If the flange is knocked on there is a risk of damaging the bearings in the motor.
Position the coupling flange at a distance C from the end surface of the motor shaft, depending on motor flange diameter A and shaft length L.
See table in fig. 14.8.
Tighten the pointed screw M10, pos. 2 with **40 Nm**.
- Mount the elastic intermediate part pos. 4 on the motor coupling flange and secure with screws pos. 5. Tighten screws with **35 Nm**.
- Carefully lead the motor in its longitudinal direction towards the bearing cover, pos. 20, making sure that the two coupling

parts engage in each other.
Through the two openings in the bearing cover check whether the teeth on the two coupling parts have engaged within the measure $D=0/+2$ mm.

- Secure the motor with the screws and fit the wiring connections.

- Remove the lifting gear or the sliding tools.
- When starting up the compressor check the sense of rotation by looking through the inspection opening in the bearing cover, pos. 20, closest to the coupling. By correct sense of rotation the visible part of the coupling must move **downwards**.

Fig. 14.8



T4840139_0

Systems for regulation of compressor capacity and V_i -ratio of SAB 110

In this section the following systems are treated:

1. Regulation of compressor capacity
2. Manual regulation of V_i -slide

Please, check the system of your compressor on page 1.

1. Regulation of compressor capacity

The regulating system is a complete unit as shown on the following drawing. It regulates the compressor capacity by admitting or draining oil from capacity cylinder Pos. 50 (see spare parts drawing.)

The system is connected to oil pressure at connecting piece B and oil returns from ca-

capacity cylinder through connecting piece A. Connecting piece C is connected to capacity cylinder.

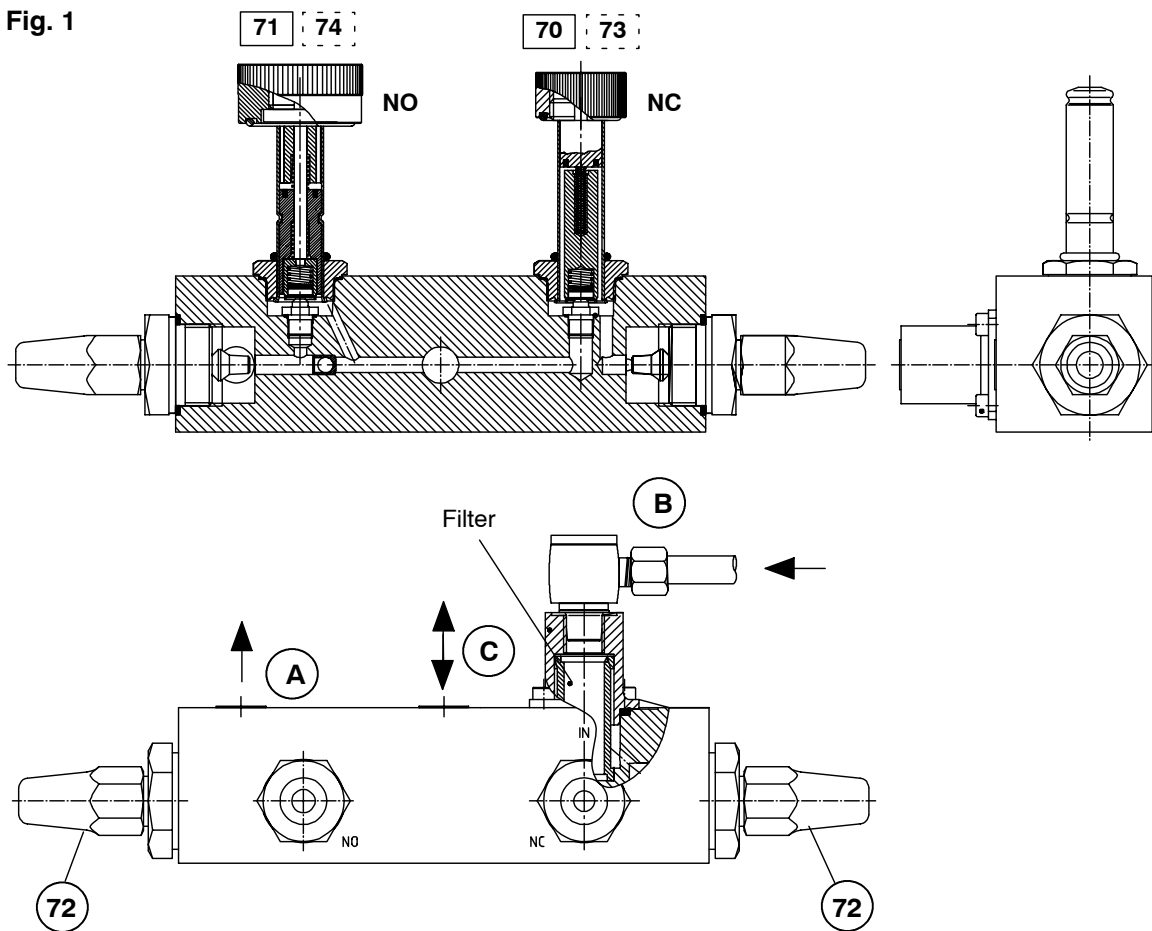
The system has two throttle valves Pos. 72 built in, whereby oil flow and thus moving speed of capacity piston can be regulated. The throttle valves are meant to ensure a smooth and easy movement of capacity piston, adapted to operating conditions.

If spindles are turned **clockwise** oil flow is reduced.

Pos. 70 is a normally closed valve.

Pos. 71 is normally open, which is to say that by a non energized coil, it is open for through flow.

Fig. 1



Function

1. At constant capacity, both solenoid valves are closed as Pos. 70 is dead while current is being supplied to Pos. 71.
2. When regulating to higher capacity, current is switched on to coil Pos. 70, whereby both coils are energized. This opens Pos. 70 and puts oil pressure on capacity cylinder while Pos. 71 remains closed.
3. When regulating to lower capacity, current is shut off to both coils. This makes Pos. 70 close and cuts oil pressure to capacity cylinder. Pos. 71 opens and allows oil to flow away from capacity cylinder by the power from spring Pos. 191.
4. When compressor stops, the current to both solenoid valve coils is switched off.

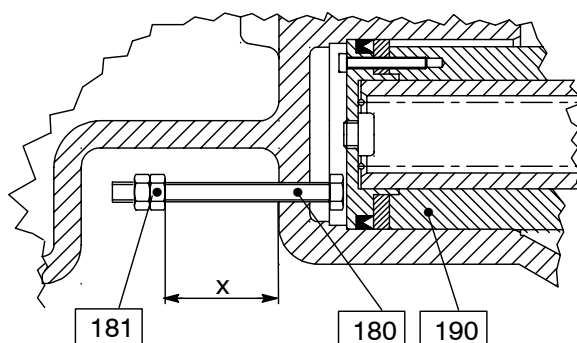
This moves capacity piston to 0% position - as described in point 3 - and the compressor is unloaded when starting up again.

On HFC/HCFC plants the oil contains a fair amount of refrigerant. Therefore, the oil present in the cylinder of the capacity slide can, under the influence of heat from the compressor frame and possibly pressure drops, separate some of the refrigerant. Hereby, the oil/gas mixture will become compressible.

It may happen that the capacity slide moves in jumps. It may also happen that when the compressor capacity is going to be changed 100% to a lower capacity, the slide will hesitate and not move right after being activated.

2. Manual regulating of V_i -slide

Fig. 2



T0177141_0/V6

The above drawing - which is a section from the blue spare parts drawing - shows the design of the manual V_i -system operating as follows:

Function

The V_i -slide Pos. 190 functions as a movable stop for capacity slide Pos. 200 when this is in its max. position. On turning the adjusting screw Pos. 180 the compressor V_i is set so that its compression ratio is adapted to the pressure ratio $\frac{CT}{ET}$ of the plant when working at max. capacity.

This way the compressor works most economically.

- By turning the spindle **clockwise** a higher V_i is obtained.

- By turning the spindle **anti-clockwise** a lower V_i is obtained.

Note:

On adjustment of the V_i the compressor must be stopped and the pressure between the compressor discharge side and suction side must be equalized.

Adjusting of V_i

Before the initial start-up of the compressor, check the x measure as shown in fig. 2, **while the compressor is idle.**

- Turn the spindle Pos. 180 **anti-clockwise** until it gets loose and is easy to turn by hand.
- By hand, turn the spindle **clockwise** until it touches the end of the V_i -slide stop as shown in fig. 2.
- Check the distance x which, depending on the compressor size, must be:
 - SAB 110S, $x = 44$ mm
 - SAB 110L, $x = 54$ mm
- If necessary, the x measure can be adjusted by loosening the two nuts Pos. 181 and counter-tightening them again after the adjustment.

For correct adjustment of V_i -slide position, use the diagrams on the next pages as follows:

Use diagram for either SAB 110S or SAB 110L. For the actual refrigerant (R717 or R22, R134a, R404A/R507, R407C) and evaporating temperature TE, follow horizontal line to intersection with curve for actual condensing temperature TC.

From this intersection point, two readings can be made by following the line vertically up or down:

- **Vertically up**, the V_i -ratio referring to scale on compressor capacity indicator is read. Observe whether or not the compressor is connected to an **economizer**.

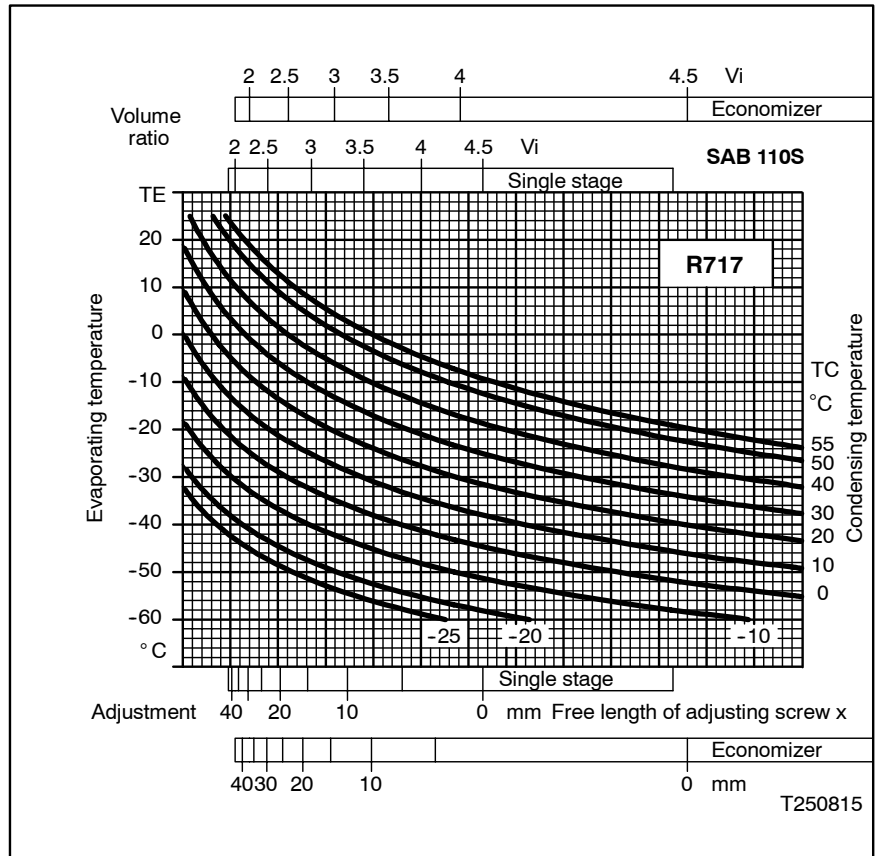
- **Vertically down**, the length x is read in mm (fig. 2), to which the adjusting screw Pos. 180 must be adjusted in order to achieve the correct V_i -setting. Also here observe whether or not the compressor is connected to an **economizer**.

The setting of the V_i -slide may be checked by reading of the scale on the indicator glass.

Note, that the values of the V_i -scale are only valid as long as the compressor runs at 100% capacity.

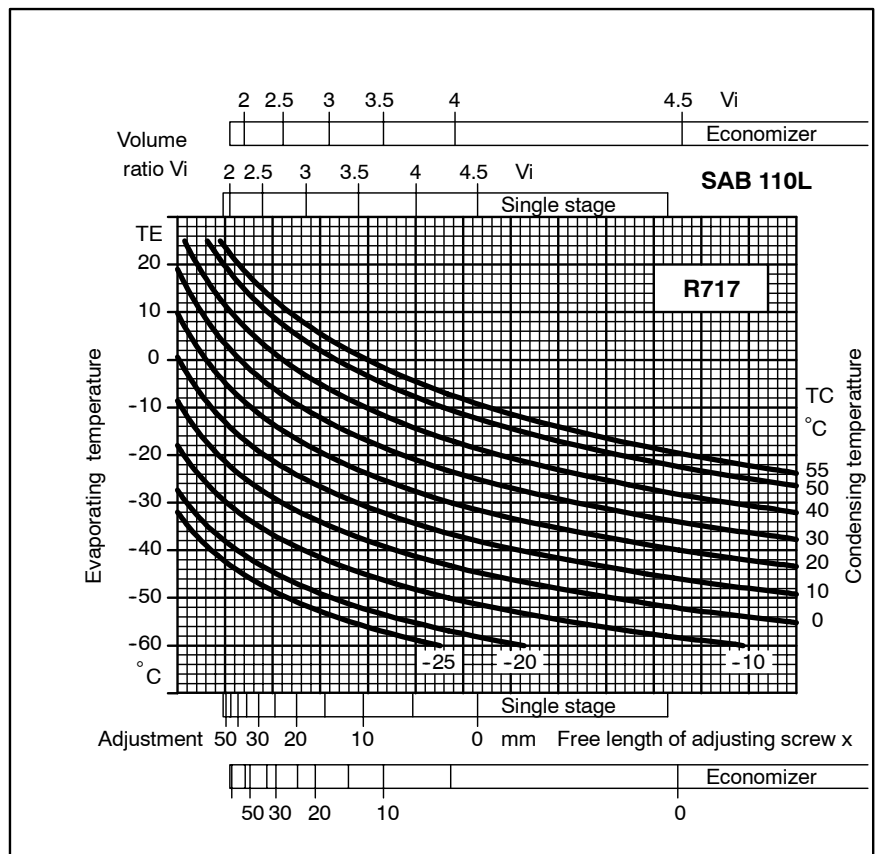
**Adjusting the
Vi-slide stop
position
SAB 110 S
R717**

(T250815)



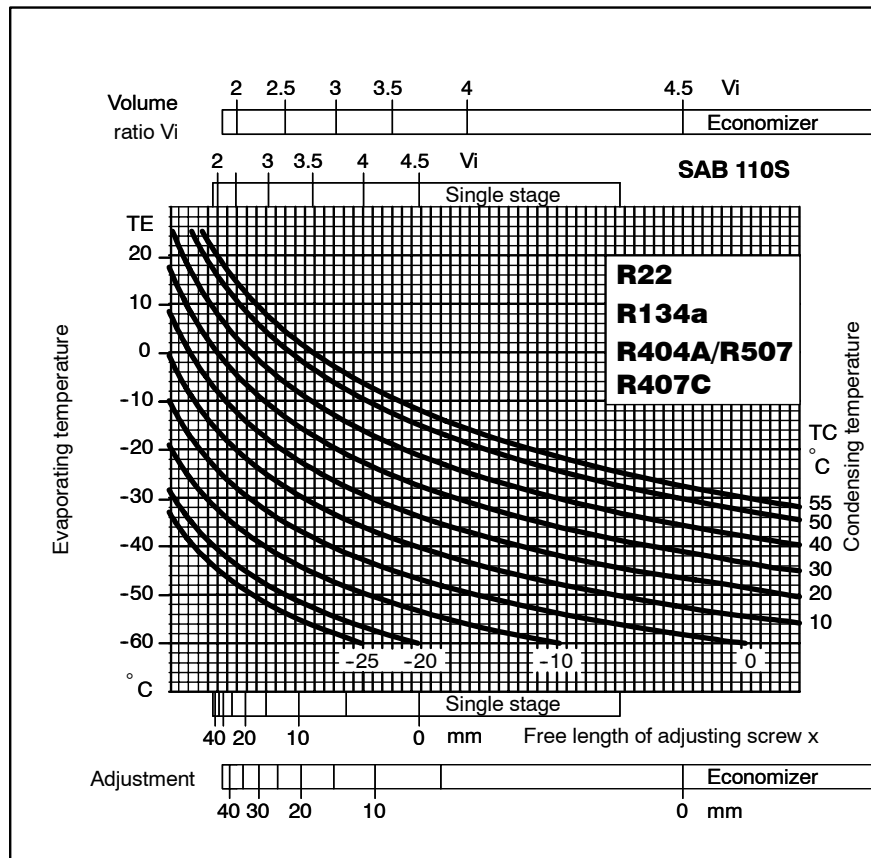
**Adjusting the
Vi-slide stop
position
SAB 110 L
R717**

(T250816)



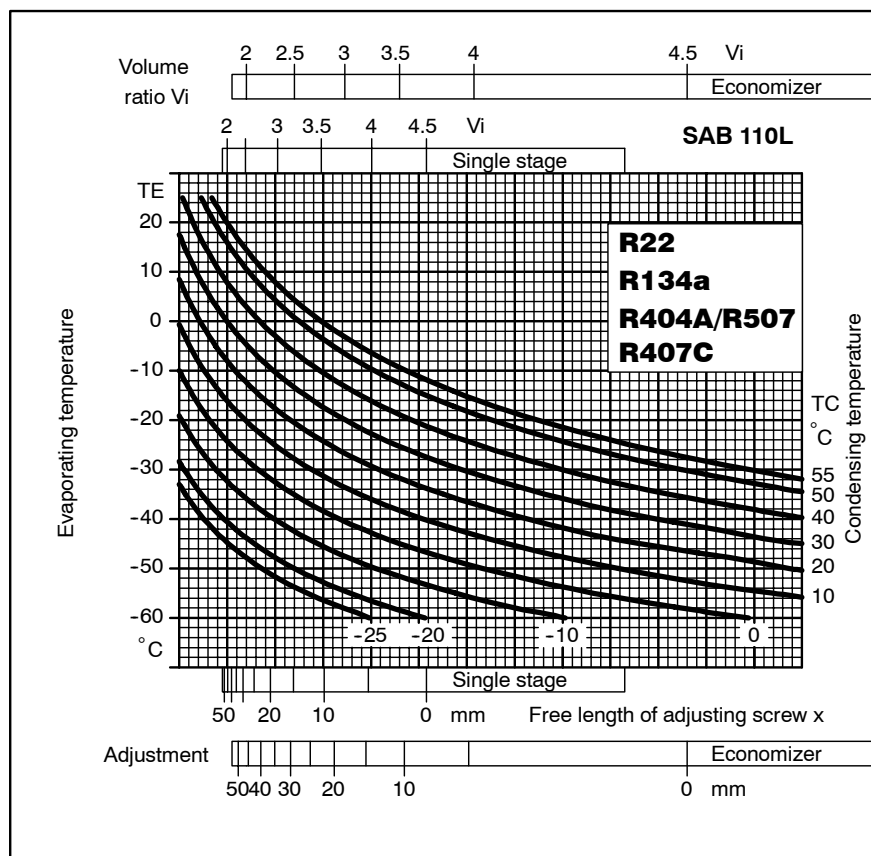
**Adjusting the
V_i-slide stop
position
SAB 110S
R22
R134a
R404A/R507
R407C**

(T250813)

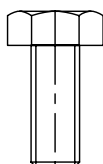


**Adjusting the
V_i-slide stop
position
SAB 110L
R22
R134a
R404A/R507
R407C**

(T250814)

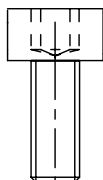


Torque moments for screws and bolts



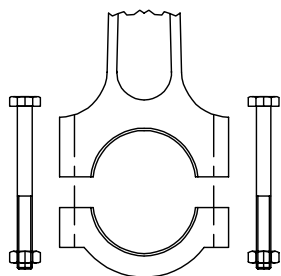
Metric thread (ISO 8.8)

M	4	5	6	8	10	12	14	16	18	20	22	24	27
Kpm	0.28	0.53	0.94	2.2	4.1	7.0	11	15	23	30	38	52	68
ft.lbf.	2.1	3.9	6.8	16	30	50	80	110	170	220	270	370	490
Nm	2.7	5.2	9.2	22	40	69	108	147	225	295	375	510	670



