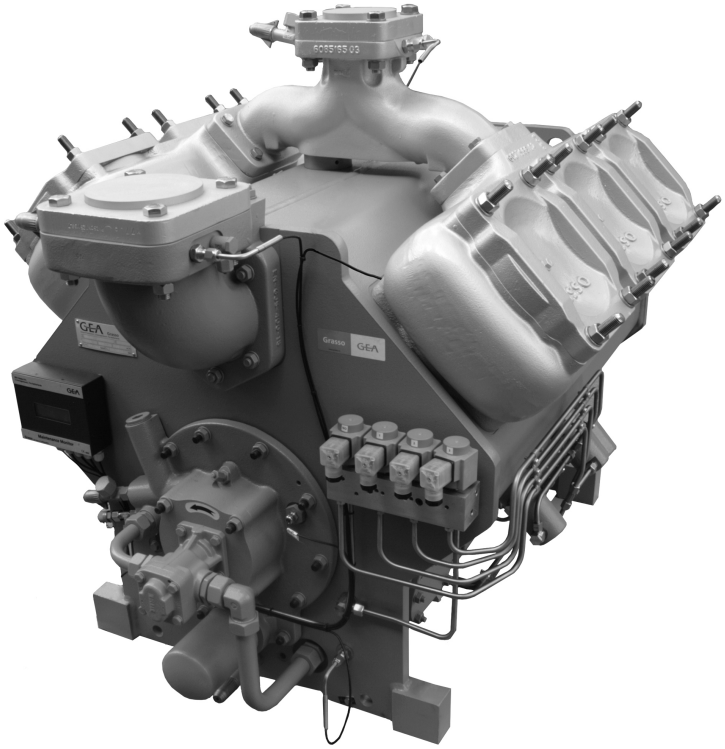

Reciprocating Compressors for industrial refrigeration

GEA Grasso V

Installation and Maintenance instructions

0089288gbr_11

engineering for a better world

gea.com

LEGAL NOTICE

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SYMBOLS USED

Danger

Stands for an immediate danger leading to severe physical injuries or death.

► Description for avoiding the danger.

Warning!

Stands for a potentially dangerous situation leading to severe physical injuries or death.

► Description for avoiding the dangerous situation.

Caution!

Stands for a potentially dangerous situation which could lead to minor physical injuries or damage to property.

► Description for avoiding the dangerous situation.

Notice!

Stands for important information that must be observed for the intended use and function of the product.

► Description of the required action for the intended function of the product.

SAFETY INSTRUCTIONS

Hint!

This manual must be carefull read and understood prior to installing and servicing the compressor (package)

Safety

This manual is written with great care, but the contractor/installer is held responsible to examine this information and to take care of possible additional and/ or deviated safety measures.

Safety instructions

It is the task of the contractor/installer to inform and explain to his client the operation of the compressor (Package).

Do respect all federal, state or local safety regulations/legislations during installing, connecting and operating this compressor (package).

Construction changes

Warning!

In compliance with the regulations of the Pressure Equipment Directive it is mandatory that no changes be made to the construction of pressurised parts such as the crankcase housing, suction filter housing etc.

Installer oriented information

The compressor (package) is filled with nitrogen to prevent penetration of moisture. Therefore, keep the compressor closed until the compressor (package) is being installed.

Warning!

The compressor is not filled with oil.

Hint!

After the successful initial run of the compressor (package) the warranty chart must be filled in and returned to Grasso. A warranty chart is attached to each compressor.

PREFACE

General

1. All documentation can be downloaded via our web site.
2. GEA technical manuals includes “generic paragraphs”; this means that ***it can occur*** that not all data as described is relevant for the current compressor series as mentioned in this manual. (For instance, not all compressor series are suitable for all mentioned refrigerants or not all compressor series includes two-stage compressors)

Directives

Equipment is based on Pressure Equipment Directive (PED 97/23/EG) regulations and according to Machine Directive (MD 2006/42/EG) regulations.

The applied standards are:

NEN-EN-IEC 60204, NEN-EN-ISO 12100, NEN-EN-ISO 13857, NEN-EN 378

CYLINDER NUMBERING, BOOSTER AND SINGLE-STAGE OPERATION

Cylinder numbering

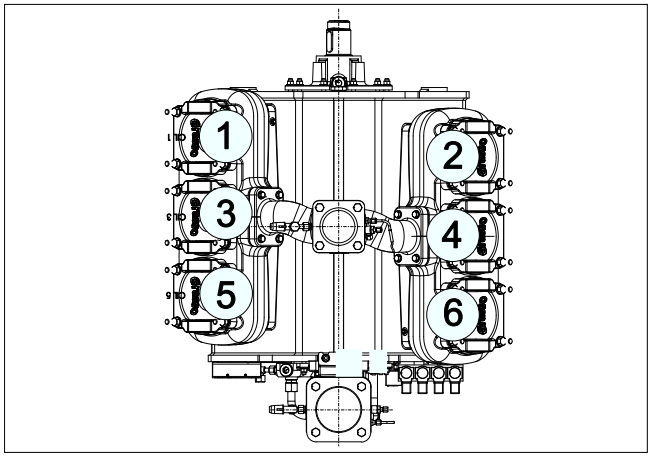

Fig.1: Example cylinder numbering 6 cylinder compressor

Booster or single-stage operation

1. Booster operation applies if condensing temperature < +5 °C
2. Single-stage operation applies if condensing temperature >= +5 °C