Metric thread (ISO 12.9)

M	4	5	6	8	10	12	14	16	18	20	22	24	27
Kpm	0.42	0.78	1.4	3.2	6.1	10	16	23	34	44	55	76	100
ft.lbf.	3.0	5.7	10	23	44	75	120	160	240	320	400	550	720
Nm	4.1	7.6	14	31	60	98	157	225	335	430	540	745	980



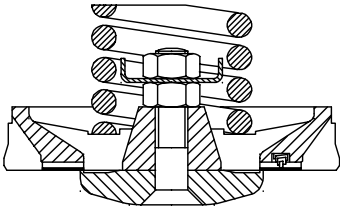
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Connecting rods with UNF thread

	HPO/CMO	HPC/SMC 100	SMC 180
UNF	5/16"	3/8"	5/8"
Kpm	2.1	4.4	17
ft.lbf.	15	32	130
Nm	20	43	167

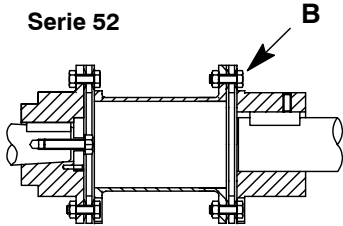
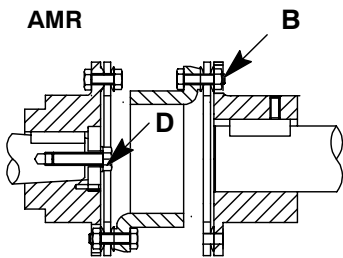
Bolts for top-, side- and end covers

Compressor Location	T/CMO		HPO		T/SMC 100	HPC	T/SMC 180
	Top/side covers	End covers	Top/side covers	End covers	Top/side and end covers	Top/side and end covers	Top/side and end covers
M	M12	M14	M12	M14	M14	M14	M20
Kpm	8.6	13.7	13.2	20.3	13.7	20.3	42.7
ft.lbf.	63	100	95	147	100	147	310
Nm	85	135	130	200	135	200	420



Bolt on discharge valve

	HPO/CMO	HPC/SMC 100	SMC 180
Kpm	3.2	10.2	35
ft.lbf.	23	75	255
Nm	32	101	344



Compressor Type	Coupling Type	Thread	Torque					
			Kpm.		ft.lbf.		Nm	
			B	D	B	D	B	D
HPO/CMO/TCMO	AMR225	5/16"	3.5	13	25	96	34	130
	104-108 AMR312S	7/16"	5.6	20	40	147	55	200
HPC/ SMC/ TSMC	112-116 AMR350S	1/2"	13	20	95	147	128	200
	186-188 AMR450S	11/16"	28	13	200	96	275	130
Compressor Type	Coupling Type	Thread	Torque (B)					
			Kpm.	ft.lbf.	Nm			
SAB	128	Serie 52	225	5/16"	3.5	25	34	
	163		262	3/8"	4.2	30	41	
	202		312	7/16"	5.6	40	55	
VMY Depends on the size of the motor	Serie 52	200	5/16"	3.5	25	34		
		225	5/16"	3.5	25	34		
		262	3/8"	4.2	30	41		
		312	7/16"	5.6	40	55		
		350	1/2"	13	95	128		
		375	9/16"	18	130	177		
		425	5/8"	25	175	245		
		450	11/16"	28	200	275		

Component description

SAB 110

In the component descriptions of this section the same position nos. are used as in the pipe diagram. Some descriptions include drawings. In case wearing parts or gaskets are included in the component, the spare part numbers can be found in the list on unit spare parts.

Oil separator, pos. 25

The oil separator of the compressor unit has several functions:

- It serves as oil reservoir for the oil system which ensures lubrication and cooling of the screw compressor.
- It also serves as basis for compressor block with flanged on motor. On fig. 1 and 2 is shown the application of the individual connections.
- Further, the oil is separated from the discharge gas in the oil separator by making the discharge gas pass through a wire-mesh filter in which the major part of the oil is separated, and then a fine filter called a **hydrophobic filter element**, in which the smaller oil drops are held back.

In this way the oil separation is made so effective that the oil remains after the oil separator becomes less than 25 ppm.

At the other end of the oil separator a flange is fitted through which the hydrophobic filter element can be removed for inspection and replacement, if necessary.

Service

Normally, there is no need to inspect neither the wire-mesh filter nor the hydrophobic filter element.

Only in case of an abnormal rise in oil consumption should an inspection of the hydrophobic filter element be carried out.

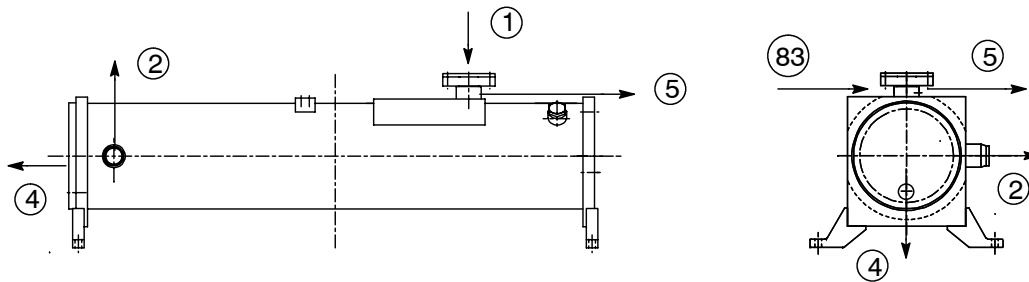
Note:

The hydrophobic element is secured by a number of stay bolts. If you dismantle the element, the stay bolts - which are all screwed into the intermediate plate - must be tightened with teflon tape in the threads. In this way, the necessary tightness is obtained for the oil between the two chambers of the oil separators.

The oil held back in the hydrophobic element is returned to the suction side of the compressor through a filter **pos. 51** and a nozzle **pos. 52**.

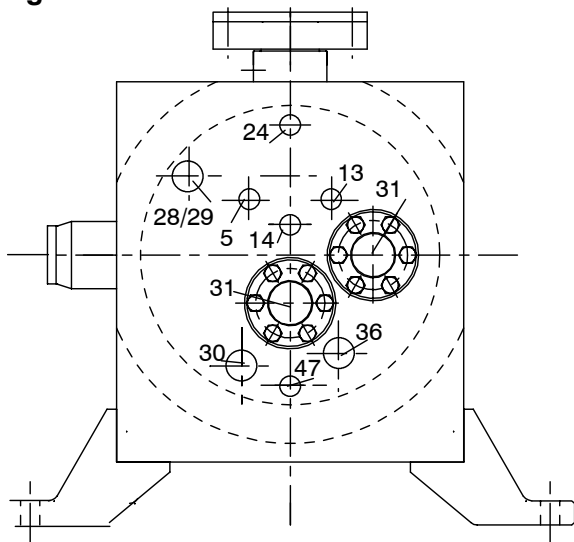
During operation **the oil level** in the oil separator must be visible between the middle of the lower sight glass and the middle of the upper sight glass, both of which are placed in the flat end plate as illustrated in fig. 2.

Fig. 1



Connection	Applied for
1	Oil inlet refrigerant
2	Outlet refrigerant gas
3	Oil for oil cooler
4	Oil from fine separator
5	Discharge pressure to instrument panel or UNISAB II
83	Sensor positioning for injection valve for HLI cooling

Fig. 2



No.	Applied for
36	Oil admission to oil cooler/oil filter
31	Oil level sight glass
5	Discharge temp. Instr. panel = thermometer UNISAB II = sensor PT 100
24	Service valve
28/29	Safety valve G 3/4"
13	Discharge temp. external oil cooler = sensor KP81
5	HLI injection oil cooling = sensor KP79 (only where instrument panel applied)
14	Injection oil cooling discharge temp. = sensor KP77 (only where instrument panel applied)
47	Service valve
30	Heating rod

In the table on oil charging you may see the oil quantity for the compressor unit but it does **not** include the amount of oil which is circulating in the refrigerating plant. In R22 systems with large quantities of refrigerant special allowance must be made for the

amount of oil dissolved in the refrigerant.

Consequently, attention must also - during the operating period after the initial start-up - be paid to the fact that the oil level may sink rather quickly until the oil contents in the refrigeration system has stabilized.

Discharge stop valve and non-return valve

Discharge stop valve:

The standard unit is delivered with a **stop valve** welded on the discharge branch of the oil separator. The discharge branch of the stop valve is made for welding connection and has the following dimensions:

Units with the following compr.type	Stop valve dimension mm
SAB 110	DN 50

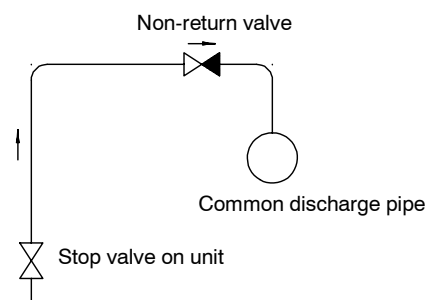
Non-return valve:

Next to the discharge stop valve a non-return valve must be fitted in the discharge pipe which closes tightly whenever the pressure in the oil separator is reduced to suction pressure in the unit standstill period.

The non-return valve **must** be positioned on the uppermost part of the discharge pipe as shown in fig. 3. This prevents any condensation that may have been created in the discharge pipe during the standstill of the unit from running into the oil separator during re-start of the unit.

The size of the non-return valve must be calculated on the basis of the current operating conditions of the unit.

Fig. 3



Heating Rods, pos. 30, Element for Oil Heating

In order to keep the lubricating oil in the compressor warm during an idle period, the oil receiver has one or two built-in heating rods. Before start-up, the heating rod/s must have been activated for six to eight hours to ensure that there is only a minimum of refrigerant in the oil. When containing much refrigerant, the oil will lose its lubricating property and the following operational interruptions may occur:

In **reciprocating compressors** there is a serious risk that the oil will foam when the compressor starts as a result of the falling suction pressure.

For **screw compressors** starting with much refrigerant dissolved in the oil, there is a risk of the compressor being stopped by the flow switch. The reason for this is that the oil will

foam owing to the fall in pressure through oil pipe and oil filter.

As illustrated in the drawing Fig. 1.1 the heating rod consists of an electric heating element incorporated in a pipe with a diameter of 30 mm. The entire heating cartridge is screwed on tight at the G 1 1/4" thread.

Note:

The heating rod must not be energized if the oil level in the receiver is below the minimum mark in the sight glass, and it should generally be switched off during compressor operation. For reciprocating compressors, remember to turn off the heating rod whenever the crankcase is opened for inspection.

The following table shows which heating rods are used for the various compressor types. The spare parts lists for compressor and unit include the current part numbers.

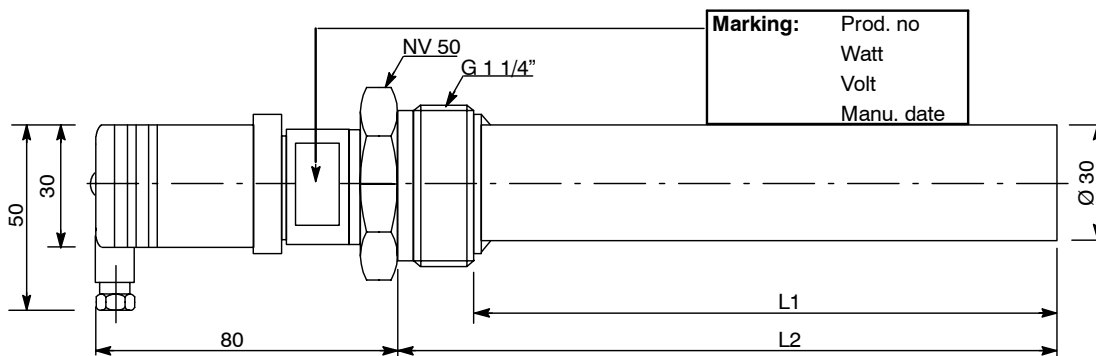
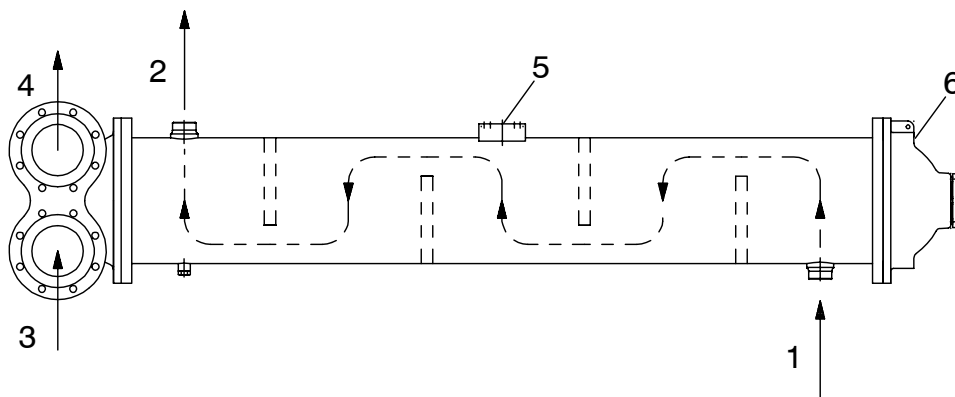


Fig. 1.2

Heating rods				Used for:
Power Watt	Voltage V	L1 mm	L2 mm	
270 270 270	250 230 115*	158	175	CMO - TCMO - SMC 100 - TSMC 100
460 460 460	250 230 115*			HPO-HPC-SMC180-TSMC180- SAB81/83/85/87/89-SAB110-SAB128Mk3/4- SAB163Mk3/4-SAB128HR-SAB163HR- SAB202-SAB330-VMY536-SAB283L/E-SAB355L

* Can be delivered with a UL approval. All heating rods are executed in **Degree of Protection IP54**.

Water-cooled oil cooler, type OWSG/OWRG for screw compressors types SAB 110, SAB 128/163 Mk3, SAB 202



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No	Application
1	Hot oil inlet
2	Cooled oil outlet
3	Water inlet
4	Water outlet
5	Type plate
6	Air purging from water side

For oil cooling with water a welded shell and tube heat exchanger of the OWSG/OWRG type can be supplied.

Design

In principle the oil cooler consists of a cylindrical shell with a steel tube insert.

The cooler has oil inlet and outlet branches in the shell, whereas the water inlet and outlet are positioned in one of the end covers.

The covers are made of cast iron. The tube insert consists of two tube plates into which a number of tubes are welded.

Baffle plates are positioned between the tubes to extend the oil passage through the cooler, thus causing the oil to flow across the

tubes. This improves the heat transmission from oil to cooling water significantly.

The end covers are designed to lead the water back and forth a number of times to ensure adequate water velocity.

Oil cooler, type **OWRG**, is made of stainless steel and available in two versions, one for freshwater and one for sea water. The type is indicated on the name plate.

Furthermore, the oil cooler can be fitted with end cover corrosion plugs. To ensure the oil cooler corrosion resistance, the pipes must never become overheated. Consequently, they must **not** be uncovered.

To avoid this, it is important that:

- there are no air pockets on the water side. Therefore, the oil cooler must be supplied

with a purge valve at the top of the cover without connections. This valve may be left out if the water discharge pipe points upwards so that air can escape together with the water.

- the water velocity through the oil cooler is never be below 1.5 m/sec. Furthermore, the high water velocity prevents fouling in the oil cooler.

In the fresh water versions, the content of chloride (Cl^-) in the water must not exceed 400 ppm.

In the case of a chlorine treatment, if any, of water for the sea water version, the amount of chlorine must not exceed 0.5 mg Cl_2 per litre water for 30 min. once every 24 hrs.

Besides, the oil cooler must be drained of water for longer standstill periods (more than 1 or 2 weeks).

Application

The **OWSG** type oil cooler is designed for connection to a freshwater system incorporating anti-corrosion and anti-scaling measures.

When operating with a cooling tower, rust inhibitors, algicides and anti-fouling must be

added to the water according to normal practice in connection with cooling tower systems.

The **OWRG** oil cooler type is used where the quality of the water cannot be guaranteed satisfactory and constant.

Cleaning

Fouling or soiling of the water side will reduce the heat transfer, and hence the cooler capacity.

The cooler must therefore be checked and cleaned at regular intervals, depending on the degree of cooling water purity. The internal pipe diameter is 8 mm.

The **OWSG/OWRG** oil cooler can be cleaned by removing the end cover with no connection branches and scrubbing the tubing clean with a bronze brush.

Give the tubing a final rinse with fresh water. Alternatively, ready-mixed inhibitive scouring acids can be used with subsequent neutralization. Such agents must be designed for untreated steel tube heat exchangers. The chemical manufacturer's instructions should be followed precisely.

Regulating the oil temperature

Open system:

If the oil cooler is connected in an **open system**, i.e. it cools by means of cooling tower water, other fresh water or sea water, the oil temperature must **not** be regulated by altering the water flow through the cooler.

A decreasing water flow will result in fouling and perhaps in clogged-up tubes which would lead to corrosion on the tubes.

Instead, the following is prescribed:

- If necessary, use a temperature-regulated three-way valve to regulate the oil flow through the cooler.

On SAB 202 the oil temperature regulation is based on a two-way valve incl. pilot valve. See piping diagram.

- Or use a temperature-regulated three-way valve on the water side in connection with a water pump to maintain the prescribed water flow through the oil cooler.

Closed system:

OWSG

If this oil cooler is connected in a **closed system**, such as a heat recovery system, the water flow can still be regulated.

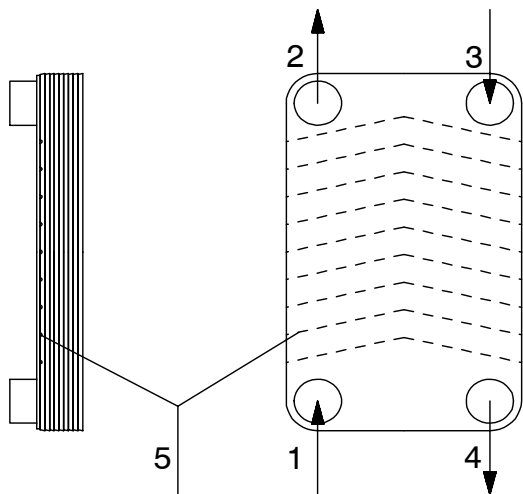
OWRG

Only use the mentioned oil coolers for the prescribed water flow in order to minimize the risk of corrosion as a result of the combination of **high temperature** and **Cl⁻** content in the cooling water.

Therefore, we recommend the use of the same regulating system as prescribed under *Open system*.

Water-cooled oil cooler, type B

SAB 110, SAB 128/163 Mk3, SAB 202



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No	Application
1	Hot oil inlet
2	Cooled oil outlet
3	Water inlet
4	Water outlet

Design

The type B oil cooler, is a stainless steel plate heat exchanger. A V pattern is moulded into each plate together with the inlet and outlet holes. The plate heat exchanger is assembled by turning the V patterns alternately upwards and downwards. All points of contact between the V patterns are soldered with copper. On each side a supporting plate is soldered. Between the supporting plate fitted with connecting branches and the first heat exchanger plate a row of channels is visible. Check by means of a welding rod that the V pattern faces upwards so that water will not accumulate. The heat exchanger cannot be dismantled and must **not** be used in R717 plants.

Application

The type B oil cooler can only be used with freshwater as cooling agent.

For water cooling of oil in units with HFC/ HCFC, a type B soldered plate heat exchanger can be used. Refer to page 1 to see the type of oil cooler used for this unit.

Cleaning

Since the oil cooler cannot be dismantled, mechanical cleaning is not possible. It is therefore recommended to fit the water filter before the oil cooler. Cleaning can only be carried out with a cleaning fluid. The cleaning intervals for the cooling water side of the heat exchanger should be determined on the basis of the hardness of the water and its tendency to leave deposits.

For cleaning purposes a weak acid can be used, e.g. a 5% phosphoric acid or if the heat exchanger is cleaned often, a 5% oxalic acid solution. Afterwards it is necessary to rinse with plenty of pure water to remove any remaining acid and dirt.

Oil temperature regulation

Open system

If the oil cooler is connected in an **open system**, ie that it is cooled by means of water from a cooling tower, other fresh water or sea water, the oil temperature must **not** be regulated by altering the water flow through the cooler.

A decreasing water flow could lead to fouling and perhaps clogged-up cooling pipes which would lead to corrosion on the pipes.

Instead, the following is prescribed:

- Adjust the oil flow through the cooler by means of the temperature-regulated three-way valve.

- Or use a temperature-regulated three-way valve on the water side in connection with a water pump to maintain the prescribed water flow through the oil cooler.

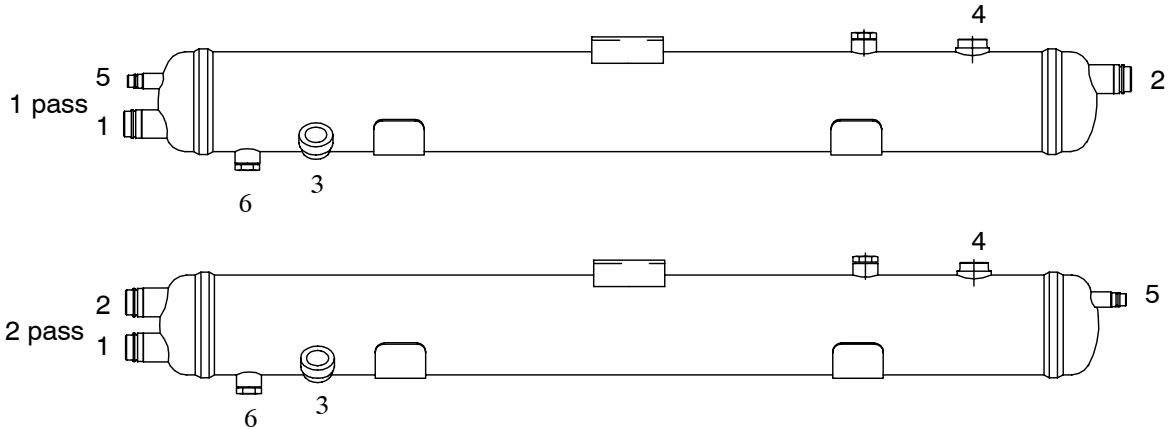
Closed system

Only use the type B oil coolers for the prescribed water flow in order to minimize the risk of corrosion as a result of the combination of **high temperature** and **Cl⁻** content in the cooling water.

Therefore, we recommend the use of the same regulation system as prescribed under *Open system*.

Refrigerant-cooled oil cooler type OOSI

SAB 110, SAB 128/163 Mk3



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1	Oil inlet	4	Refrigerant outlet
2	Oil outlet	5	Oil draining (oil side)
3	Refrigerant inlet	6	Oil draining (refrigerant side)

Construction

The oil cooler consists of a cylindrical shell with welded-on tube plates in which is welded a number of tubes. Each tube plate has an end plate welded in. The oil cooler is thus an assembled, all-welded construction. The end plates are provided with welding branches for oil connection and drainage. The shell has welding branches for refrigerant connection, and for draining oil when operating with the R717.

Function

Oil flows through the tubes, which are designed for extremely efficient heat transfer between oil and tube walls.

For cooling of the oil, liquid refrigerant from the system receiver or a special priority tank is fed to the oil cooler. The refrigerant partly evaporates on the outside of the tubes, and the mixture of liquid and gas is piped to the condenser.

The receiver or priority tank is normally positioned at a suitable height above the oil cooler, thus supplying adequate refrigerant by natural circulation. Alternatively, a pump can be used to effect refrigerant supply.

Cleaning

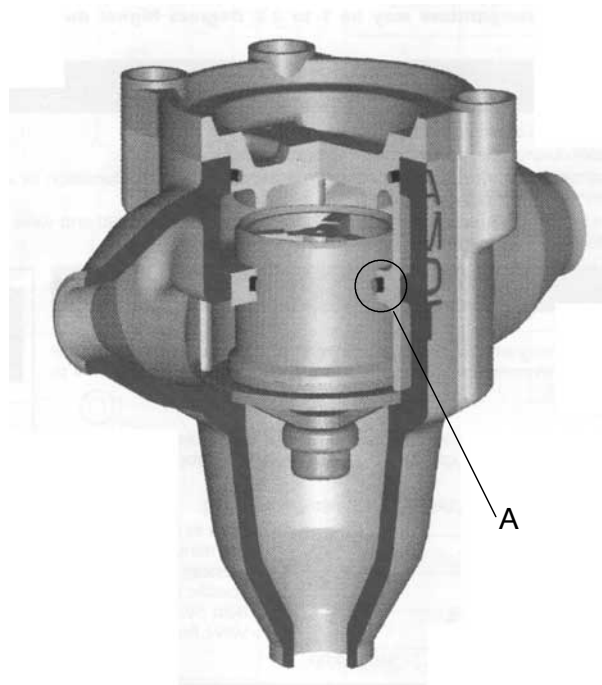
Since both the oil side and the refrigerant side of the oil cooler form part of closed systems, no cleaning will be required.

Oil temperature regulating system

SAB 110, 128, 163, 202 and VMY 536

In above screw compressor units, in which the oil system is cooled by means of either a refrigerant-cooled oil cooler type OOSI or a water-cooled oil cooler type OWSG, the oil temperature is usually regulated by a **thermostatic three-way valve** as illustrated in fig. 1.

Fig.1



This thermostatic three-way valve is used in the following dimensions for above-mentioned compressor units:

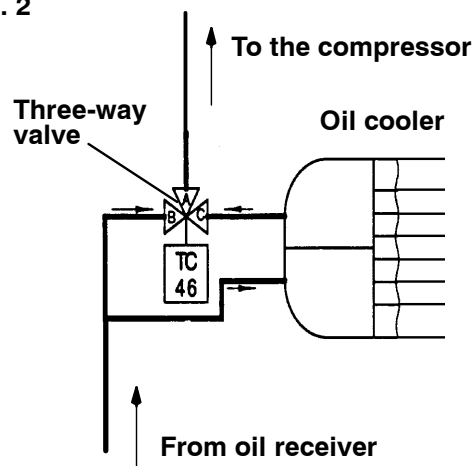
Compressor unit	Valve dimension	Welded connection
SAB 110	RT3	DN 25
SAB 128	RT3	DN 25
SAB 163	RT5	DN 40
SAB 202	RT6	DN 50
SAB 330	RT6	DN 50
VMY 536	RT6	DN 50

The valve dimension can be read from the nameplate on the valve cover.

Function

Valve pos. 46 is fitted in a bypass piping system as shown in fig. 2:

Fig. 2



As shown in fig. 3 and 4, it works by letting a built-in thermo element, pos. 1, regulate a cone, pos. 2, so that cold and warm oil is mixed to the set temperature.

In fig. 3 the thermo element is shown in its cold position, i.e. the flow of cold oil has been shut off whereas the flow of warm oil is completely unobstructed. Fig. 4 illustrates the opposite situation in which the thermo element is in its warm position, hereby shutting off the flow of warm oil.

During operation the thermo element will adjust the regulating cone modulantly so that the two oil flows are mixed to the set oil tem-

perature, leaving the valve through connecting branch A.

Fig. 3

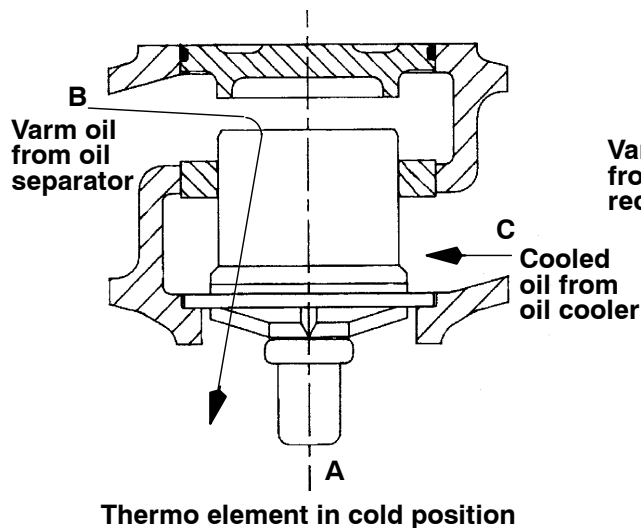
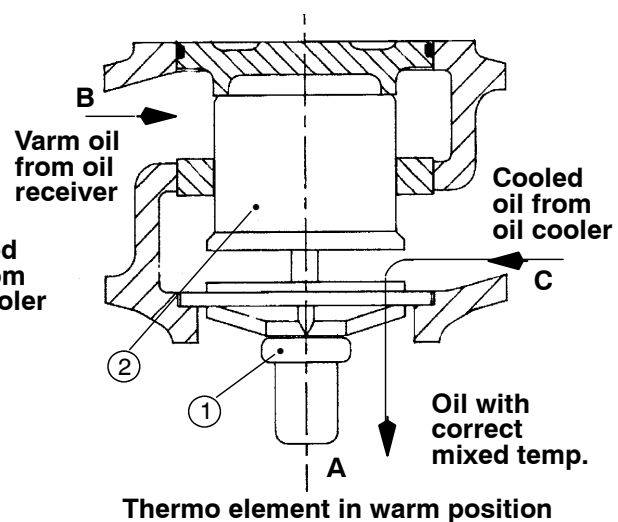


Fig. 4



The thermo element is factory set to maintain a mixed oil temperature of **48°C**, allowing for a few degrees' deviation and it **cannot be readjusted**.

Service:

As a rule, it is not necessary to dismantle a well-functioning three-way valve as it does **not** contain any gaskets or wearing parts that must be replaced at fixed intervals.

Dismantling:

During dismantling, if any, apply the following procedure:

- After the pressure in the piping system has been equalized to atmospheric, unscrew the four Allen screws that keep the cover fixed to the valve housing.
- The cover which reaches down into the valve housing in order to keep the thermo element in a fixed position, is most easily dismantled by turning it slightly and then

lift it up by means of a big screwdriver.

Watch out ! There may still be oil in the system.

- The thermo element can now be extracted from the valve housing by hand.

Assembling:

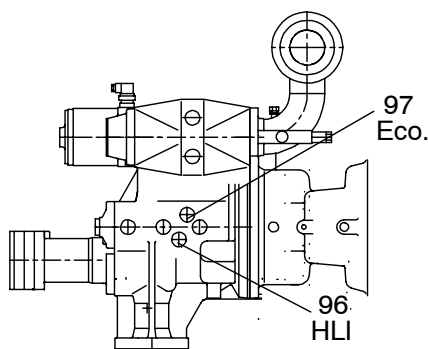
Assembling the valve is done in the reverse order and attention should be paid to the following:

- The O-ring, fitted in the cover, should be replaced by a new one. See section *Spare Parts Survey* in this manual.
- **No** sealing ring should be fitted between the inner guideway of the cover and the valve cone.
- In case the three-way valve does not regulate the oil temperature correctly, the thermo element and cone can be replaced as one entire unit. See section *Spare Parts Survey* in this manual.

Injection of refrigerant into compressor HLI (High-stage Liquid Injection) SAB 110

Function

During compression of refrigerant vapours from evaporator pressure to condensing pressure, some heat is generated that must be dissipated in order to keep gas and oil temperatures at a suitable level. This is done by injecting liquid refrigerant from the receiver into the compressor at a suitable stage in the compression process, controlled by a modulating injection valve type TEAT. The liquid refrigerant evaporates in the hot mixture of oil and refrigerant gas, whereby the mixture is cooled.



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Size of injection valve and temperature range of thermo couple have been chosen on the basis of evaporation temperature of refrigerant, condensing temperature and cooling requirements as specified in order.

The thermo couple, measuring discharge gas temperature at inlet to oil separator, is available in 2 different versions with working areas:

- A:** 35-65°C
- B:** 55-95°C

Sensor type **A** is always used for refrigerant R717. For refrigerant R22, both thermo ele-

ments can be used, provided that:

Type **A** is used **up to and including**

TC = 35°C

Type **B** is used **above**

TC = 35°C

An economiser can be connected to the compressor. An economiser is a heat exchanger cooling liquid from receiver to plant. A minor part of the liquid will evaporate and be sucked to compressor gate no. 97.

The liquid supply to the HLI-system must be taken from a place in the plant in which refrigerant is **always** sure to be found. In this way cooling of compressor is ensured!

Adjustment

The injection valve is factory **opening temperature** in the middle of the temperature area of the thermo couple.

Before starting compressor, adjust **opening temperature** of injection valve to:

20°C lower than the desired discharge gas temperature.

See *Diagram for Adjusting Values* and Danfoss Instructions for setting the injection valve.

Fine adjust the valve once the installation is in stable operation.

By HLI operation, there is normally a thin foam layer on the oil in oil separator. Heavy foaming may be a sign of excessive liquid supply in which case it must be checked that the discharge gas temperature is not too low in relation to condensing temperature!

See Adjustment Diagram.

Safety and monitoring devices

SAB 110, SAB 128/163 Mk3, SAB 202, SAB 283L/283E

Compressor units with relay control or terminal strip for remote control are normally equipped with the following instruments for safety and operating control, depending on the specific order.

Safety devices

Pos. 28 Safety valve on oil separator with exhaust to the atmosphere. The exhaust line must be routed from the engine room out into the open air.

The SAB 110 compressor has a built-in by-pass safety valve which, in case of too high differential pressure across compressor, will lead gas from the oil separator to the compressor suction chamber. The opening pressure the of safety valve is indicated on its name plate.

Pos. 43 Flow control in the oil distributor pipe. A spherical float with a permanent built-in magnet is able to actuate a reed switch in the float guide. The switch is wired up to a timing relay which will stop the compressor if the flow control chamber is not filled with oil within max. 50+10 sec. after start-up, or after 10 sec. without oil during normal operation.

Pos. PAZ1 Pressure cut-out **KP1**, which stops the compressor in the event of the suction pressure falling below the set value. The

pressure cut-out is not equipped with a reset, so the compressor starts again when the pressure has risen above the difference between the setpoints of the pressure cut-out.

Pos. PAZ2 High pressure cut-out **KP5**. The pressure cut-out is intended to safeguard the compressor against excessive discharge pressure.

Note: On units to be approved by TÜV (*Germany*), the **KP5** is replaced by a pressure cut-out **KP 7ABS** which has been approved by TÜV. This high pressure cut-out will stop the compressor in the event of damage to the cut-out bellows or excessively high discharge pressure.

Pos. PDAZ 11 Differential oil pressure cut-out **MP55**. This pressure cut-out is designed to ensure sufficient lubricating pressure and oil pressure for capacity regulation. The pressure cut-out is equipped with a time lag of 45 secs. If the preset differential pressure has not been obtained by that time, the compressor will stop. The **MP55** is equipped with manual reset.

Pos. 0376-A12 Differential pressure cut-out for control of pressure drop across oil filter. If pressure drop across oil filter becomes excessive

due to impurities, the pressure cut-out will stop the compressor and a pilot lamp will light. Further, the differential pressure cut-out contains a visual indication of pressure drop represented by a green field for permissible pressure drop and a red field indicating excessive pressure drop across oil filter in which case the pressure cut-out will stop the compressor.

Pos. TAZ12 Thermostat **KP79** with sensor in oil flow control. Designed to safeguard against excessive oil temperature.

Pos. TAZ13 Thermostat **KP79** or **KP81** with sensor in oil separator. Designed to safeguard against excessive discharge gas temperature.

Pos. TC14 Thermostat **KP77** with sensor in oil separator. Designed to safeguard against too low discharge

pipe temperature and hence too low oil temperature in connection with **HLI** oil cooling.

Please see section on setting of safety devices for various values.

Monitoring devices

Pos. PI15 Suction pressure gauge (evaporator pressure)

Pos. PI16 Discharge pressure gauge (condenser/intermediate pressure)

Pos. TI5 Thermometer in oil separator (discharge gas temperature)

Pos. TI6 Thermometer in oil flow control (oil temperature)

Pos. TI7 Thermometer with sensor in suction pipe. Supplied as extra. Used to calculate superheat of the suction gas. Superheat is the temperature difference found by deducting the temperature read off the suction pressure gauge from the temperature read off the thermometer.

Refrigeration Plant Maintenance

Operational reliability

The prime causes of operating malfunctions to the plant are:

1. Incorrect control of liquid supply to the evaporator.
2. Moisture in the plant.
3. Air in the plant.
4. Anti-freezing liquid is missing.
5. Congestion due to metal shavings and dirt.
6. Congestion due to iron oxides.
7. Congestion due to copper oxides.
8. Inadequate refrigerant charge.

Below, some information is given about ways of keeping contaminants out of the refrigerating system and at the same time facilitating day-to-day supervision of the refrigeration plant.

Pumping down the refrigeration plant

Before dismantling any parts of the refrigeration plant for inspection or repair, pump-down must be carried out.

1. Open suction and discharge stop valves on compressor.
2. Close liquid stop valve after condenser or receiver so that liquid refrigerant can be collected in the tank. Any solenoid valves in the liquid line should be opened by force, adjusting the thermostat to its lowest position so that the liquid line can be

bled of refrigerant. Adjust any constant-pressure valves to bring evaporator pressure down to atmospheric.

3. Start up the compressor. Adjust regulating system to lower suction pressure.
4. **Keep a close eye on the suction pressure gauge!** When the suction pressure is equal to atmospheric, stop the compressor and quickly shut off the discharge stop valve. Shut off any stop valve in the oil return line.

If the receiver has an extra stop valve in the feed line, this can be closed; practically the entire refrigerant charge will then remain shut off in the receiver.

Note:

The receiver must not be overfilled! There should be a minimum gas volume of 5%.

5. A slight overpressure should normally remain in the piping system - this safeguards the system against the penetration of air and moisture.
6. Before dismantling parts, **the operator should put a gas mask on.**

Dismantling plant

In order to prevent moisture penetrating into the refrigeration plant during any repair work, it is advisable to follow the rules below:

1. No component should be opened unnecessarily.
2. When dismantling the system, the pressure in the system should be a little higher than atmospheric.

3. Note:

*If the piping system is colder than the surroundings, there is a considerable risk of damp precipitation (condensation) on cold plant parts. Plant components to be dismantled **must** be warmer than the ambient temperature.*

4. No two points in the system should be opened at the same time.
5. Plug, close or at least cover opening with oiled paper or suchlike.
6. Be aware of the possibility of filters being very moist.

Tightness testing and pump-down of refrigeration plant

Before charging refrigerant into that part of the refrigeration plant which has been opened, this should be pressure-tested as described in the section entitled *Pressure testing*.

Afterwards, pump down in order to eliminate air and moisture. In this regard, consult the section on *Evacuation*.

Otherwise, follow the instructions given in the separate instruction manual on plant components.

Note:

If the oil in the crankcase of the piston compressor or the oil separator of the screw compressor has been in contact with the atmospheric air for any length of time, it must be replaced with fresh oil of the same grade and make.

Troubleshooting on the Screw Compressor Plant

Operating condition

Experience shows that pressure and temperature variations in a refrigerant system can provide information about the operating condition of the refrigeration plant.

In particular, suction and condenser pressures as well as the temperatures of suction and discharge gases may provide important information as to the operating conditions of the plant.

Considerable changes in operating conditions can often be produced by only very slight modifications to variable pressures and temperatures.

Using the following troubleshooting chart, it is possible to ascertain the cause of and remedy for any operating disturbance.

Using the troubleshooting chart

In the following chart each individual error possibility is indicated by a code number in the left hand column, with the error briefly described in the second column. The third column states code numbers for the possible causes of the error.

The code numbers refer to the subsequent chart. The section entitled *Remedying malfunctions* states how to remedy the observed error. See the following example for the correct procedure.

Example

Observed error: "excessive suction pressure" - error code 5.

Cause codes: 2. (compressor lacks capacity) and 48. (safety valve leaky or opens prematurely). The entry keys to the subsequent section are therefore (5,2) and (5,48).