GENERAL INFO

Main setup data			
Description	**Value**		**Remark**
	Grasso V 300 (T) .. V 600 (T)	**Grasso V 700 (T) .. V 1800 (T)**	
Start frequency	max. 6 starts per hour		The **NO-solenoid has to be de-energised 20 seconds after starting the compressor** motor to enabel the motor to reach the minimum speed and the compressor to develop the required oil pressure.
Time interval between stopping and re-starting	min. 2 minutes		
Time interval between starting and re-starting	min. 10 minutes		
Time interval between loading and unloading	min. 3 minutes		For continuous minimum part-load (i.e. more than 30 minutes) consult Grasso. Adjust the steps between up and down loading, in such a way that the system is running stable.
Oil level	25-75% crankcase sight glass		
Min. oil temperature	> 30 °C and > $P_{saturated\ crankcase\ pressure}$ + 15 K		Indicated minimum value is the lowest oil temp. at which the compressor is allowed to be started.
Max. oil temperature	Refer to oil selection table/applied type of oil		Required oil viscosity; ≥ 10 cSt during operation at location of bearings. The maximum temp. depends on the operating conditions of the compressor, the oil type used and (A minimum actual oil viscosity of 10 cSt in the bearings is always requried; bearing temp. to determine oil viscosity is approx. oil temperature + 15K)
Control oil pressure	suction pressure + 8 bar (g)		
Lubricating oil pressure difference	between 1.3 and 4.5 bar Setting approx. 2.0 bar (g)		After a mimimum of 15 minutes running time at an oil temperature of approx. 50 °C
Max. discharge temperature	170 °C		
Min. suction pressure	0.3 bar(a)		
Max. intermediate pressure Max. suction pressure	8.5 bar (a)	7 bar (a)	
Pdischarge - Psuction	≤ 25.0 bar (g)	≤ 19.0 bar (g)	
Superheat	>0 K		
Oil discharge - **running in - filter**	Factory mounted; **to be replaced after max. 100 running hours** by “normal” oil discharge filter element		
Oil discharge filter	Supplied loose; replacement for factory mounted running in filter		

TABLE OF CONTENTS

1 INSTALLATION AND PREPARATION FOR USE

1.1 Running-in oil filter has to be installed after an overhaul or big repair

Hint!

This is why and when the running in oil filters are required:

Warning!

A running in oil filter has always to be installed after an overhaul or big repair for the 1st 100 hours of operation!

The oil and oil filters have to be replaced by new oil and filters.

Due to running-in wear of liners and piston rings, it's normal that the oil becomes grey during the 1st 100 operating hours.

After 100 operating hours, the oil could slightly become clear again.

1.2 INSTALLATION

Warning!

The compressor is not charged with oil, therefore, DO NOT start the compressor before it has been installed and prepared according to Grasso's instructions.

This section contains instructions for the proper installation of a Grasso compressor (package). Before the compressor (package) is ready for the initial start up, the installation instructions in the following paragraphs must be followed:

1. The Compressor (Package) should be levelled and securely anchored to the foundation.
2. All piping should be completed.
3. The system and the compressor are to be pressure tested for leaks (see. Section 1.3.1, Page 22)
4. The system should be evacuated to remove air and moisture.
5. The electric wiring should be completed as per wiring diagrams. Do not energise the main power control cabinet until oil is added and the direction of rotation has been checked.
6. The compressor is to be filled with the correct type and amount of lubricating oil and has to be pre-lubricated (Refer Section 4.7, Page 60) before the first start.
7. 'Open compressors' only;

   7.1 Open compressors;
   The drive system should be installed.

   7.2 (Semi) hermitic compressors;
   Mark R-S-T-N power supply in the terminal box of the motor.

8. The system should be charged with the correct amount of refrigerant.
9. The oil should be warmed up above minimum start up oil temperature (see "Product Information").
10. The control cabinet should be energised to check the package controls.

Hint!

Do not forget to charge the oil separator (if present) initially with oil, to the level of the float assembly

1.2.1 Moving instructions and storage

For loose component or compressor package weights, refer either to the relevant component type plate or package lay-out or to the suppliers document. For bare compressor weights, see "Product Information".

⚠ Caution!

Every precaution must be taken while moving the package to its final location. Pushing, pulling or climbing on any package component or piping, can easily create damage.

1.2.2 Storage

The compressor (package) is filled with dry nitrogen. Keep the system closed until the package is installed. If the compressor (package) is stored, it should be kept at all times in a dry location to prevent corrosion damage. If the compressor (package) is to be stored for a prolonged period of time, it should be checked weekly to ensure that the holding charge of dry nitrogen remains above atmospheric pressure.

1.2.3 Hoisting and moving instructions

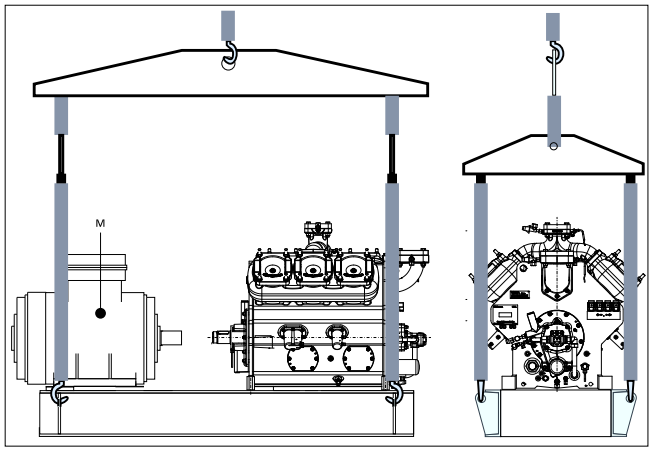

Fig.2: Hoisting a compressor package

Packaged base frame:

The only places that can be used for safe hoisting of the package are the four hoisting eyes on the steel base frame as shown in the above figure. Prior to hoisting a compressor package with a V-belt drive arrangement, the factory mounted drive guard has to be removed. Attach spreader bars to the slings so as to prevent damage to piping and components.

⚠ Warning!

DO NOT use the compressor or motor or oil separator hoisting eyes to move the package! These hoisting eyes are intended for lifting loose components only and not for the entire package!

Bare compressor or loose components:

Determine the dead weight of the particular component (see "Product Information (ED)"), prior to moving a bare compressor or loose component. Use the hoisting eyes only, DO NOT sling from other compressor parts (see Figure 3, Page 15).