Fault Code	Observed Fault	Probable causes
1 2 3	Excessive suction pressure Suction temperature is too low Suction pressure is too low	2, 28, 48, 49. 31, 32. 1, 14, 27, 28, 29, 30, 33, 40, 42.
4 5 6	Compressor starts and stops too frequently, at low-pressure cut-out Excessive suction pressure Compressor starts and stops too frequently, at high-pressure cut-out	1, 14, 27, 28, 29, 30, 33, 39, 42, 49. 2, 48. 38, 41, 43, 44.
7 8 9	Excessive condensing pressure Condensing pressure too low Oil pressure too low	22, 23, 24, 26, 38, 41, 43, 44. 2, 22, 23, 24, 26. 5, 11, 25, 31, 32.
10 11 12	Oil temperature too high Oil temperature too low Excessive pressure drop across oil filter	13, 18, 19, 20, 37, 48. 21, 50. 19.
13 14 15	Excessive capacity - aut. controls out of order Insufficient capacity - aut. controls out of order Oil level in the reservoir falls	3, 4, 12. 3, 4. 15, 16, 17.
16 17 18	Oil foams vigorously during standstill Oil reservoir sweating during standstill Abnormal noise from compressor	31, 32. 47, 50. 5, 7, 8, 9, 10, 31, 32, 48, 52.
19 20 21	Compressor motor will not start Compressor runs continuously Liquid in the suction line	6, 12, 13, 19, 34, 35, 36, 40, 41, 45, 46, 47 2, 3, 4, 42, 48, 49. 1, 31, 32.

Code	Cause	Code	Cause
1	Compressor has excessive capacity	26	Water filter clogged
2	Compressor lacks capacity	27	Filter before valve in liquid or suction line clogged
3	Solenoid valve in regulating system fails to open	28	Excessive suction gas superheating
4	Timer or other automatic control out of order	29	Freezing-up of thermostatic expansion valve
5	Excessive capacity during decrease in temperature	30	Thermostatic expansion valve has lost its charge
6	Capacity regulation not set to 0%	31	Excess flow through expansion valve (liquid in suction line)
7	Loose foundation bolts	32	Loose or misplaced sensor
8	Misalignment of motor and compressor	33	Solenoid valve in liquid or suction line not opening
9	Friction between rotors and housing or defective bearings	34	Oil filter needs cleaning - pressure cut-out has cut
10	Loose bolts in coupling	35	Oil pressure too low - pressure cut-out has cut
11	Oil pressure regulating valve set too low	36	Oil too hot - oil thermostat has cut
12	Oil pump out of order	37	Oil thermostat set too high
13	Oil too hot - oil thermostat cut out	38	High-pressure cut-out set too low
14	Too much oil circulating in system (evaporators)	39	Low-pressure cut-out set too high
15	Filter in solenoid valve in oil-return line clogged	40	Low-pressure cut-out shut off
16	Solenoid valve in oil return out of order	41	High-pressure cut-out shut off
17	During initial start-up, some of the oil will be led out into the plant	42	Insufficient charge in plant
18	A valve in the oil line is being throttled	43	Too much charge in plant
19	Oil filter clogged	44	Air or non-condensable gases in system
20	Insufficient water through oil cooler	45	Fuses blown
21	Excessive oil cooling - oil too cold	46	Thermal relay reset
22	Insufficient water or air through condenser	47	Main switch interrupted
23	Condenser tubing clogged by sludge or scale	48	Safety valve leaky or opening prematurely
24	Cooling water too hot	49	Evaporator soiled or iced up
25	Too much water through condenser	50	Heating element blown
		52	Liquid in suction line

Remedying Malfunctions

1. Excessive suction temperature

1.2	Inadequate capacity	Increase capacity
1.28	Excessive superheating of suction gas	Check and regulate thermostatic valves on evaporators
1.48	Safety valve leaky or opening prematurely	Check condenser pressure and adjust or repair safety valve

2. Suction temperature too low

2.31	Liquid in suction line	Regulate expansion valves or float valves
2.32	Loose or misplaced sensor	Check whether sensors are making good contact with suction pipe and whether correctly positioned

3. Suction pressure is too low

3.1	Excessive capacity	Reduce compressor capacity
3.14	Too much oil in evaporators	Draw oil off evaporators
3.27	Filter in liquid line clogged	Examine and clean filters in the liquid lines
3.28	Excessive superheating of suction gas	Regulate expansion valves
3.29	Freezing in thermostatic expansion valve	De-ice thermostatic expansion valve with hot wet cloths and run the liquid from the receiver through the drying filter Note: <i>Never add methanol to the system to avoid freezing, as this will give rise to corrosion and chemical attacks in compressor, etc.</i>
3.30	Thermostatic expansion valve has lost its charge	Valve fails to open - change the valve
3.33	Solenoid valve in liquid or suction line not opening	Coil may have blown - change the coil
3.42	Insufficient charge	Charge more refrigerant into the plant

4. Compressor starts and stops too frequently at low-pressure cut-out

4.1	See point 3.1	
4.14	See point 3.14	
4.27	See point 3.27	
4.28	See point 3.28	
4.29	See point 3.29	
4.30	See point 3.30	
4.33	See point 3.33	
4.39	Low-pressure cut-out set too high	Adjust pressure cut-out
4.42	See point 3.42	
4.49	Evaporator soiled or iced up	Clean or defrost evaporator

5. Excessive suction pressure

5.2	Compressor lacks capacity	Regulate compressor capacity
5.48	Safety valve leaky or opening prematurely	Adjust or repair valve

6. Compressor starts and stops too frequently at high-pressure cut-out

	See point 7	
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7. Excessive condensing pressure

7.22	Insufficient water or air through condenser	Regulate water supply or clean condenser
7.23	Condenser tubing clogged by sludge or scale	Clean condenser tubing
7.24	Cooling water too hot	Procure colder cooling water or reduce compressor capacity

7.26	Water filter clogged	Clean water filter
7.38	High-pressure cut-out set too low	Adjust pressure cut-out
7.43	Too much charge in plant	Draw fluid off into empty vessel
7.44	Air or non-condensable gases in system	Blow air out at condenser

8. Condensing pressure too low

8.2	Compressor lacks capacity	Check whether compressor capacity corresponds to load on plant. Regulate water supply to condenser.
8.25	Too much water through condenser	Adjust water supply

9. Oil pressure too low

9.5	Excessive capacity during decrease in temperature	<p>Excessive capacity during temperature decrease (run-down) may result in liquid being sucked along in suction line. This liquid may cause the oil in the oil reservoir to foam vigorously so that the oil pressure drops, thus stopping the machine. Before restarting, check whether there is liquid in the oil reservoir.</p> <p>This liquid must be boiled off using a heating element or by heating the oil reservoir with hot water or steam. The plant must therefore be run-down at reduced capacity.</p>
9.11	Oil pressure regulator set too low	The regulator is set to the 2.5 kp/cm prescribed by the manufacturer, but must be checked during operations.
9.31	Excess flow through expansion valve (liquid in suction line)	See comments under point 9.5
9.32	Loose or misplaced sensor	Loose sensor on expansion valve may cause liquid throughflow to suction line - see also comments under point 9.5.

10. Oil temperature too high

10.13	Thermostat cut out	See section <i>Pressure and temperature settings</i> for setpoint.. The reason for the oil overheating must be found in the following points
10.18	A valve in the oil line is being throttled	Check whether all valves are open
10.20	Insufficient water or refrigerant through oil cooler	Check whether valves are open or whether water filter or oil cooler need cleaning
10.48	Safety valve leaky or opening prematurely	Adjust or repair valve

11. Oil temperature too low

11.21	Excessive cooling of oil	Regulate oil cooling
11.50	Heating element in oil reservoir out of order	Change heating element

12. Excessive pressure drop across oil filter

12.19	Oil filter clogged	Change filter element
-------	--------------------	-----------------------

13. Excessive capacity - automatic controls out of order

13.3	Solenoid valve in regulating system fails to open	Change valve or coil
13.4	Timer or other automatic control out of order	Change or fix
13.12	Auxiliary pump out of order	When the compressor stops, the auxiliary pump must ensure capacity regulation is set to 0% capacity so that the compressor is ready for re-starting. Check whether the pump is being energized or whether pump or motor is out of order.

14. Insufficient capacity - automatic controls out of order

14.3	See point 13.3	
14.4	See point 13.4	

15. Oil level in the reservoir falls

15.15	Filter for solenoid valve in oil-return line clogged	Clean filter
15.16	Solenoid valve in oil return out of order	The oil return line must be hot during operation.
15.17	During initial start-up, some of the oil will be let out into the plant	On HCFC plants, particularly, some of the oil will circulate in the plant. When the system is balanced, top up with oil, if necessary.

16. Oil foaming vigorously during standstill

16.31	Excess flow through expansion valve (liquid in suction line)	Check expansion valve
16.32	Loose or misplaced sensor	Check sensor positioning

17. Oil reservoir sweating during standstill

17.47	Main switch interrupted	If the compressor is stopped and the current interrupted at the main switch, any refrigerant in the oil reservoir will evaporate. As the heating element in the oil reservoir has also been cut off, the heat needed for evaporation must be taken from the surroundings. The oil will therefore go very cold and will require heating up before re-starting.
17.50	Heating element blown	See point 17.47

18. Abnormal noise from compressor

If any abnormal noise is coming from the compressor, the machine must be stopped immediately, and the cause pinpointed and remedied before restarting.

18.5	Excessive capacity during run-down	Excessive capacity during run-down may result in liquid being sucked along into the compressor suction line. Therefore, operate at reduced capacity during run-down.
18.7	Loose foundation bolts	Tighten bolts
18.8	Misalignment of motor and compressor	Adjust alignment
18.9	Friction between rotors. Friction between rotors and defective bearings	Do not start the compressor. Open and repair.
18.10	Loose bolts in coupling	Stop compressor and tighten bolts
18.31	Liquid in suction line	Check and adjust the valves with excess throughflow
18.32	Loose or misplaced sensor	Check sensor positioning
18.48	Safety valve opens	Check opening pressure of safety valve

19. Compressor motor will not start

19.6	Capacity regulation not set to 0%	See under points 13.3-13.4 and 13.12
19.12	Auxiliary pump out of order	See under point 13.12
19.13	Excessive oil temperature	See under point 10
19.19	Oil filter clogged	Clean oil filter. Reset pressure cut-out
19.34	Differential oil pressure cut-out has cut	Clean oil filter. Reset pressure cut-out
19.35	Oil pressure too low	See under point 9
19.36	Oil too hot	See under point 10
19.40	Low-pressure cut-out interrupted	The compressor will restart after a rise in suction pressure sufficient to re-activate the pressure cut-out - see point 3 also.
19.41	High-pressure cut-out interrupted	See under point 7
19.45	Fuses blown	Check cause and change fuses
19.46	Thermal relay has interrupted	Check cause of overloading
19.47	Main switch interrupted	Switch power on

20. Compressor runs continuously

20.2	Compressor lacks capacity	See under point 14
20.3	Solenoid valve in capacity regulating system fails to open	See under point 13.3
20.4	Timer or other automatic control out of order	See under point 13.4
20.42	Insufficient charge on plant	Top plant up with refrigerant
20.48	Safety valve leaky or opening prematurely	See point 10.48
20.49	Evaporator soiled or iced up	Clean or defrost evaporators

21. Liquid in suction line

21.1	Compressor has excessive capacity	Reduce capacity
21.31	Excess flow through expansion valve	Adjust expansion valve
21.32	Loose or misplaced sensor for expansion valve	Check sensor positioning and rectify

Selecting Lubricating Oil for SABROE Compressors

During the past few years YORK Refrigeration has experienced a number of problems with mineral oils, particularly in R717 plants. The problems can be divided into two groups:

- a:** The oil changes viscosity
- b:** The oil decomposes (becomes very black)

The problems have been seen with several mineral oil brands, often occurring within a few operating hours and resulting in severe consequences for both compressor and plants.

Following the careful investigation undertaken by YORK Refrigeration during the past few years, it has been decided to introduce a range of synthetic oils which can fulfil the demands of modern refrigeration plants.

Mineral oils may continue to be used in refrigeration plants, providing the lubricating quality is carefully monitored. For modern, high capacity refrigeration plants, where long lifetime for both lubricants and moving parts is expected, YORK Refrigeration recommends the choice of synthetic lubricating oils.

The application areas and specifications for these synthetic oils can be found in the following pages. Installers and/or users are at liberty to choose either YORK Refrigeration's own or alternative oil brands which fulfil the necessary specifications.

General

This recommendation only deals with the lubrication of the compressor. The performance of the lubricant in the plant (receiver, evaporator, etc.) must, however, also be taken into consideration.

Lubricating oils with relatively high viscosities must be used to ensure satisfactory lubrication of refrigeration compressors.

To obtain the best lubrication, the oil must:

- Provide the required fluidity at the lowest evaporating temperature encountered in the plant and at the highest permissible temperatures in the compressors.
- Provide acceptable fluidity at start-up.
- Provide sufficient oxidation stability (the oil must be moisture-free when added to the system).
- Provide sufficient chemical stability when used together with the particular refrigerant.

In addition, the extent to which different refrigerants dissolve in the oil must be determined, so that the oil return systems, etc. can be designed to function properly.

Stratification

It should be noted that in certain plants, particularly with HFC and HCFC refrigerants, the oil may stratify into layers in the refrigerant receivers and evaporators at certain operating conditions and at particular oil concentrations.

The *Oil recommendation diagrams* for SABROE compressors for HFC and HCFC will indicate the limits for Sabroe oils at which this stratification occurs. The oil concentrations stated in these diagrams must not be exceeded. This will enable suitable oil rectification/return systems to be designed to balance with the compressor oil "carry-over" so that the maximum concentration is not exceeded.

For area **A** in the diagrams, the max oil concentration in liquid phase must not exceed

2%. For the other area, the max. oil concentration must not exceed 5%. For area **B**: please contact YORK Refrigeration.

Plants with several different compressor types/makes

In plants comprising several different interconnected compressor types and makes, it is strongly recommended that all compressors should use the same type of oil. This is essential where automatic oil return systems are employed.

If it is intended to change the oil from one type to another, please refer to the *Oil changing on SABROE compressors* later in this publication.

Selecting the lubricating oil

There are a number of operating diagrams for the selection of lubricating oils for Sabroe compressors operating with various refrigerants. Once the **general** conditions concerning the lubrication of the compressor and oil type in the plant have been considered, the **specific plant conditions** must be taken into consideration.

Use the *Oil recommendation diagrams* to select the appropriate **oil code number**.

The **oil code number** consists of letters designating the oil type together with the Sabroe viscosity grade number.

Code design	Oil types
M	Mineral oil
A	Synthetic oil based on Alkylbenzene
PAO	Synthetic oils based on Polyalphaolefin
AP	Mixture of A and PAO-oils
E	Synthetic ester-based lubricants

In the *oil recommendation diagrams* for each refrigerant and compressor type, it is possible

to determine the **code number** for the oil best suited to the operating conditions. With this **code number**, it is possible to select the correct Sabroe oil for the application. The marked area on each side of the separating line in the diagram shows the zone where both oils are useable.

Oil types and oil companies

As a result of the large number of oil companies world-wide that deals in oil for refrigeration plants, it is impossible for YORK Refrigeration to test the many different brands of oil on the market. It is our experience, however, that some oil brands during use can change character and thus no longer fit the specifications given by the companies at delivery. We have thus experienced changes in the specifications as well as in the formula and performance without having had any information about this from the oil company. This makes it very difficult for YORK Refrigeration to give a general approval of the various oil brands.

For this reason YORK Refrigeration has, in cooperation with a large recognised oil company, developed a series of three oils which cover most purposes. YORK Refrigeration has however, also listed a limited number of oils which can be supplied through YORK Refrigeration. The typical data of these oils can be found in the *Data Sheet for Sabroe Oils*. We suggest you to use these Sabroe oils, which are delivered in 20 litre pails and 208 litre drums and can be ordered using the parts no. listed in the *List of Oils*.

It is of course possible to use similar oils from other oil companies, and in this connection, the *Data Sheet for Sabroe Oils* may be helpful.

Please note, however, that YORK Refrigeration has not tested any other oils than our own brand, and hence we cannot answer for the quality, the stability or the suitability of other oils for any purposes. The oil company in question is thus solely responsible for the quality and suitability of the oil delivered, and if any problems are experienced with these oils in the compressors or in the refrigeration plant, the oil supplier should be contacted directly.

When choosing oils from other oil companies, please pay particular attention to the oil's effectiveness in the compressor and the refrigeration plant as a whole.

Pay particular attention to the following aspects:

- Oil type
- Refrigerant type
- Compressor type
- Miscibility between refrigerant and oil
- Operating data for the compressor
 - Discharge gas temperature
 - Oil temperatures:

Reciprocating compressors:

Normal oil temp. in the crankcase
50-60 °C

Max. permitted oil temperature = Setting point for alarm

Min. permitted oil temperatures = setting point for alarm - if fitted

Screw compressors:

The oil temperature before injection in the compressor, but after the oil cooler

Max. permitted oil temperature = setting point for alarm

Min. permitted oil temperature = setting point for alarm

- Condensing pressure
 - Evaporating pressure
 - Oil viscosity in the compressor during operation and under the influence of:
 - Refrigerant type and solubility of refrigerant in the oil
 - Operating temperatures
 - Vapour pressure in the oil reservoir
- Reciprocating compressor:* Suction pressure and oil temperature in the crankcase.
- Screw compressor:* Discharge pressure and gas temperature.
- Compatibility with the neoprene O-rings: the aniline point gives an indication of how the O-ring material reacts to the oil. At an aniline point less than approximately 100°C the material tends to swell, and at an aniline point higher than approximately 120°C it tends to shrink.

For this reason it is not recommended to change oil type from M oil to PAO oil as a leakage may occur if the O-rings are not changed. YORK Refrigeration therefore recommends using the Sabroe AP68 oil as it reduces the risk of leaks considerably in this case.

YORK Refrigeration can supply a calculation showing the operating data on request.

Attention is drawn to the following viscosity limits during operation:

- Optimum viscosity range (to be designed for) = 20 to 50 cSt
- Max. permissible viscosity = 100 cSt
- Min. permissible viscosity = 10 cSt (only applicable to HCFC and HFC under certain operating conditions: 7cSt)
- Max. permissible viscosity during the starting of the compressor = 500 cSt

Maximum refrigerant concentration in the oil at running condition: 25% - also if viscosity requirements are met.

Use of mineral oil

Lately we have experienced a number of problems with mineral oil, particularly in R717 plants. The problems can be divided into two groups:

- a:** The oil changes viscosity within a few operating hours.
- b:** The oil decomposes (becomes very black) within a few operating hours.

The problems have been seen with several oil brands and have resulted in severe consequences for both compressors and plants.

When using mineral oil, it is thus important that the plant is monitored very closely, that oil samples are taken regularly (every 1-2,000 hours) and that the condition/colour of the oil is checked on a weekly basis.

YORK Refrigeration therefore recommends only to use M oil at moderate operating conditions - cf. the attached oil recommendation diagrams.

YORK Refrigeration is aware, however, that several customers have been using mineral oils for many years without problems. Those customers who wish to continue using mineral oils in existing, as well as new, compressors can do so, providing the compressor type and operating conditions are similar to the existing ones (excepting the HPC and HPO series compressors).

YORK Refrigeration has therefore decided to market a brand of mineral oil which has been tested and found to be suitable for most general refrigerating purposes.

If another brand of mineral oil is chosen, the specifications in the data sheet in this recommendation should be followed as a guideline.

Mineral oil can be used in refrigerating plants, providing the lubricating quality is carefully monitored. For modern, high capacity refrigeration plants, in which a long life-time for both lubricant and moving parts is expected, YORK Refrigeration recommends using synthetic lubricating oils.

A benefit of using the synthetic lubricant oil is a much lower oil carry-over to the plant and longer intervals between oil changes. A better fluidity at lower temperatures also gives an easier drainage at the cold parts of the plant.

How to use the oil recommendation diagrams:

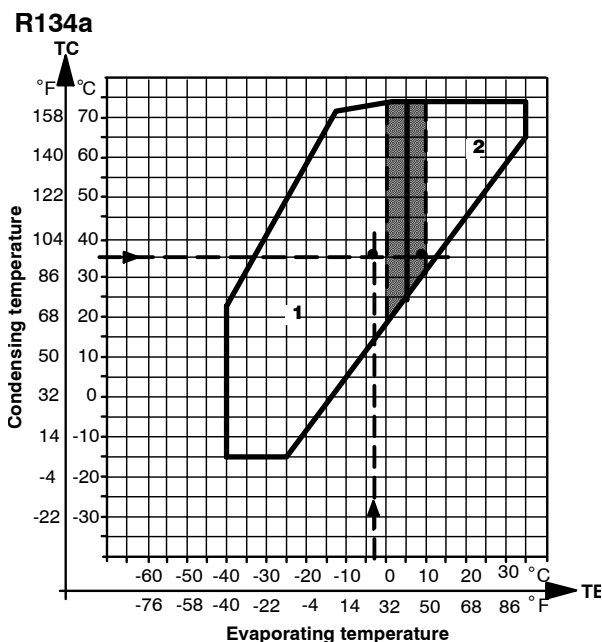
To determine the **code number**, first refer to the *Oil recommendation diagram* for the refrigerant and compressor type and then plot the proposed operating conditions.

Example (recip. compressors):

Refrigerant: **R134a**
 Condensing temp. **TC +35°C**
 Evaporating temp. **TE -3°C**

Please observe !

Plants may operate at different conditions from time to time, for example at different evaporating temperatures due to plant variations or at different condensing temperatures due to seasonal changes. By plotting TC and TE in the oil recommendation diagram, this example would require a No 1 oil. If, however, TE changes at certain times, e.g. from -3 to +7°C, a No 2 oil should be utilised. But, as +7°C is inside the marked area, the No 1 oil can be utilised also at this TE.



By referring to the *Oil recommendation table* placed at the bottom of each *oil recommendation diagram*, it is possible to select the **code number** for the appropriate oil type. In

the example above, a **oil code number E5** can be selected.

Code no	Area no	
	1	2
E5	▲	
E9		▲

In plants which incorporate both screw and reciprocating compressors and where the recommendations indicate the use of different oil types, please contact YORK Refrigeration for advice.

Changing oil on Sabroe compressors

The oil should never be changed to another type without consulting the oil supplier. Nor is it advisable to "top up" compressors with an other oil than the one already used for the particular plant and compressor.

Mixing different oils may result in operating problems in the refrigerant plant and damage to the compressors. Incompatibility between the different oil types may degrade the lubricating properties or may cause oil residues to form in the compressor or oil separator or in the plant. These oil residues can block filters and damage the moving parts in the compressor.

Furthermore, changing the oil from one type or make to another should only be undertaken in connection with a careful procedure involving the drainage and thorough evacuation of the refrigeration plant. Information on a suitable procedure can be obtained from YORK Refrigeration as well as from a number of oil companies.

It is imperative that oil is only used from the original container and that both the make and type complies with the specification for the plant.

Ensure that the original container is sealed during storage to prevent moisture from the air being absorbed into the oil - many oils, particularly the polyolester oils, are extremely hygroscopic. Consequently, it is recommended that the oil is only purchased in containers corresponding to the amount to be used on each occasion.

If the oil is only partially used, make sure that it is effectively re-sealed in the original container and that it is stored in a warm, dry place. Ideally with nitrogen blanketing of the oil to keep the water content below 50 ppm.

Oil drums should, ideally, be "racked" and mounted with a proper barrel tap to ensure an effective airtight seal.

Oil changing intervals

A list of the recommended intervals for changing the oil can be found in the compressor instruction manual. These are provided for guidance only. The actual interval between oil changes will often be determined by a variety of operating parameters within the plant.

It is strongly recommended to monitor the quality of the oil by carrying out oil analyses with regular intervals. This will also give a good indication of the condition of the plant. The service can be supplied by YORK Refrigeration or the oil suppliers.

Oil recommendation diagram symbols:

- ▲ : In case of a new plant. Very suitable.
- ☆ : In case you wish to change from mineral oil
- Ⓐ : Max oil concentration in liquid phase at: T_E : 2% W
- Ⓑ : Max oil concentration in liquid phase: contact YORK Refrigeration
- Ⓒ : Min suction temperature -50°C : at $T_E < -50^\circ\text{C}$ superheating must be introduced.
- * : Dry expansion systems only. Flooded systems to be considered individually: contact YORK Refrigeration
- SH: Suction gas superheat, K (Kelvin)
- ▨ : Zone in which both oils are useable
- ▩ : Calculation must be performed using COMP1

Data Sheet for Listed Sabroe Oils

Typical data for lubricating oils for Sabroe compressors

Sabroe code	Viscosity		Viscosity Index	Spec. grav. at 15°C	Flash p. COC °C	Pour p. °C	Anilin °C point	Acid no. mg KOH/g
	cSt 40°C	cSt 100°C						
M1	63	6.4	14	0.91	202	-36	81	0.02
A3	97	8.1	13	0.86	206	-32	78	0.05
AP1	64	9.3	121	0.858	195	-51	121	0.04
PAO3	66	10.1	136	0.835	266	<-45	138	0.03
PAO5	94	13.7	147	0.838	255	<-45	144	0.03
PAO9	208	25	149	0.846	260	<-39	154	0.03
E3	Due to the big difference between polyolester-based lubricants from various suppliers, it is not possible to present typical data for these oils. When using another oil brand than the one recommended by YORK Refrigeration, please contact the oil supplier to select the correct oil type.							
E5								
E9								
E11								

The listed data are typical values and are intended as a guideline only when selecting a similar oil from a different oil company. Data equivalence alone does not necessarily qualify the oil for use in YORK Refrigeration's Sabroe compressors.

List of part numbers for available Sabroe oils

Oil brand	Oil code no.	Part no.	
		20 litre pail	208 litre pail
Mobil Gargoyle Arctic 300	M 1 (M68)	1231-264	1231-296
Sabroe Oil A100	A 3 (A100)	1231-263	1231-262
Sabroe Oil AP68	AP 1 (AP68)	1231-257	1231-260
Sabroe Oil PAO68	PAO 3 (P68)	1231-256	1231-259
Mobil Gargoyle Arctic SHC 228	PAO 5 (P100)	1231-282	1231-283
Mobil Gargoyle Arctic SHC 230	PAO 9 (P220)	1231-284	1231-285
Mobil EAL Arctic 68	E 3 (E68)	1231-272	1231-273
Mobil EAL Arctic 100	E 5 (E100)	1231-274	1231-275
Mobil EAL Arctic 220	E 9 (E220)		1231-279
Sabroe H oil	E11 (E370)	3914 1512 954 ¹⁾	9415 0008 000

¹⁾ 18.9 litre pail (5 US gallons)

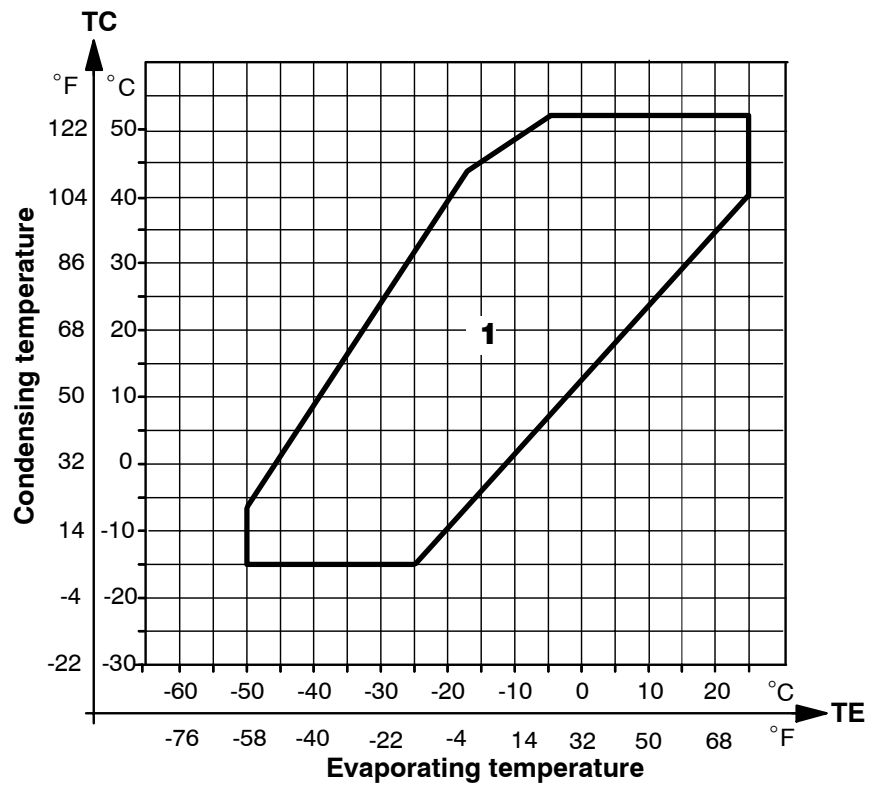
The oils recommended by the former Stal Refrigeration correspond to the following oils:

Stal Refrigeration oil type	Sabroe oil		
A	Mobil Gargoyle Arctic 300	-	M1 (M68)
B	Sabroe Oil PAO 68	-	PAO 3 (PAO 68)
C	Mobil Gargoyle Arctic SHC 230	-	PAO 9 (PAO 220)
H	Sabroe H oil	-	E 11 (E 370)

R717

one-stage
reciprocating
compressors

Code no	Area no
	1
PAO 3	▲
AP 1	☆/▲
M1	See note



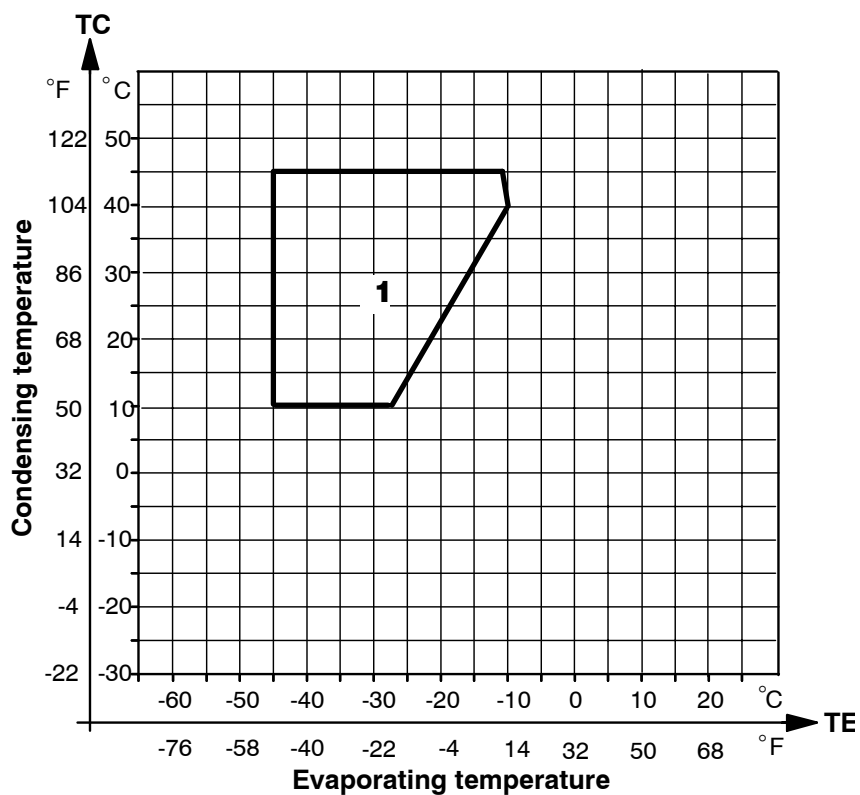
Note: YORK Refrigeration recommends that the use of M oils is restricted to moderately loaded compressors and that the oil quality is monitored carefully via regular oil analyses.

- ▲ : In case of a new plant. Very suitable.
- ☆ : In case you wish to change from mineral oil

R717

two-stage
reciprocating
compressors

Code no	Area no
	1
PAO 3	▲
AP 1	☆/▲
M1	See note



Note: YORK Refrigeration recommends that the use of M oils is restricted to moderately loaded compressors and that the oil quality is monitored carefully via regular oil analyses.

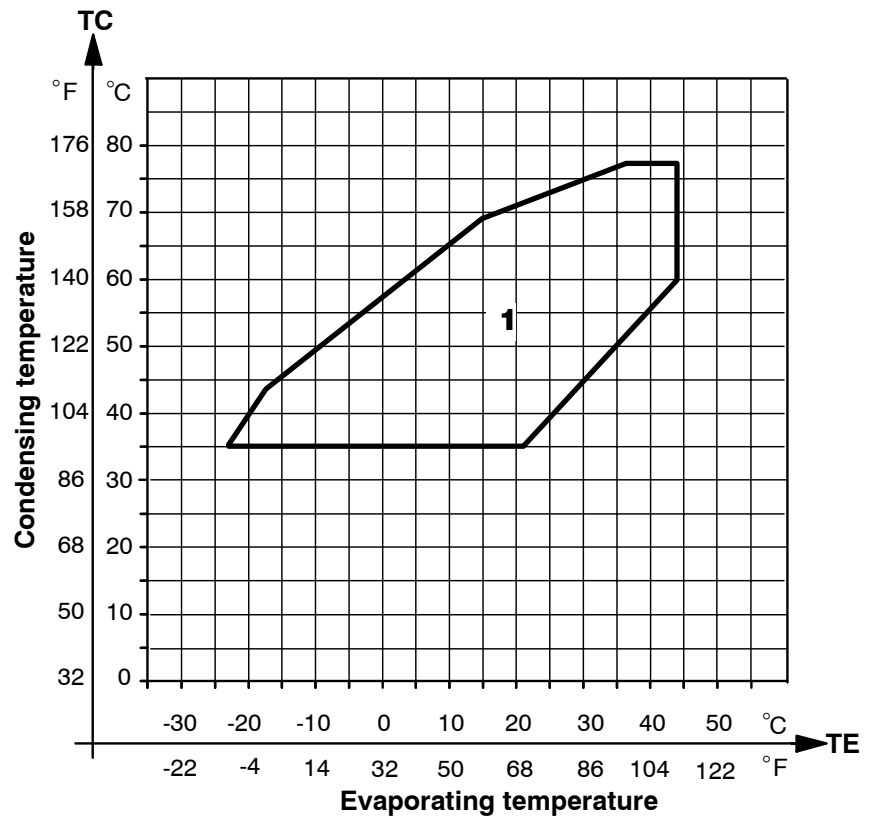
▲ : In case of a new plant. Very suitable.

☆ : In case you wish to change from mineral oil

R717

HPO and HPC reciprocating compressors

Code no	Area no
PAO 5	▲



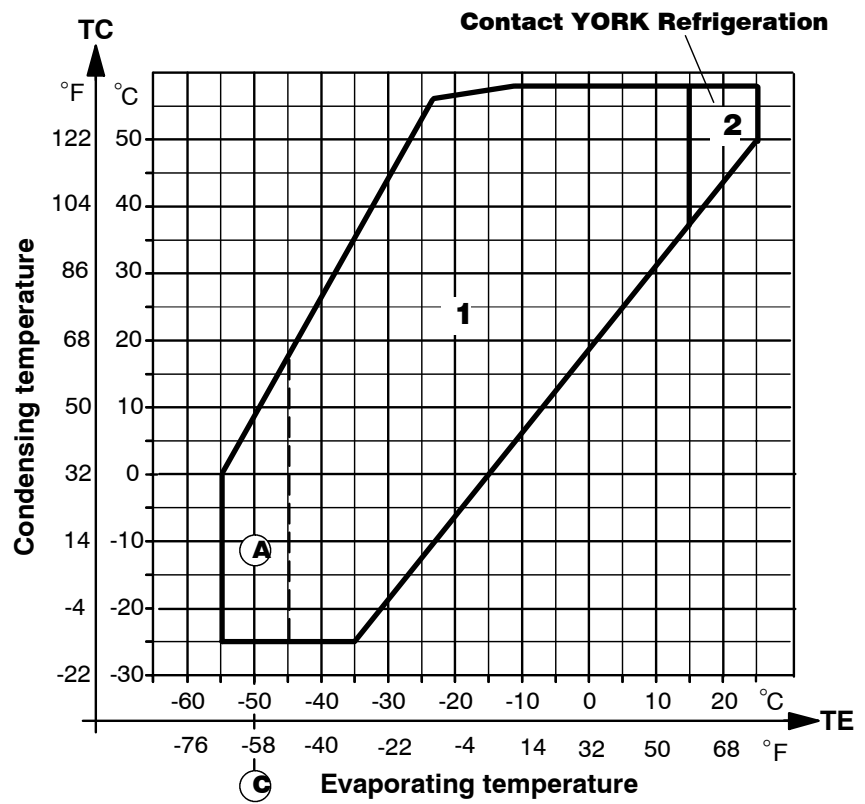
Please observe: PAO 5 oil is the only oil which can be used in the HPO and HPC compressors.

▲ : In case of a new plant. Very suitable.

R22

one-stage
reciprocating
compressors

Code no	Area no
	1
A 3	▲

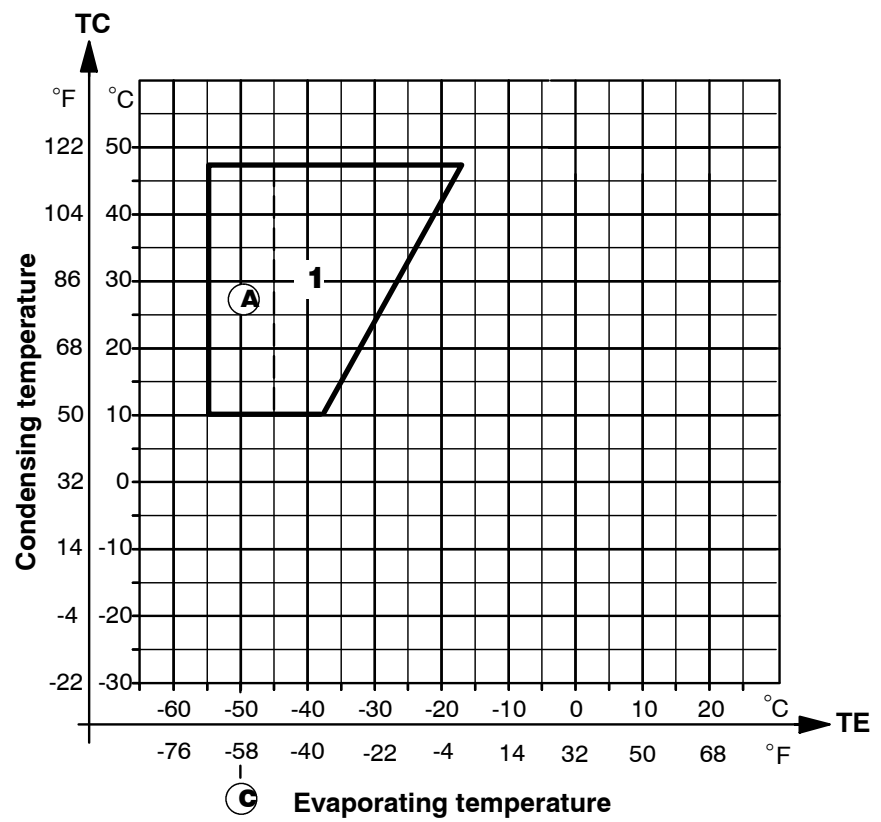


- ▲ : In case of a new plant. Very suitable.
- Ⓐ : Max oil concentration in liquid phase at: T_E : 2% W
- Ⓒ : Min suction temperature -50°C : at $T_E < -50^\circ\text{C}$ superheating must be introduced.