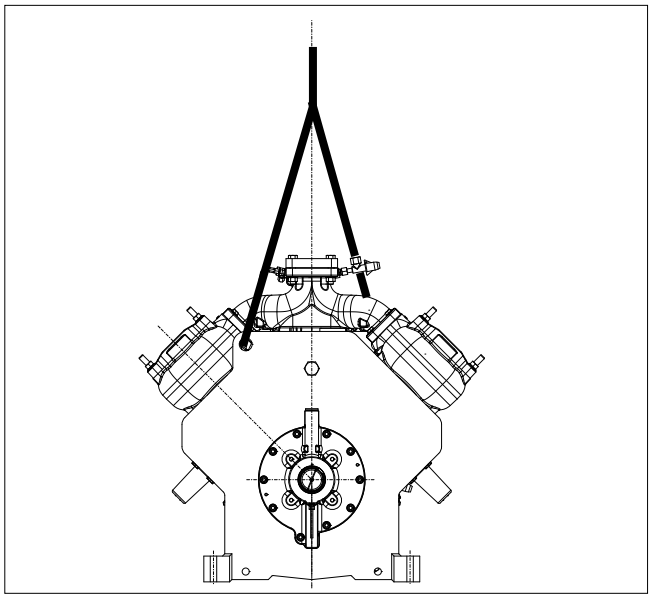

Fig.3: Hoisting angle

Moving by fork-lift truck

The bare compressor or package can be transported with a fork-lift truck with the forks spread as much as possible between the skids. To simplify moving, the 2 wooden transport beams must still be mounted underneath the base frame and stored in this way, until the package is positioned above its approximate location.

1.2.4 Required free space

For easy operating, servicing and maintenance access, the compressor (package) should be installed with sufficient free space around it.

Hint!

Refer to “Product Information“ for minimum requirements.

1.2.5 Foundation requirements

Hint!

Compressor (package) has to be mounted on a concreted block. On request, Grasso can calculate the exact dimensions of the concrete block, based on the compressor size and operating conditions.

This paragraph covers measures to be taken for a compressor (package) mounting on a concrete block.

Two foundation arrangements are described:

1. Compressor package with steel base frame mounted on a concrete block.

   Following base frames are possible;

   1.a Frame designed for mounting on concrete block.

   For more instalation details refer to; Section 1.2.5.1, Page 16, Section 1.2.5.2, Page 17, Section 1.2.5.3, Page 18, Section , Page 19, Section , Page 19.

   1.b Frame designed for mounting on vibration dampers.

   For more details in case mounting base frames on vibration dampers is applied, refer to separate instruction sheet and other order documentation like package drawing, supplied with the compressor package and consult Grasso if required.

2. Bare compressor direct mounted on a concrete block via grouted anchors.

   For more installation details refer to; Section 1.2.5.1, Page 16, Section 1.2.5.2, Page 17, Section 1.2.5.4, Page 19.

1.2.5.1 Concrete structure

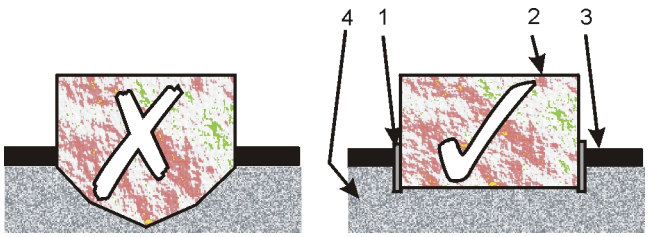

Fig.4: Concrete block

1	Cork board
2	Concrete base
3	(Concrete) Floor
4	Sand

The concrete block for compressor and motor or compressor package should have a profile as illustrated in Page 16 and made according to the following recommendations:

- The concrete block should be set on firm footings or on a floor capable of carrying the weight of the concrete block and capable of absorbing the free forces and gas forces of the compressor during operation. The ground under the concrete block should be horizontal and flat.
- The top surface of the block should be level and even.
- There should be sufficient free space around the block to install corkboard (or similar).
- The block should be provided with anchor bolt recesses or holes according to the anchor bolt spacing as per package lay out drawing.

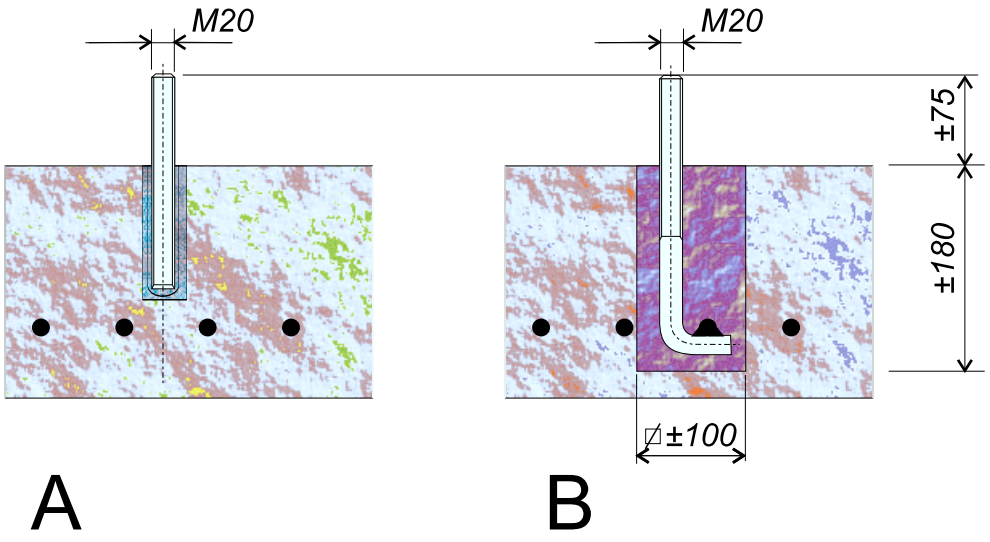

Fig.5

A	Chemical anchor
B	Grouted anchor, grounded to reinforcing steel

It is recommended to consult a concrete specialist/ constructor for the following items:

- The compound of the concrete with/without reinforcement.
- The exact grouting depth (dependent on the soil conditions).
- Installing foundation onto an existing floor, with sealing corkboard or vibration isolators.