R22

two-stage
reciprocating
compressors

Code no	Area no
	1
A 3	▲

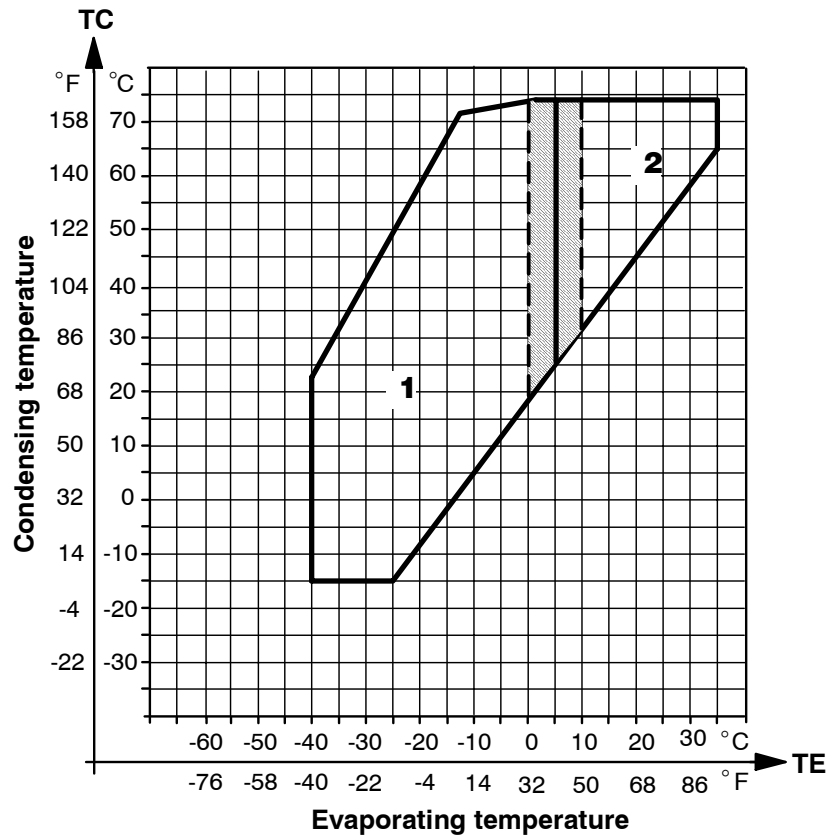


- ▲ : In case of a new plant. Very suitable.
- A : Max oil concentration in liquid phase at: T_E : 2% W
- C : Min suction temperature -50°C : at $T_E < -50^\circ\text{C}$ superheating must be introduced.

R134a

one-stage
reciprocating
compressors

Code no	Area no	
	1	2
E 5	▲	
E 9		▲

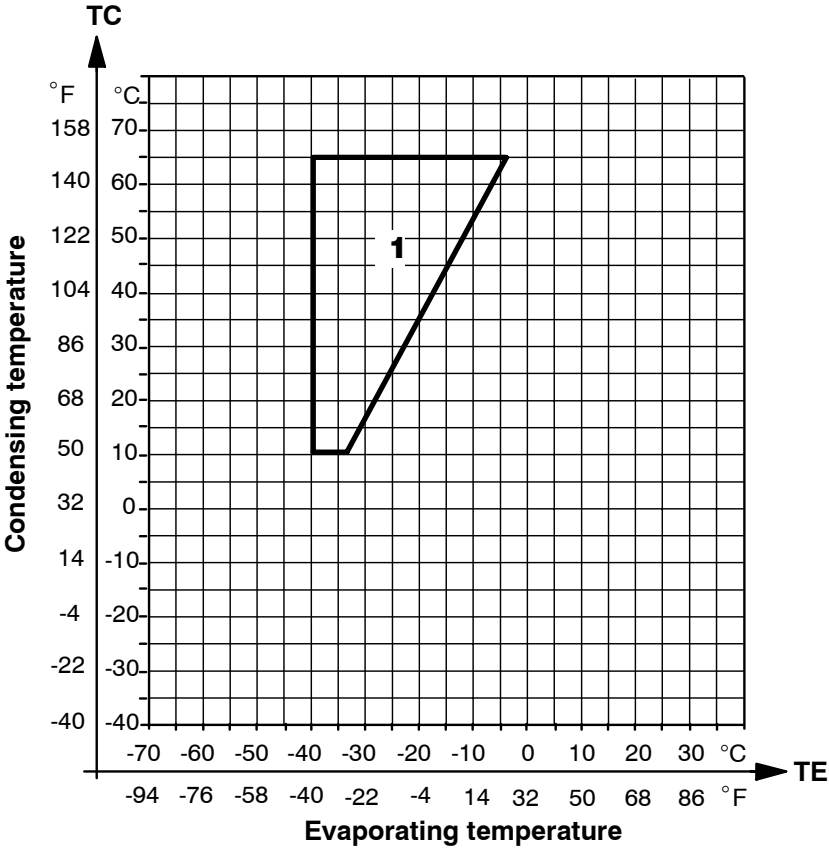


- ▲ : In case of a new plant. Very suitable.
- ▨ : Zone in which both oils are useable

R134a

two-stage
reciprocating
compressors

Code no	Area no
	1
E 5	▲

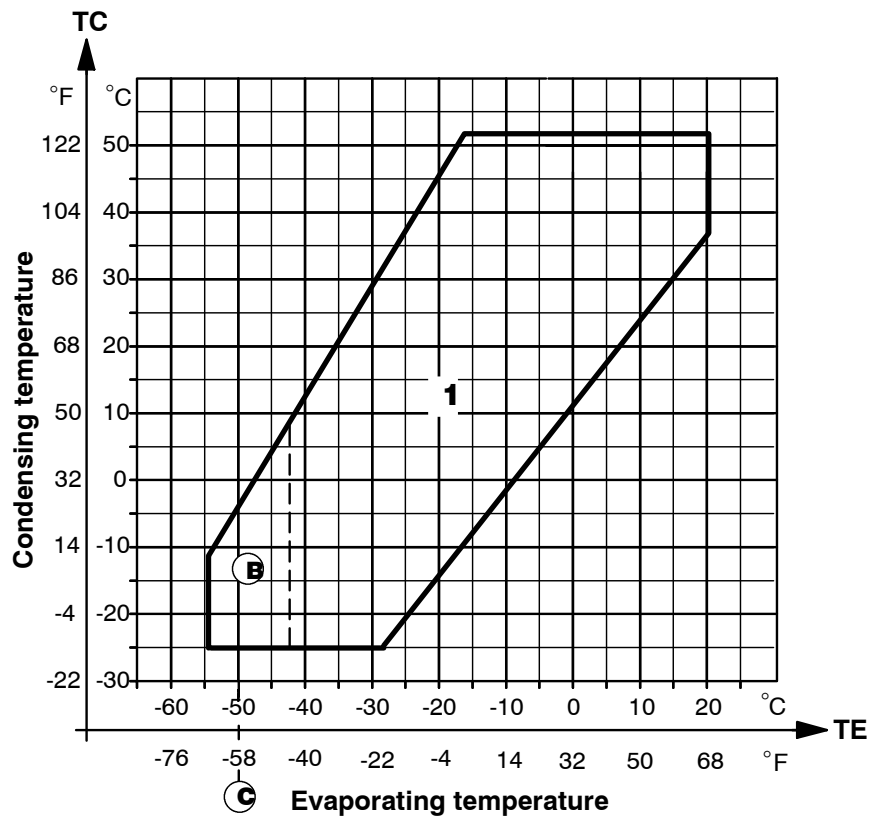


▲ : In case of a new plant. Very suitable.

R407C

one-stage
reciprocating
compressors

Code no	Area no
E 3	▲

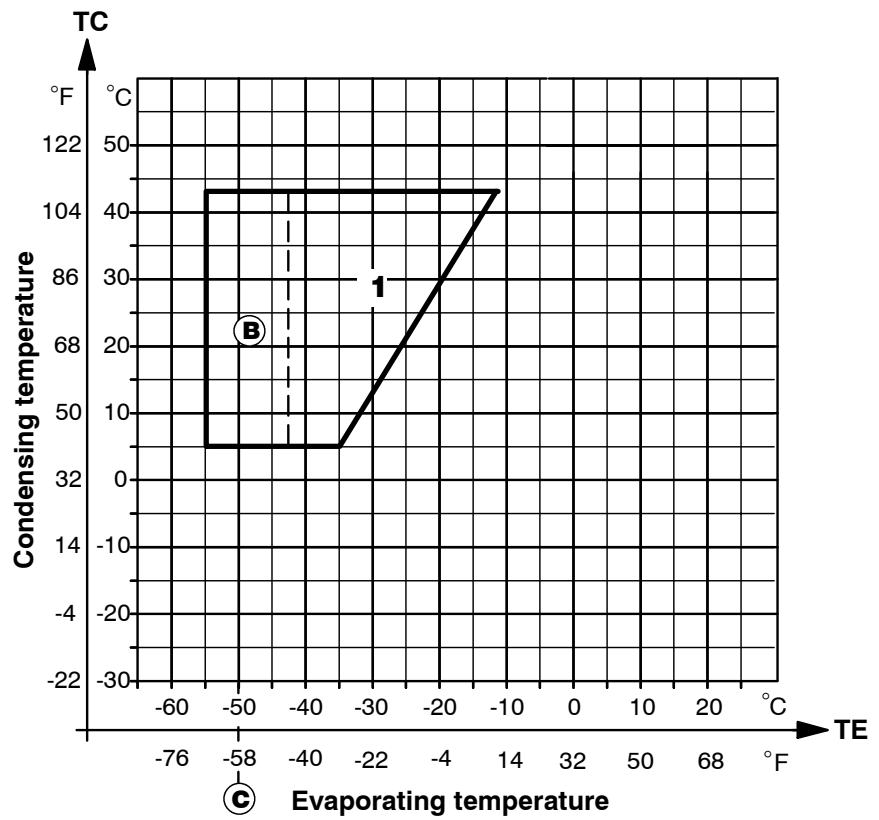


- ▲ : In case of a new plant. Very suitable.
- Ⓑ : Max oil concentration in liquid phase: contact YORK Refrigeration
- Ⓒ : Min suction temperature -50°C: at TE < -50°C superheating must be introduced.

R407C

two-stage
reciprocating
compressors

Code no	Area no
	1
E 3	▲

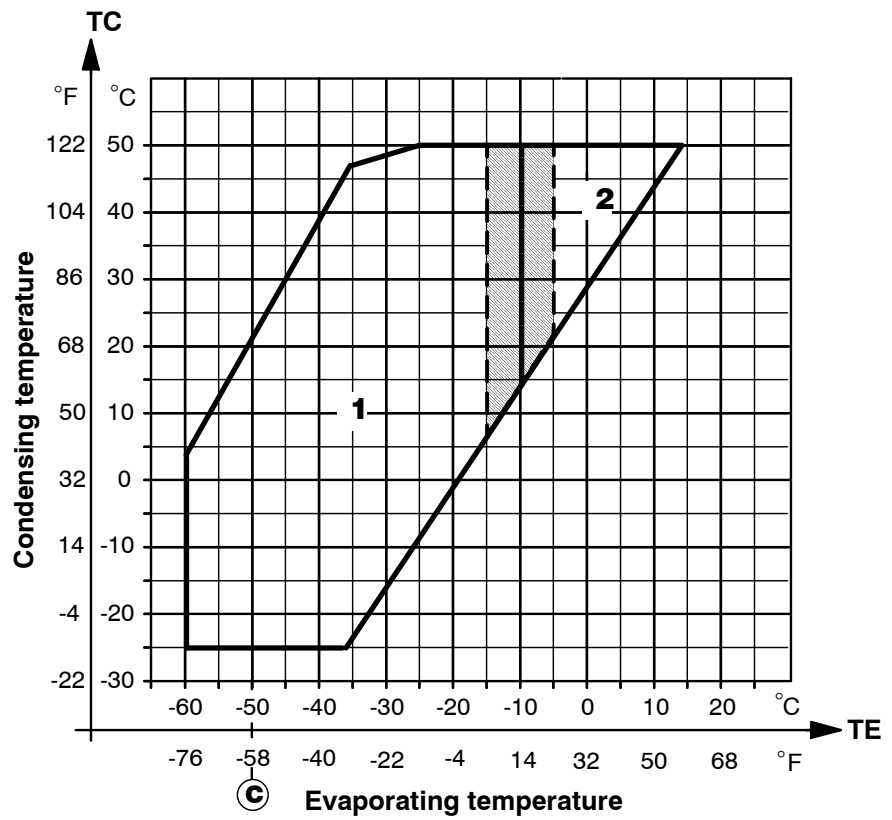


- ▲ : In case of a new plant. Very suitable.
- Ⓑ : Max oil concentration in liquid phase: contact YORK Refrigeration
- Ⓒ : Min suction temperature -50°C : at $\text{TE} < -50^{\circ}\text{C}$ superheating must be introduced.

R404A

one-stage
reciprocating
compressors

Code no	Area no	
	1	2
E 3	▲	
E 5		▲

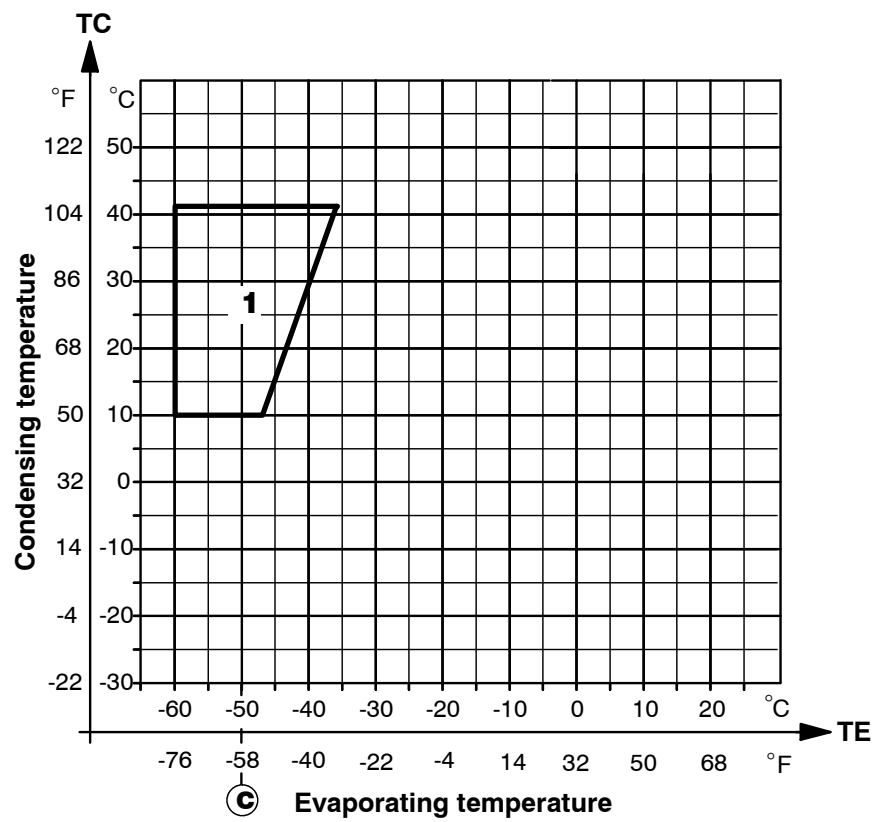


- ▲ : In case of a new plant. Very suitable.
- Ⓒ : Min suction temperature -50°C : at $\text{TE} < -50^{\circ}\text{C}$ superheating must be introduced.
- ▨ : Zone in which both oils are useble

R404A

two-stage
reciprocating
compressors

Code no	Area no
	1
E3	▲



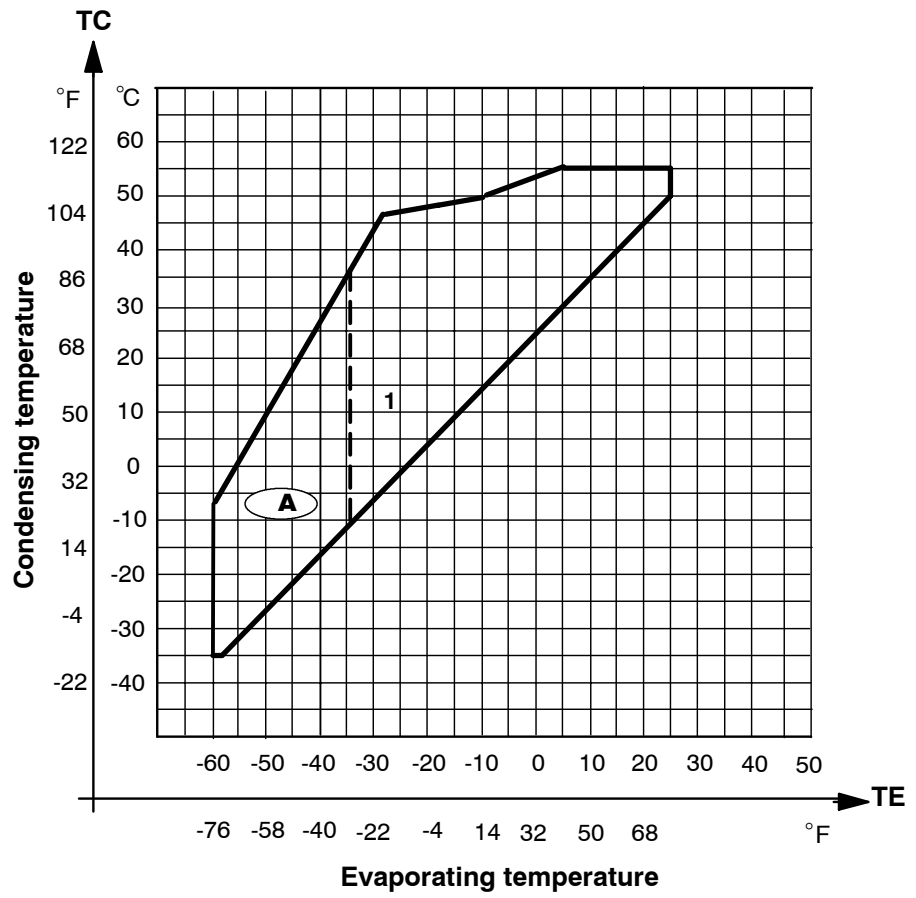
▲ : In case of a new plant. Very suitable.

Ⓒ : Min suction temperature -50°C : at $\text{TE} < -50^{\circ}\text{C}$ superheating must be introduced.

R410A

HPO og HPC
reciprocating
compressors

Code no	Area no
	1
E 5	▲

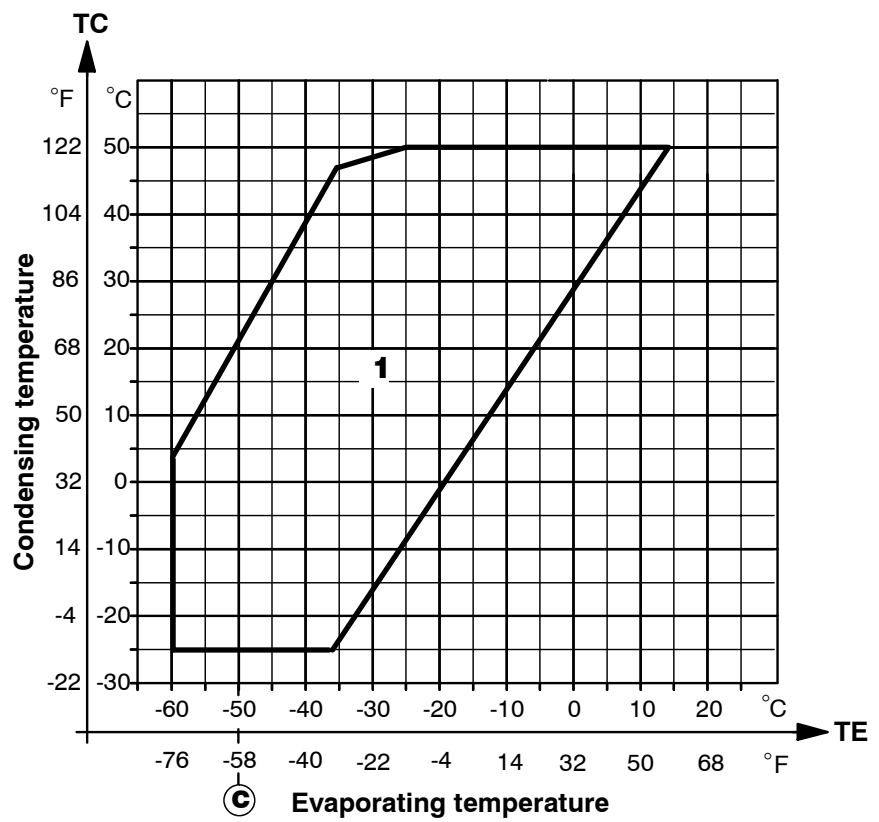


- ▲ : In case of a new plant. Very suitable.
- Ⓐ : Max oil concentration in liquid phase at: T_E : 2%

R507

one-stage
reciprocating
compressors

Code no	Area no
E 5	▲

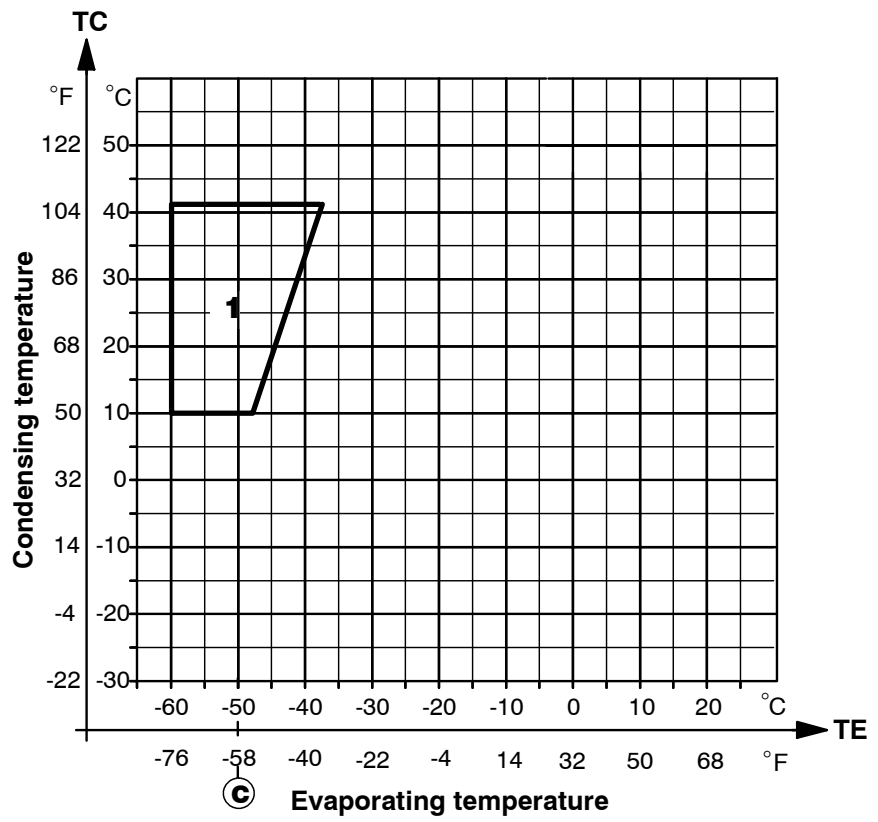


- ▲ : In case of a new plant. Very suitable.
- Ⓒ : Min suction temperature -50°C : at $\text{TE} < -50^{\circ}\text{C}$ superheating must be introduced.

R507

two-stage
reciprocating
compressors

Code no	Area no
E 5	▲

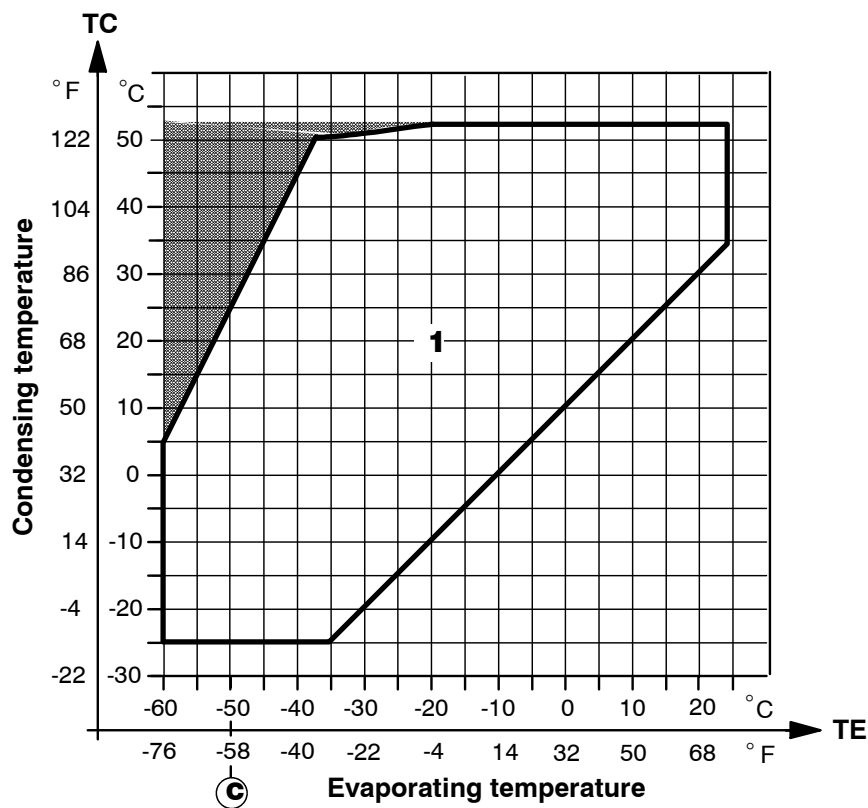


- ▲ : In case of a new plant. Very suitable.
- © : Min suction temperature -50°C : at $\text{TE} < -50^{\circ}\text{C}$ superheating must be introduced.

R717

screw compressors

Code no	Area no
	1
PAO 3	▲
AP 1	☆/▲
M1	See note



Note: YORK Refrigeration recommends that the use of M oils is restricted to moderately loaded compressors and that the oil quality is monitored carefully via regular oil analyses.

HLI: Calculation must be performed using COMP1

▲ : In case of a new plant. Very suitable.

☆ : In case you wish to change from mineral oil

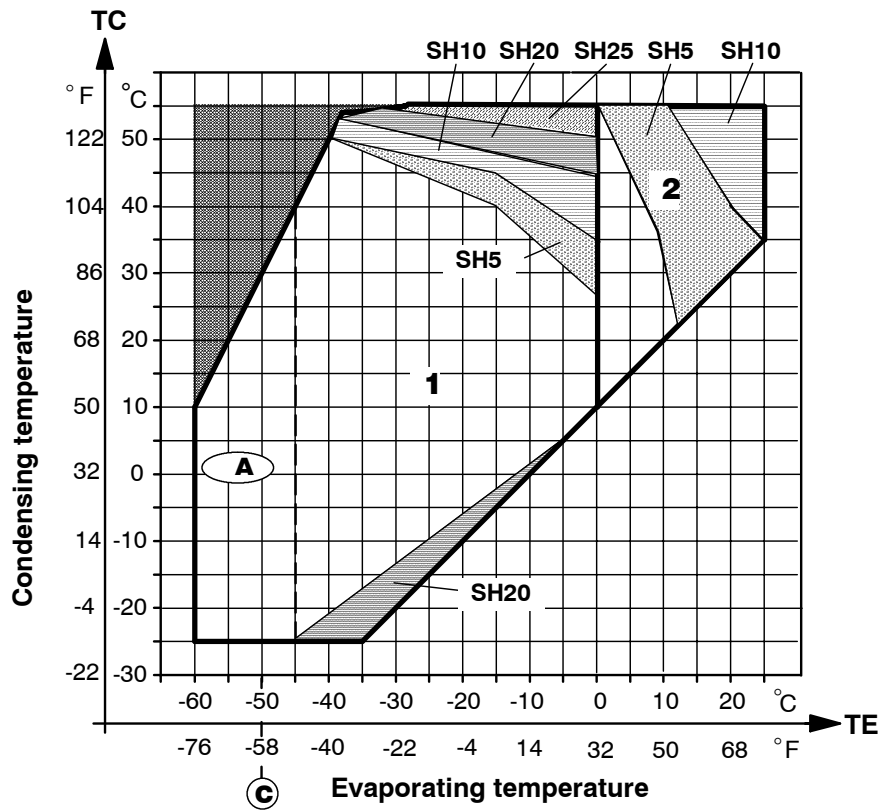
Ⓢ : Min suction temperature -50°C : at $\text{TE} < -50^{\circ}\text{C}$ superheating must be introduced.

■ : Calculation must be performed using COMP1.

R22

screw compressors
with journal bearings
or roller bearings

Code no	Area no	
	1	2*
A 3	▲	
PAO 5		▲



Using the calculating programme COMP1 it is possible to optimize the requirement for suction superheat values (SH) as stated in the diagram. See *Oil types and oil companies* in this section. Due to the ongoing development of lubrication oils, please contact YORK Refrigeration for an update on the requirement for superheat.

HLL: Calculation must be performed using COMP1.

▲ : In case of a new plant. Very suitable.

Ⓐ : Max oil concentration in liquid phase at: T_E : 2% W

Ⓒ : Min suction temperature -50°C : at $T_E < -50^\circ\text{C}$ superheating must be introduced.

* : Dry expansion systems only. Flooded systems to be considered individually: contact YORK Refrigeration

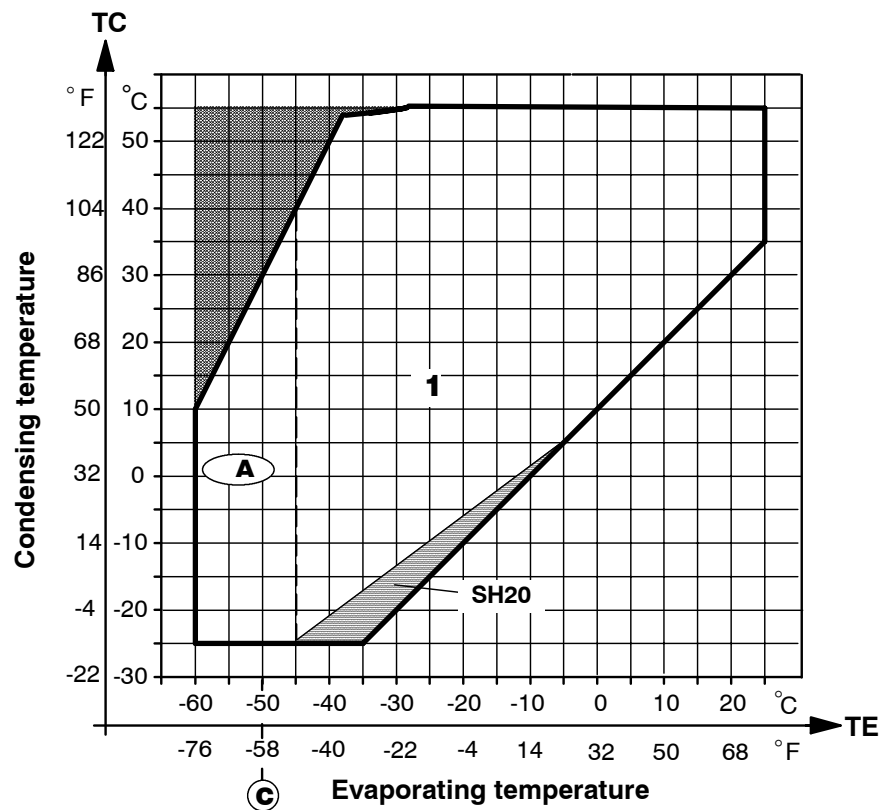
SH: Suction gas superheat, K (Kelvin)

■ : Calculation must be performed using COMP1

R22

screw compressors
with roller bearings
only

Code no	Area no
	1
A 3	▲



Using the calculating programme COMP1 it is possible to optimize the requirement for suction superheat values (SH) as stated in the diagram. See *Oil types and oil companies* in this section. Due to the ongoing development of lubrication oils, please contact YORK Refrigeration for an update on the requirement for superheat.

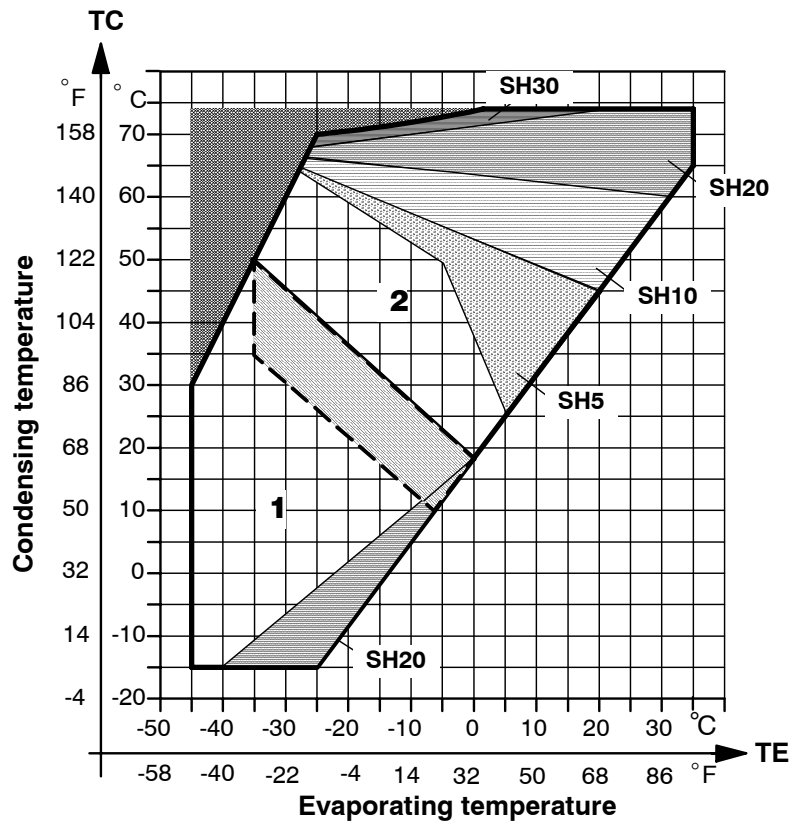
HLL: Calculation must be performed using COMP1.

- ▲ : In case of a new plant. Very suitable.
- Ⓐ : Max oil concentration in liquid phase at: T_E : 2% W
- Ⓒ : Min suction temperature -50°C : at $T_E < -50^{\circ}\text{C}$ superheating must be introduced.
- * : Dry expansion systems only. Flooded systems to be considered individually: contact YORK Refrigeration
- SH: Suction gas superheat, K (Kelvin)
- : Calculation must be performed using COMP1

R134a

screw compressors

Code no	Area no (See note)	
	1	2
E 5	▲	
E 9		▲



Note: For the compressors type "S", "Rotatune", "SAB 81", "SAB 83", and "SAB 85" only Sabroe oil H is approved.

Using the calculating programme COMP1 it is possible to optimize the requirement for suction superheat values (SH) as stated in the diagram. See *Oil types and oil companies* in this section. Due to the ongoing development of lubrication oils, please contact YORK Refrigeration for an update on the requirement for superheat.

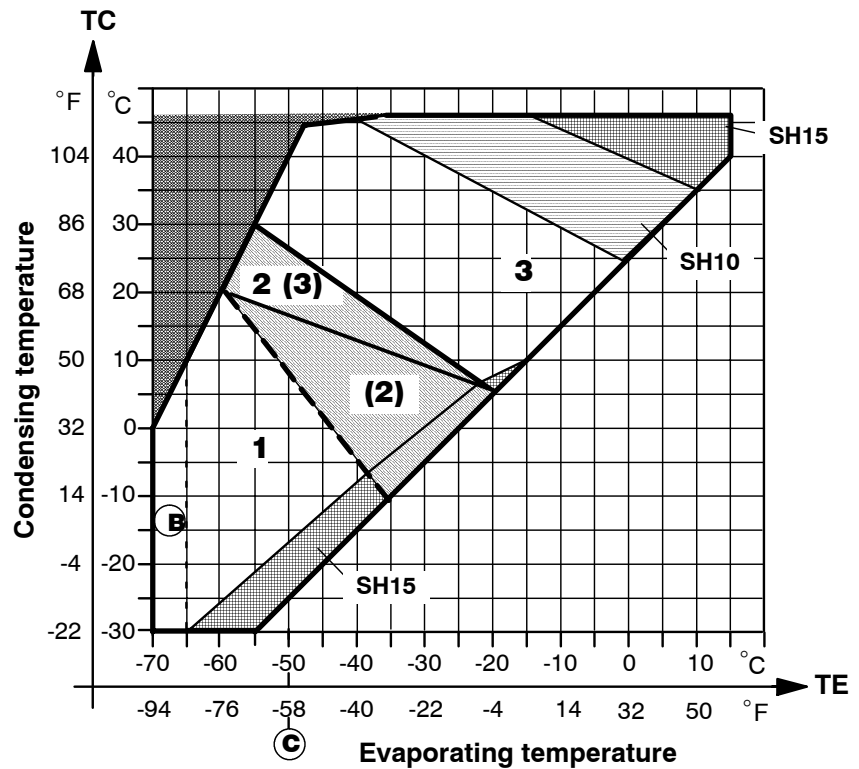
HLL: Calculation must be performed using COMP1.

- ▲ : In case of a new plant. Very suitable.
- SH: Suction gas superheat, K (Kelvin)
- ▨ : Zone in which both oils are useable
- ▩ : Calculation must be performed using COMP1

R404A

screw compressors

Code no	Area no (See note)		
	1	2	3
E 3	▲		
E 5		▲	
E 9			▲



Note: For the compressors type "S", "Rotatune", "SAB 81", "SAB 83", and "SAB 85" only Sabroe oil H is approved.

Using the calculating programme COMP1 it is possible to optimize the requirement for suction superheat values (SH) as stated in the diagram. See *Oil types and oil companies* in this section. Due to the ongoing development of lubrication oils, please contact YORK Refrigeration for an update on the requirement for superheat.

HLL: Calculation must be performed using COMP1.

▲ : In case of a new plant. Very suitable.

ⓑ : Max oil concentration in liquid phase: contact YORK Refrigeration

Ⓒ : Min suction temperature -50°C : at $\text{TE} < -50^{\circ}\text{C}$ superheating must be introduced.

SH: Suction gas superheat, K (Kelvin)

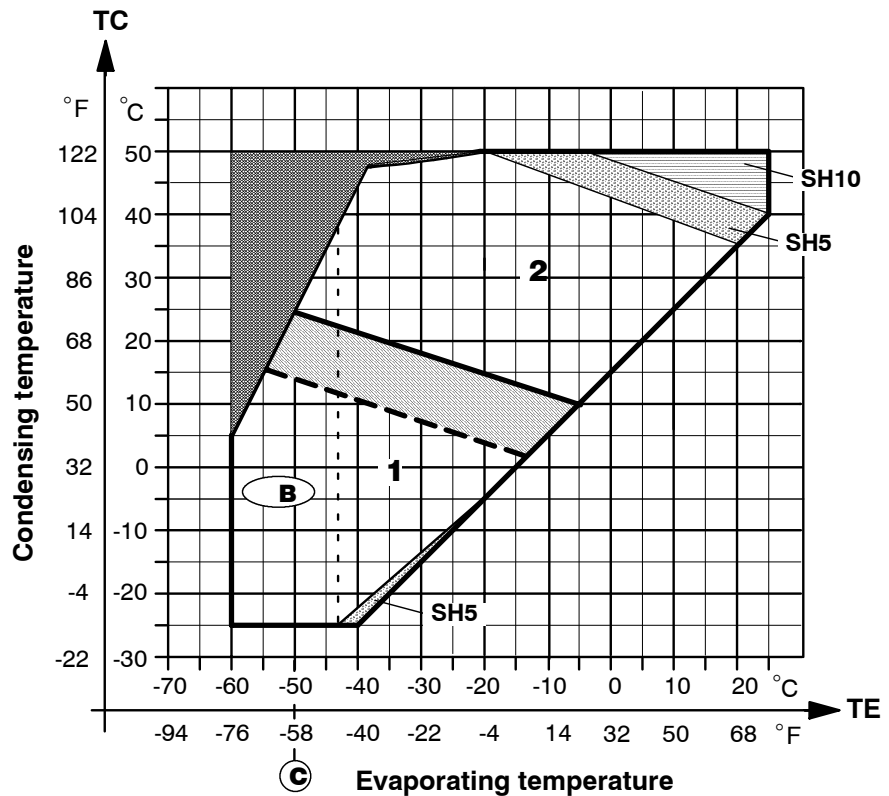
▨ : Zone in which both oils are useable

▩ : Calculation must be performed using COMP1

R407C

screw compressors

Code no	Area no (See note)	
	1	2
E 3	▲	
E 9		▲



Note: For the compressors type "S", "Rotatune", "SAB 81", "SAB 83", and "SAB 85" only Sabroe oil H is approved.

Using the calculating programme COMP1 it is possible to optimize the requirement for suction superheat values (SH) as stated in the diagram. See *Oil types and oil companies* in this section. Due to the ongoing development of lubrication oils, please contact YORK Refrigeration for an update on the requirement for superheat.