1.2.5.2 Anchoring

After the concrete block has cured the anchors should be installed as shown above and in case of a package in accordance with the package lay out drawing. Templates should be made to locate the anchor bolts or chemical anchors to match the holes in the bottom flange of the base frame.

Grout the mortar according to the supplier instructions. Install chemical anchors as illustrated in Figure 6, Page 18 and according to the instructions of the anchor supplier.

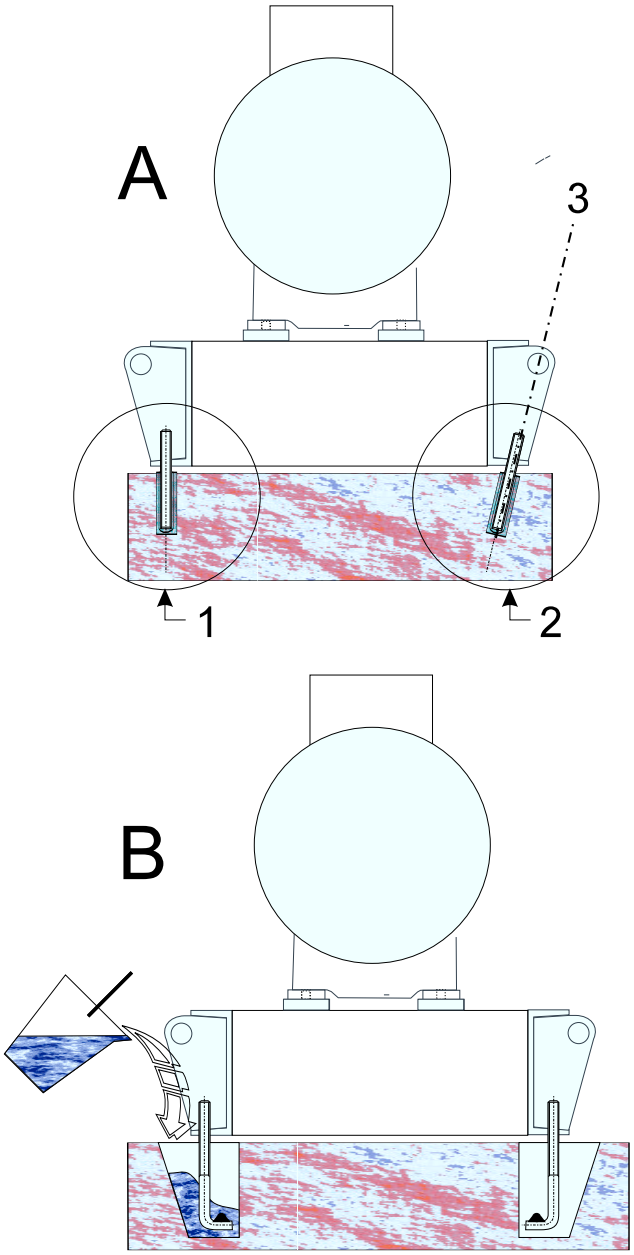

Fig.6: Anchoring details

A	Drilled chemical anchor (M20)
B	Grouted anchor recesses (M20)
1	Installed chemical anchor before placing the base frame
2	Installing chemical anchor after placing the base frame (base frame cannot be removed easily)
3	Drilling angle

1.2.5.3 Mounting the base frame on a concrete block

General

After the space between base frame and concrete base has been filled-up with a filling grout, the package base frame must be secured tightly to the foundation block or floor.

Levelling the base frame

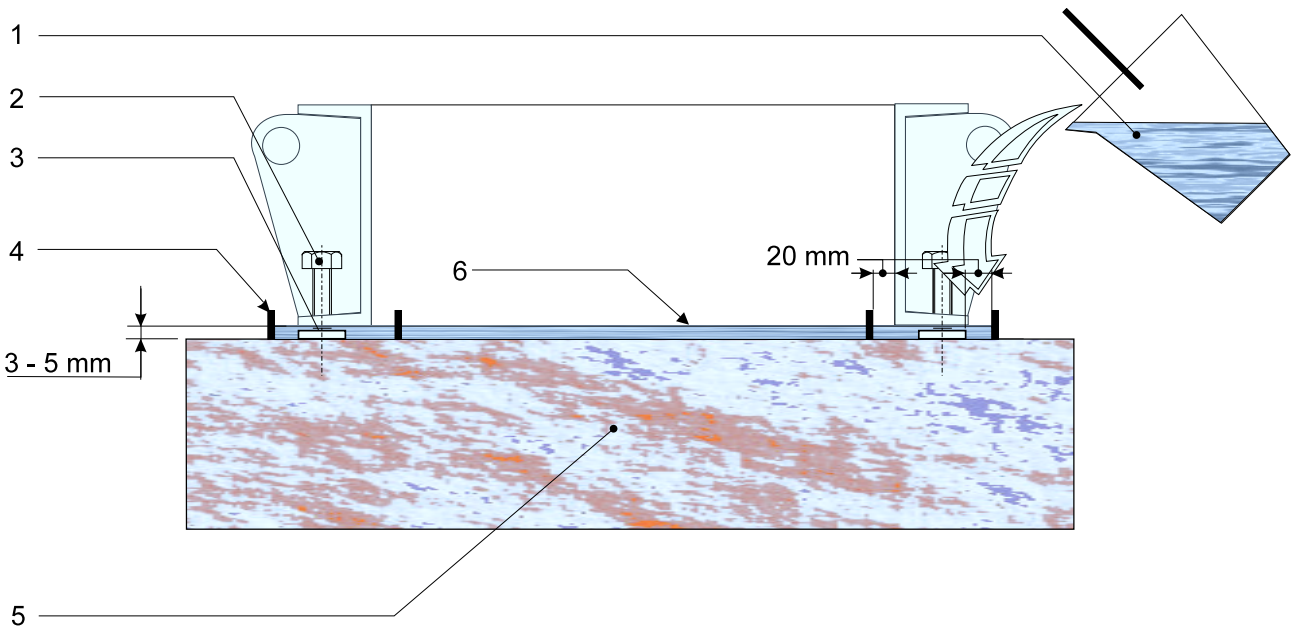

Fig.7: Grouting details

1	Self-levelling grout
2	Adjusting bolts (4x)
3	Washer
4	Temporary barrier strip around and inside frame
5	Complete cured concrete block
6	Grout layer

After the anchor filling mortar has completely cured the frame should be levelled with a space between block and lower frame flange of 3 - 5 mm*. This space is necessary for levelling using the base frame adjusting bolts with metal washers (supplied separately). The base frame should be levelled on each frame side. Adjust the frame on each adjusting place until all frame sides are horizontal.

This space largely depends on the sort of grout or mortar used. Determine this space according to the instructions of the grout or mortar supplier.

Finishing with a self-levelling grout

After levelling has been completed the adjusting bolt ends must be greased to avoid bonding to the self-levelling grout. The space between concrete block and frame must be completely filled with the self-levelling grout to ensure that the complete bottom surface of the base frame will be supported. Therefore, it is not allowed to use shims between concrete base and base frame.

Grouting must be carried out in accordance with the instructions provided by the grouting supplier. After complete de-aeration of the grouted layer, secure the base frame by tightening the anchor bolt nuts and remove all adjusting bolts. At this stage the drive system can be installed. These (accessories) installation instructions can be found in the order manual.

1.2.5.4 Mounting bare compressor on a concrete block

If base frame is not applied the approximately the same procedure of levelling the base frame has to be applied for the bare shaft compressor (refer Section 1.2.5.3, Page 18).

The mounting surfaces of the compressor feet must be level without any deviation and projecting at least 10 mm above the concrete base.

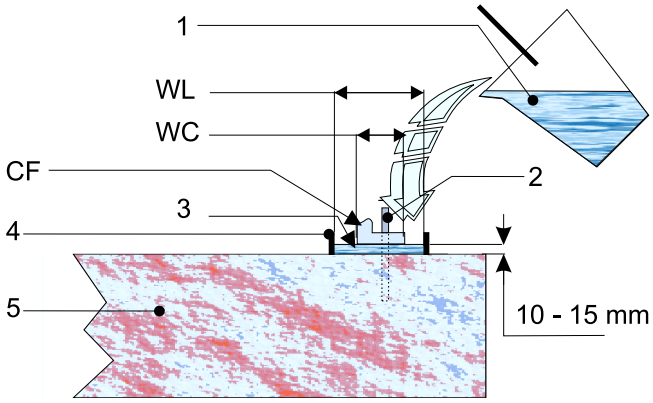

Fig.8: Grouting details of bare compressor on concrete block

Legend	
1	Self leveling grout
2	Foundation anchor
3	Layer of self leveling grout (10 - 15 mm)
4	Temporary barrier strip aroud each compressor foot
5	Complete cured concrete block
CF	Compressor foot
WL	Width of grout layer (WL-WC > 40 mm)
WC	Width of compressor foot (WL-WC > 40 mm)

1.2.6 Connecting to refrigerating system pipework

⚠ Warning!

DO NOT ground through the compressor when arc welding

After the compressor (package) has been levelled and secured to the foundation, the system piping may be connected. The suction line(s) and discharge line(s) should be installed and supported such that there is no load exerted on the compressor. The size and location of the suction and discharge connections, can be found in the "Product Information" (bare compressor) and in case of a package, the package lay out drawing.

Hint!

If an oil rectifier system is applied in the refrigeration system, the oil return line must be connected to the oil return connection (see "Product Information").

Suspension of system pipework

To eliminate vibration transmission to the system piping, the following is recommended:

- Install all piping free of tension.
- Secure the piping by clips or brackets in two directions.
- Install (stop) valves, piping and accessories such, that there is no load exerted on the compressor.

1.2.7 Connecting the power supply

Information about further electrical connections to be made (e.g. crankcase heater, drive motor starting equipment, thermal protection of drive motor, automatic start/ stop and other external electrical devices) can be found in the plant manual (not supplied by Grasso).

1.2.8 Earthing connections

Grasso compressors and packages are equipped with litz-wires and earth connecting points.

To avoid leakage current flowing through the components, disconnect all litz-wires when arc-welding. After all installation functions are completed, reconnect the litz-wires and ground the package to earth.

1.2.9 Separately delivered components

Hint!

Check whether the sets/parts/components belonging to this compressor are supplied loose! (Refer to order confirmation)

Mount these separately delivered sets, components and/or parts, according to the instructions as supplied with this compressor (package).

1.3 PREPARATIONS FOR USE

After the Compressor (Package) has been installed (excluding final connection of drive device), the following actions should be followed in the order given:

1.3.1 Leak test of compressor and system

The compressor (package) has been pressure tested prior to leaving the factory. In case an additional leak test is required, this test is should be carried out with dry nitrogen.

Hint!

DO NOT add oil to the compressor prior to pressure testing

A system leak test should be carried out over 24 hours to ensure that the system is tightly sealed.

Record during the pressure test, the pressure, ambient temperature and outside temperature. During the initial 6 hours a pressure drop of 2% is permissable. With respect to temperature variations, no further pressure loss should be detected in the remaining 18 hours.

1.3.2 EVACUATION/DRYING THE REFRIGERATING SYSTEM

For evacuation of compressor only, refer to Section 2.5, Page 33

Procedure to evacuate and to dry a system:

i. STATUS: System is filled with nitrogen and no oil has been added (oil prevents any trapped moisture from boiling off).

ii. Verify that all valves in that part of the system to be evacuated are opened (refer also to the plant manual).

iii. Connect vacuum pump to the evacuation/purging valve(s) of the compressor (for location of these valves refer to the "Product Information" or to a connection as mentioned in the plant manual and evacuate the system to approx. 6 mBar.

iv. Break vacuum by charging dry nitrogen into the system.

v. Repeat step iii, "Connect vacuum pump ...".

vi. Wait approx. 24 hours.

vii. If pressure has increased (system still contains moisture), repeat steps iv, and vi. Otherwise, continue with the "Initial oil charge" procedure.

1.3.3 Initial oil charge

⚠ Warning!