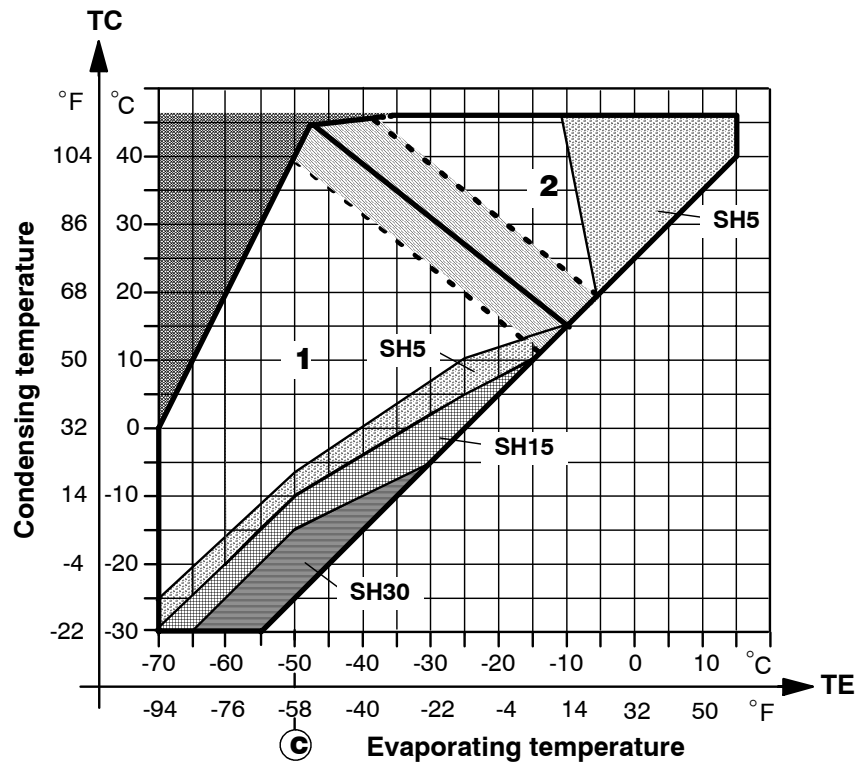
HLL: Calculation must be performed using COMP1.

- ▲ : In case of a new plant. Very suitable.
- ⓑ : Max oil concentration in liquid phase: contact YORK Refrigeration
- Ⓒ : Min suction temperature -50°C : at $\text{TE} < -50^{\circ}\text{C}$ superheating must be introduced.
- SH: Suction gas superheat, K (Kelvin)
- ▨ : Zone in which both oils are useable
- ▩ : Calculation must be performed using COMP1

R507

screw compressors

Code no	Area no (See note)	
	1	2
E 5	▲	
E 9		▲



Note: For the compressors type "S", "Rotatune", "SAB 81", "SAB 83", and "SAB 85" only Sabroe oil H is approved.

Using the calculating programme COMP1 it is possible to optimize the requirement for suction superheat values (SH) as stated in the diagram. See *Oil types and oil companies* in this section. Due to the ongoing development of lubrication oils, please contact YORK Refrigeration for an update on the requirement for superheat.

HLL: Calculation must be performed using COMP1.

▲ : In case of a new plant. Very suitable.

Ⓒ : Min suction temperature -50°C : at $\text{TE} < -50^{\circ}\text{C}$ superheating must be introduced.

SH: Suction gas superheat, K (Kelvin)

▨ : Zone in which both oils are useable

▩ : Calculation must be performed using COMP1

List of Major Oil Companies

The oil from the companies listed below are NOT tested by YORK Refrigeration and are therefore NOT approved by YORK Refrigeration either. The following list reflects the information provided by the companies themselves. The assessment of durability and suitability of specific oils for specific purposes are entirely at the companies' own discretion. Oils tested and approved by YORK Refrigeration can be found in the "List of part numbers for available Sabroe oils".

Oil Company	Oil Types				
	M	A	PAO	AP	E
Aral	•				•
Avia	•				
BP	•	•	•		•
Castrol	•	•	•		•
Chevron (UK: Gulf Oil)	•		•		•
CPI Engineering Services	•		•		•
DEA	•	•	•		•
Elf / Lub Marine 1	•	•			•
Esso/Exxon	•	•	•		
Fina	•	•			•
Fuchs	•	•	•		•
Hydro-Texaco	•	•	•		•
ICI					•
Kuwait Petroleum (Q8)	•			•	
Mobil	•	•	•	•	•
Petro-Canada	•				
Shell	•	•	•		•
Statoil	•	•			
Sun Oil	•				•

Alignment of compressor unit SAB 110

This chapter gives a description of the procedure in connection with setting up of a compressor unit, as f.inst.:

1. Alignment of compressor unit on foundation.
2. Connection of electricity, refrigerant and any cooling water connections.

In order to secure a long life for the unit as well as noise- and vibration free running, it is essential that the compressor unit is carefully aligned. Misalignment may produce stresses and vibrations that can be transmitted to compressor and bearings of motor and thereby cause break-down.

Vibrations may be due to:

- Distortion between compressor unit and foundation.

- Stains from pipe connections between compressor and plant.

1.0 Alignment of unit on foundation:

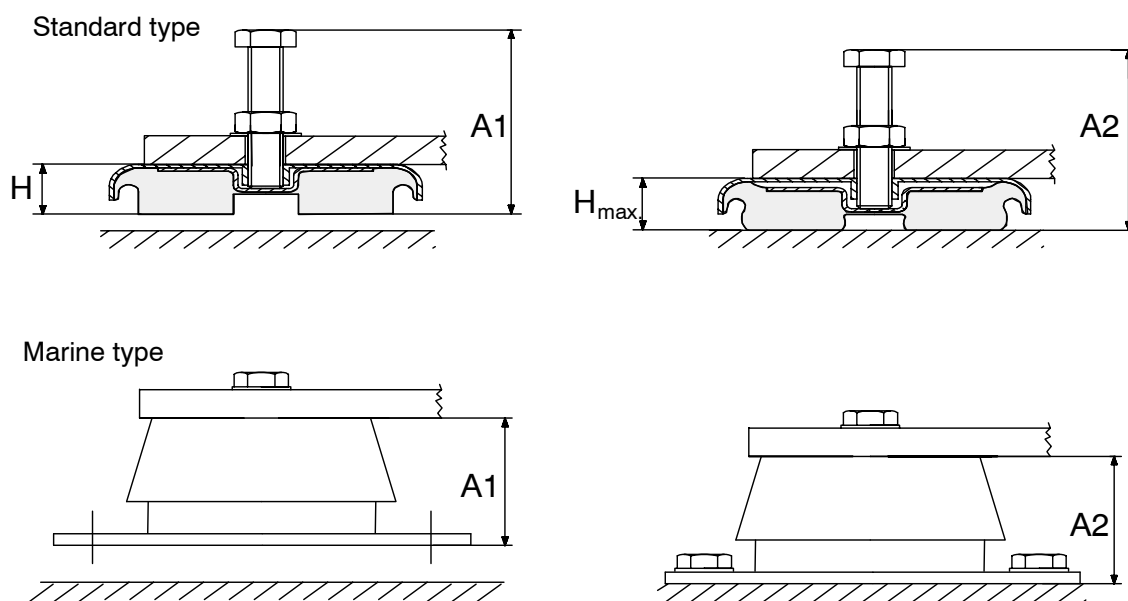
When mounting the unit on foundation or machine floor, it must stand free from stress and rest evenly on all its supports.

The unit can be mounted in the following ways:

- On vibration dampers.
- Directly on foundation or machine floor with foundation bolts.

In both cases, the unit must be aligned **before** fitting connecting pipes to the plant.

Fig. 1



T0177040_0

1.01 Mounting of vibration dampers

Depending on whether compressor unit is to be used on land ① or on a ship ② vibration dampers are included in the delivery as shown on fig. 1.

The purpose of vibration dampers is to dampen vibrations from compressor unit to foundation. Further, marine vibration dampers must dampen vibrations from foundation to compressor unit, at the same time keeping the unit fixed to foundation.

It is extremely important that the vibration dampers be placed correctly as shown on drawing forwarded to client or distributor. This drawing is valid **only** for the unit in question.

When applying vibration dampers it is assumed that the foundation has the necessary Bearing strength and is level so that the adjustment of the vibration dampers can be kept within the adjusting measures indicated on the drawing submitted.

In order that each vibration damper functions properly, must be sufficiently stressed. Measure A1 and H in non-stressed and A2 in a stressed situation.

	Industrial type ①	Marine type ②
Flexion A1-A2	min 1,0 max 2,0	min 3,0 max 5,0
Height adjustment	H _{max} = H+12	

All measures are in mm

The flexion of the **industrial type** is adjusted by increasing or reducing the load in proportion to the other supports. The foot can be raised by screwing the adjusting spindle down, thereby increasing the load and hence also the flexion.

Vibration dampers of the **marine type** are *not* adjustable. Therefore, it is essential that the foundation is even within a max. deviation of 2 mm.

If the foundation is not even within max. 2 mm, line under the vibration dampers until the prescribed flatness is obtained.

Once the plant has cooled down, check during operation that the flexion of the dampers is still correct!

1.02 Direct mounting on foundation

On direct mounting on foundation with embedded foundation bolts, carefully check that all 4 legs are stable. Alternatively, use shims in order to avoid distortion of compressor unit.

1.1 Making of various connections

Pipe connections

After aligning of unit on foundation, establish pipe connections to refrigeration plant.

Pipes which that are exposed to sizeable temperature fluctuations **must** be laid so as to allow for deflexion at appropriate points.

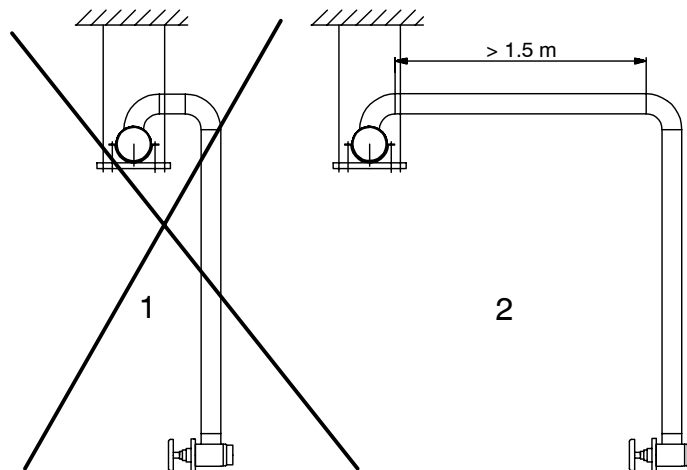
This is to safeguard against the transmission of **excessive** forces to the compressor and the unit. Enclosed pipes may give rise to very important stresses for instance in connection with changes in temperature from installation temperature to operating temperature.

Therefore, once the plant has cooled down, the vibration dampers of compressor unit should be checked for correct flexion.

The following sketch shows a rigid and unacceptable piping (1) and a more flexible one (2) which is recommended.

Electric connections

On initial start-up of unit **immediately** check whether the rotating direction of compressor is correct as indicated by the **arrow** on top of bearing cover Pos. 20.



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Key to Piping Diagrams/Component List

CS	Screw compressor	TI5	Thermometer (discharge gas temperature)
OS	Oil separator	TI6	Thermometer (oil temperature)
M	Electric motor	TI7	Thermometer (suction gas temperature) - only if specially ordered
EC	Electronic control system		
240	Coupling		
————— • —————			
PT1	Pressure transducer (suction pressure)	PDAZ10	Oil pressure difference cut-out (oil pressure - discharge pressure)
PT2	Pressure transducer (discharge pressure)	PDAZ11	Oil pressure difference cut-out (oil pressure - suction pressure) - for classified systems only
PT3	Pressure transducer (oil pressure after oil filter)	TAZ12	Thermostat (oil temperature in manifold)
PT4	Pressure transducer (oil pressure before oil filter)	TAZ13	Thermostat (discharge gas temperature)
PT5	Pressure transducer (oil pressure after oil pump)	TC14	Thermostat (pilots solenoid valve pos. 82)
TT5	Temperature transducer (discharge gas temperature)	PI15	Suction pressure manometer
TT6	Temperature transducer (oil temperature in flow control)	PI16	High-pressure manometer
TT7	Temperature transducer (suction gas temperature)	PDI17	Oil difference manometer
GT8	Position transmitter (capacity slide)	FT18	Level switch
GT9	Position transmitter (V_i slide)	YY1	Double acting, four-way solenoid valve - unload capacity
PAZ10	Safety pressure cut-out (for TÜV, SDM and SA only)	YY2	Double acting, four-way solenoid valve - load capacity
PAZ1	Low-pressure cut-out (only for classified systems)	YY3	Double acting, four-way solenoid valve - volume ratio/increase
PAZ2	High-pressure cut-out	YY4	Double acting, four-way solenoid valve - volume ratio/decrease
PDAZ3	Differential pressure cut-out (pressure drop across oil filter)	SC1	Throttle valve
		SC2	Throttle valve
		SC3	Throttle valve
		SC4	Throttle valve

BP	Throttle valve - by-pass	43	Combined flow control and oil distributing manifold
LIT1	Oil level transmitter		
19	Compressor safety valve	44	Check valve, rotor lubrication
20	Suction stop valve	45	Nozzle in injection pipe for rotors
21	Non-return valve	46	Thermostatically-controlled 3-way valve for oil temperature regulation
22	Flanged joint discharge pipe - compressor	47	Service valve for oil drainage
23	Suction filter built into compressor	48	Oil purge valve on oil filter
23a	External suction filter	49	Thermostatic water valve for water-cooled oil cooler
24	Service valve - air purge valve		
25	Oil separator	50	Stop valve
26	Non-return valve in outlet pipe from oil separator	51	Oil filter
		52	Nozzle/throttle valve
27	Stop and non-return valve in outlet pipe from oil separator	53	Oil level indicator
		54	Stop valve
28	Safety valve - the unit	55	Oil separation element (fine separation)
29	Change-over valve for double safety valve	56	Non-return valve
30	Immersion heater in oil separator	57	Hand-regulated valve
31	Oil level indicators (2 pieces)	58	Temperature regulated main valve
32	Oil cooler OOSI (refrigerant-cooled)	59	Oil receiver
		60	Stop valve
33	Oil cooler (water-cooled)	61	Oil filter
34	Stop valve for oil purging (oil side)	62	Oil charging valve
35	Stop valve for oil purging (refrigerant side)	63	Oil pump
		64	Stop valve for air purging of pump
36	Oil outlet branch to oil cooler/filter	65	Stop valve
37	Oil branch to pump suction end	66	Non-return valve for oil charging
38	Stop valve before oil filter	67	Solenoid valve (NC) - open during prelubrication
39	Oil filter	68	Stop valve
40	Oil inlet from pump	69	Non-return valve
41	Non-return valve built into oil filter	70	Solenoid valve (NC) - capacity regulation min. -> 100%
42	Stop valve after oil filter		

71	Solenoid valve (NO) - capacity regulation 100 -> min.%	104	Nozzle
72	Throttle valve for regulation of slide velocity	105	Flow switch
73	Solenoid valve (NC) - capacity regulation min. -> 100%	106	External oil filter
74	Solenoid valve (NO)	107	Oil filter for units with full flow oil pump
75	Non-return valve	108	Oil regulating valve
76	Three-way non-return valve	110	Stop valve
80	Stop valve	TC111	Thermostatic valve
81	Liquid refrigerant filter	112	Solenoid valve (NC)
82	Solenoid valve (NC)	113	Liquid filter
TC83	Liquid injection valve TEAT	114	Stop valve
84	Stop valve	115	Stop valve for oil purge
90	Oil supply to bearings at discharge end	116	Economizer vessel
91	Oil supply to shaft seal and bearings at suction end	120	Stop valve
92	Oil injection in compressor	122	Main valve
93	Oil return from capacity regulation	123	Solenoid valve (NC)
94	Oil to and from regulating cylinder	124	Stop valve for oil drainage
95	Liquid supply for HLI cooling V _i 4.0	125	Safety valve
96	Liquid supply for HLI cooling V _i 2.6	126	Float valve
97	Economizer connection	127	Stop valve
98	Oil connection from flow switch	128	Stop valve
99	Oil to and from V _i regulation (only by auto-V _i)	129	Solenoid valve (NC)
100	Oil return from fine oil separator	130	Stop valve
101	Bypass throttle valve at suction stop valve	131	Stop valve
102	Non-return valve	132	Liquid filter
103	Stop valve	PI139	Oil pressure manometer
		140	Stop- and non-return valve
		141	Main valve
		142	Pilot valve
		143	Solenoid valve
		144	Stop valve
		145	Float valve

147	Liquid filter	211	Stop valve
148	Stop valve for oil purge	212	Service valve - air purge valve
149	Non-return valve	213	Non-return valve
150	Stop valve	214	Filter
151	Safety valve	215	Non-return valve (5 bar)
152	Solenoid valve	220	Compressor protecting valve (main valve)
153	Stop valve	221	Compressor protecting valve (pilot valve for pos. 220)
154	Stop valve	222	Filter in economizer pipe connection
160	Stop valve	223	Brake motor for capacity slide
200	Gas-powered stop valve	224	Three-way solenoid valve
201	Solenoid valve (NC)	225	Oil return pump
202	Stop/non-return valve	226	Solenoid valve for baby slide (NC)
203	Non-return valve in discharge pipe	227	Quick closing oil drain valve
204	Stop valve after oil separator		
205	Filter		
206	Nozzle		
207	Solenoid valve (NO)		
208	Solenoid valve (NC)		
FT209	Oil level switch in oil separator		
210	Non-return valve		

Note:

On units supplied without valves the bracketed figures near the branches refer to the component numbers in this list. These components are to be fitted by the customer.

Ordering Spare Parts

When placing an order for spare parts, please state the following:

1. Shop No.

All compressors are fitted with an identification plate, which states the type and shop no. of the compressor and indicates what refrigerant is to be used.

2. Part No.

Spare parts drawings and parts lists inserted in an instruction manual identify spare parts with the following:

- a) Spare part no. - which is a reference number to facilitate finding a part in the drawing and cross-referencing in the parts list or vice versa.
- b) Designation of the part.
- c) Part no. - a 7-digit number which refers to SABROE's stores.

When you order spare parts, please always advise at least the designation and part num-

ber. If you are in any doubt, add the spare part no. too.

3. Forwarding instructions

When ordering spares, please advise the forwarding address, and the address to which the invoice should be sent. If appropriate, please state the name of your local bank, the way in which you want the goods transported and required delivery date.

4. Classification certificate

If you require a certificate from a Classification authority, please mark the order appropriately, as the inspection and issuing procedures take extra time and incur extra expenses.

5. Quotation No.

If a quotation no. has been given during earlier correspondence, please refer to this when placing your order - it will help us to identify and execute your order quickly.

Spare Part Sets for Screw Compressor and Unit

Types: SAB 110 - 128 (HR) - 163 (HR) - 202 - VMY 347/447 and VMY 336-436-536

It is always an advantage to have a stock of spare parts for both compressor and unit. In this way the customer or a YORK Refrigeration service engineer is able to carry out the necessary replacements without wasting time waiting for new spare parts to arrive.

On contacting YORK Refrigeration's local representative, you may receive specifications for the following spare part sets for compressor and unit.

Compressor Block:

- **Standard set of spares**

This set contains a representative selection of O-rings and gaskets.

- **Certificate set of spares**

Besides the parts from the **standard set of spares** this set also includes all bearings as well as shaft seal.

- *Safety valve:*

Gaskets, cone, O-rings

- *Oil by-pass system:*

Gaskets, teflon ring

- *Oil pump:*

O-rings

- **Certificate set of spares:**

Further to the parts contained in the **standard set of spares**, this set also includes spare parts for the below-mentioned components:

- *Coupling:*

Screws and discs

- *Oil separator:*

Sight glass, oil separator element, heating element

- *Capacity regulating system:*

Solenoid valve

- *Safety valve:*

Spring

- *Solenoid valves:*

Coils

- *Oil pump:*

Shaft seal, filter

Basic Unit:

- **Standard set of spares:**

This set includes the following spare parts for the below-mentioned components:

- *Oil separator:*

O-rings, gasket

- *Service valves:*

Gaskets, O-rings

- *Capacity regulating system:*

Gaskets, O-rings

- *Pressure outlet stop valve:*

Gaskets

- *Suction Inlet stop valve:*

O-rings, sealings rings, gaskets, teflon ring