Oil charging via the suction line of the compressor is not allowed.

Used or filtered oil should NEVER BE added to a compressor under any circumstance.

Use only new oil as selected from the Grasso oil table. (Refer Chapter 4, Page 50)

Procedure:

i. STATUS: System is dried and still evacuated.

ii. Charge the oil separator (if present) initially with oil .

iii. Close suction and discharge stop valves of compressor and oil return line of oil separator (if present).

iv. Charge the compressor crankcase with oil via the oil charge valve.

⚠ Warning!

Pre-lubrication just before the first start is obligatory.

Hint!

Filling of the afore mentioned components is also possible by means of a separate oil filling pump via the oil charge valves mounted onto the oil pump housing.

1.3.3.1 Oil quantities

Number of cylinders	Shaft seal housing incl. internal circuit of crankshaft	Oil filter	Oil pump	Crankcase (max/min)
V 300(T)	0.7	1.5	0.9	17.0 / 12.5
V 450				23.9 / 17.6
V 600(T)				34.6 / 25.5
V 700(T)				22.4 / 16.5
V 1100(T)				31.9 / 23.5
V 1400(T)				45.6/ 33.6
V 1800(T)				55.1/40.6

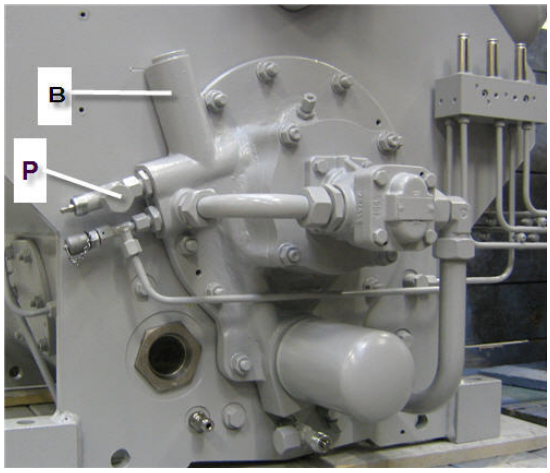

Fig.9: Pre-lubrication valve (P), Oil control pressure regulator (B)

⚠ Caution!

Pre-lubrication just before the first start is obligatory.

1.3.4 Initial refrigerant charge

Refrigerant charging should be done in accordance with the plant manual by qualified refrigeration engineers.

1.3.5 Adjustment of instruments and safety devices

1.3.5.1 CONTROL DEVICES

Hint!

Refer to separate user manuals, in case an electronic control device is installed.

1.3.5.2 PRESSURE SETTINGS

Pressure safety limit switches			
Suction pressure *1	Setting	5ºC below design evaporating temp.	
	Min.	0.3 bar(a)	
Suction and intermediate pressure	Setting	Max.= refer to Product Information (PI)	
Discharge pressure Page 24	Setting	5ºC above design condensing temp.	
	Max.	26 bar(a)	Grasso V 300(T) Grasso V 450(T) Grasso V 600(T)

1 Settings Pdischarge - Psuction must never exceed max. value as mentioned in Product Information

Pressure safety limit switches			
		24 bar(a)	Grasso V 700(T) Grasso V 1100(T) Grasso V 1400(T) Grasso V 1800(T)
Lubrication oil pressure difference	Setting	Min. =1.3 bar	

Oil pressure regulators		
Lubrication oil pressure difference *2	Setting	2.0 bar
	Min. and max. at 50 °C oil temp.	Min.=1.3 bar Max.=4.5 bar
Control oil pressure difference	Setting	8.0 bar

1.3.5.3 RE-ADJUSTMENT OF OIL PRESSURE REGULATORS

It is possible that after the compressor has been installed, the lubrication oil pressure regulator needs to be adjusted.

Location pressure regulators (control and lubricaton)

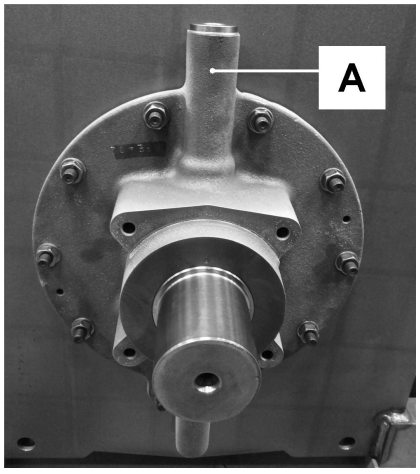

Fig.10: Oil lubrication pressure regulator (A)

2 The oil pressure regulator is adjusted at the works, but it may occur that this setting should be corrected during the initial run and also if the value <1.5 or >2.5 bar. The re-adjustment procedure is given in section “Re-adjustment of oil pressure regulator.

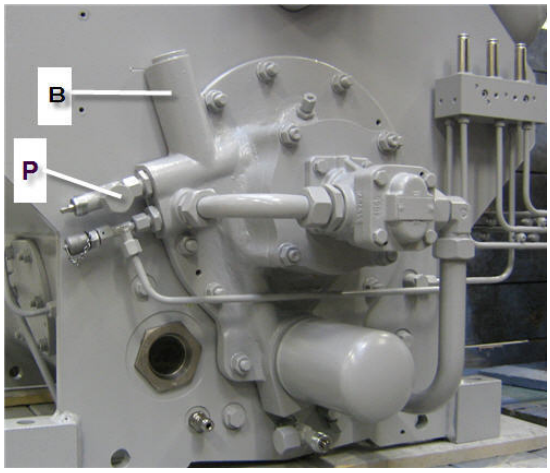

Fig.11: Oil control pressure regulator (B), Pre-lubrication valve (P)

⚠ Caution!

Oil charge valve (P) for lubrication circuit. this connection to be used for pre-lubrication of the oil circuit

Re-adjustment procedure:

i. Run the compressor for 15 minutes until the crankcase oil is at its stable operating temperature [Toil] of 50 °C and check:
   1) The lubricating oil pressure difference (A)
   2) The control oil pressure difference (B)
   After the initial run the oil pressure differences should be slightly higher.

ii. Determine the lubricating oil pressure difference (difference between the pressure gauges of the oil and suction or [dOil]).

iii. Determine the control oil pressure difference (difference between the pressure gauges of oil pump discharge [3] and suction.

iv. Remove the plug of both oil pressure regulators if the pressures need to be re-adjusted.

v. Turn the slotted pin with a screwdriver clockwise or counter clockwise for a higher or lower oil pressure respectively, until the required control & lubricating oil pressure differences have been achieved [4].

vi. Replace both plugs.

Hint!

If the valve lifting fails, check the control oil pressure regulator!

3 To be measured by means of a special control oil pressure gauge to be connected on the oil pump.

4 Re-adjusting one regulator will affect the other one, so be sure that both regulators are properly (re-)adjusted.

1.3.6 Checking direction of rotation of motor shaft

Prior to installing the intermediate coupling element or V-belts, the direction of rotation of the motor shaft must be checked. The direction of rotation can be determined from the arrow-sticker at the oil pump.

1.3.7 Installing the drive guards (if present)

Only after the compressor is ready for the initial startup! Refer to the drive guard installing procedures included in the order documentation.

1.3.8 Initial oil warm up

Prior to the initial start-up, the crankcase heater (if present) must be energised. For the min. oil temperature refer to “Product Information (PI)“.

1.3.9 Initial start-up

1.3.9.1 Limitations of part load operation and start-up

The capacity control serves to adapt the compressor capacity at any moment as closely as possible to the refrigerating capacity. In order to adjust the capacity, a number of cylinders can be put in or out of action either individually or collectively by means of solenoid valves.

⚠ Warning!

Due to start-up limitations and to limitations of part load operation it may be that not all available part load steps are allowed under certain conditions. Use of incorrect control steps can damage compressor and/or components.

For a detailed description about start-up and part load limitations refer to GEA Grasso Selection Software.

1.3.9.2 WIRING LOGIC NORMALLY OPEN UNLOADED START SOLENOID

1. If compessor is NOT running then NO-solenoid is not energised.
2. Energise the NO-solenoid 10 - 20 seconds before starting.
3. If compressor starts then NO-solenoid is energised and de-energised by means of an auxiliary time relay.
4. Ensure that the NO-solenoid valve is not de-energised until the minimum allowed compressor speed has been achieved and the specified lubrication oil pressure has been established.
5. Energise the NO-solenoid 5 seconds before stopping until the compressor is stopped completely.

1.3.9.3 Frequency controlled compressor

Hint!

In case of frequency controlled compressors, a separate instruction 00.87.041 is required. If you don’t have this instruction consult Grasso.

1.3.9.4 Pre-start check list

The following Paragraph covers only the initial start of the compressor and not the complete refrigeration plant.

Be sure that all necessary system valves are open and that the refrigeration system is ready for start up. Use the following check to guarantee that no items of importance regarding the compressor (package) have been overlooked.

i. System is charged with refrigerant.

ii. Settings of safety limit switches are adjusted properly.

iii. Direction of rotation of compressor crankshaft is correct.

iv. Check capacity control: Set the electrical capacity control to the position of the lowest part load step.

v. Oil level established in sight glass.

vi. Stop valves to the pressure gauges are open.

vii. Suction stop valve is closed (in case the evaporating temperature is much higher than the design evaporating temperature) and the discharge stop valve is open and in case of two- stage compressors that the stop valves in the intermediate circuit lines are open.

viii Stop valve in the oil return line of the oil separator (if present) is closed.
.

When all items are verified, the compressor (package) is ready for the start-up.

1.3.10 Starting and stopping procedures

Hint!

For all limitations refer to "Main setup data"-overview! The values in the main setup data tables, overrules the values as mentioned in the text.

When starting the compressor a distinction should be made between:

1.3.10.1 First start

1. Notice "Pre-start check list", also consult the plant manual and verify the following items:
   - Check the oil temperature (refer to the "Product Information").
   - Check crankcase oil level (refer to Section 2.4.1, Page 33).

2. Start the compressor and check whether the oil pressure increases.

⚠ Warning!

The time interval between stopping and starting should be at least 2 minutes and between starting and re-starting 10 minutes.

3. Slowly open suction stop valve and watch suction pressure, which may not exceed the max. value.

⚠ Warning!

Refrigerant liquid hammer, will damage the compressor; Dry gas (superheat) is always necessary!

4. In case of electrically operated capacity control:
   One or more cylinders will be energized.
5. Watch maximum allowable motor current (refer to motor type plate).
6. Watch discharge temperature and max. allowable motor current (refer to motor type plate).
7. Adjust pressure gauge stop valves, in order to avoid vibration of the pointers. (if present)
8. Open the stop valve in the oil return line from the oil separator (if present).
9. After 50 hours of operation retighten the coupling bolts or check and/or correct the tension of the V-belts and retighten the foundation bolts (with due respect to the torque settings given by the supplier of the fasteners!).

1.3.10.2 Restart

Hint!

For the time interval between stopping and starting refer to "Main setup data"-overview.

Proceed to the complete starting procedure like “First start“

1.3.10.3 Restart after a short standstill period of time (less than 1 month)

- Refer to Section 1.3.10.2, Page 29.

1.3.10.4 Restart after a long standstill period of time

After a seasonal standstill (1 till 6 months) or maintenance operations;

⚠ Warning!

After a standstill period of time more than 1 month, pre-lubrication just before starting is always obligatory. Refer Section 4.7, Page 60

- Check settings of control and safety equipment.
- Proceed to the complete starting procedure.

⚠ Warning!

Restarting compressor after a standstill period of time more than 6 months, consult your supplier. It is recommended to proceed with the initial start up procedure.

1.3.10.5 Stopping the compressor

The compressor can be stopped at any moment, however, consult the supplier if further actions are required.

2 INSPECTION AND TROUBLE SHOOTING

2.1 Periodical inspection

These inspections should be made during the normal shut-down periods as much as possible, so the compressor is always ready to operate when required. If, at that time, the number of running hours slightly differs from the scheduled period below, the inspection should nevertheless be carried out.

In this way it will not be necessary to stop the compressor at inconvenient times.

The frequency of inspections is dependent on the type of installation, operating conditions and local regulations. In the case of automatically controlled plants, the periodical inspection are particularly important. The table below sums up all the points on the compressor that have to be inspected or maintained along with inspection and maintenance frequencies.

2.2 Survey of periodical inspections

Apart from the check points in the table below, the sound produced by the compressor also provides an indication of its mechanical condition. If abnormal sounds are audible, their cause should be traced and removed immediately in order to prevent serious breakdowns.

2.2.1 Check list periodical inspection

Check list periodical inspection				
CHECK POINTS *[5]	**FREQUENCY**			**REMARKS**
	daily	**weekly**	**monthly**	
Oil level in crankcase	•			Between 25% and 75% height of the sight glass. For topping up oil, refer to Section 2.4.1, Page 33.
Colour of the oil			•	The oil should be transparently clear. A disappearing white colour points to dissolved refrigerant.
Lubricating oil pressure difference	•			
Min. control oil pressure		•		
Oil temperature max.		•		Refer to the "Product Information"
Oil leakage of shaft seal max.			•	In case of more than 1 cc/hr contact supplier.
Suction pressure		•		Check against design conditions. Refer to plant manual.
Discharge pressure		•		Refer to plant manual. For the max. allowable discharge pressure refer to the technical data of compressor.
Suction superheat Intermediate superheat		•		≥0 K (NH_3)
Discharge temperature max.		•		170 °C.
Oil temperature min.			•	During compressor standstill the lower part of the crankcase must remain warmer than the surroundings: ≥ 20 °C (NH_3)
Condition of V-belts			•	Check belts for: 1) Wear (fraying, cuts etc.) and ensure that they do not touch the groove bottom. 2) Tension. Too low a tension gives rise to excessive flapping or oscillation in operation. For correct tension consult Grasso instruction 0087516
Adjustment and operation of pressure safety switches			•	Refer also to instructions of switch manufacturer.
Capacity control (if provided)		•		
Switching frequency of the compressor		•		
Number of operating hours			•	Check the number of operating hours in view of any maintenance operations to be carried out.

2.3 STEPS FOR LONGER SHUT-DOWN PERIODS (> 6 months)

5 During the first 50 operating hours the compressor should be checked regularly for all the points mentioned above, at least twice every 24 hours and more frequently in cases where irregularities are found.

To shut down a compressor for long term periods, proceed as follows:

i. Tightly shut both the suction and discharge stop valves and the stop valve of the oil return line (if present).

ii. Disconnect the power source from the compressor drive motor and the electrical control cabinet.

iii. Place a moisture absorbing compound (eg a dessicant such as silica gel) inside the control cabinet.

iv. Place warning tags on the electric system and all closed stop valves.

Prior to starting up after a shut down, change the oil and exchange the oil filters. Determine the starting and stopping procedure from prior to start the compressor.

2.4 LUBRICATION DATA

Determine max Toil and set this value in the safety device.

Change the oil as soon as an oil analysis indicates contaminated oil.

⚠ Warning!

It is expressly pointed out that it is not permitted to mix different types of oil. If another type of oil is used, first remove all the stale oil in the filters, oil pump, crankcase, shaft seal, oil separator and oil drains of the installation.

2.4.1 Topping up oil with compressor operating

Hint!

Use Grasso's hand-operated oil pump, part. no. 18.13.121

Topping up oil is permitted during compressor operation.

Be sure that this oil is the same as in the plant (refer to Section 2.4, Page 33).

Without affecting the operation of the compressor, the oil may be topped up by means of a separate oil pump. This pump enables the oil to be forced into the crankcase via the oil charging valve, against suction pressure.

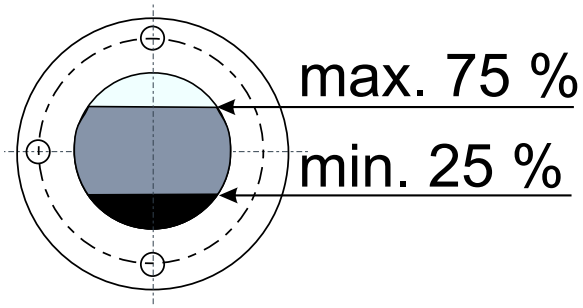

Fig.12: Oil level in compressor sight glass

2.5 EVACUATION, LEAK TESTING AND START-UP OF THE COMPRESSOR/PACKAGE

To evacuate the refrigeration system refer to Section 1.3.2, Page 22,

Always use a vacuum pump or pump-down unit to evacuate the refrigerant from the compressor.

2.5.1 EVACUATION OF REFRIGERANT BEFORE SERVICING

Procedure to evacuate the compressor:

1. Switch off main control panel
2. Remove main fuses
3. Close shut-off valves
4. Remove the refrigerant by means of a vacuum pump or pump-down unit, via the evacuation/purging valve(s) as prescribed by local safety regulations. For the location of these valves refer to the "Product Information".
5. Drain the oil from the compressor and oil separator, oil return /oil rectifier system if present.

2.5.2 LEAK-TIGHTNESS AFTER SERVICING

The necessary safety precautions should be taken before carrying out the leak-tightness test. To check leak-tightness use dry nitrogen at a positive pressure which is less than the admissible operating pressure of the low pressure stage.

2.5.3 EVACUATION AFTER SERVICING

After the pressure test has been completed, the compressor (package) must be evacuated and undergo a vacuum test. Evacuation is used to remove air and moisture from the compressor (package)

2.5.4 START-UP AFTER SERVICING

1. STATUS: Compressor (package) is dried and still evacuated.
2. Charge the oil separator, if present, with oil.

   See the appropriate Product Information for the correct quantity.
3. Charge the compressor crankcase with oil via the oil charge valve until the minimum level is seen at the sight glass at the level as indicated in IMM.

   It is mandatory to pre-lubricate the oil circuit by adding the final quantity of oil via the charge valve mounted onto the oil pump by means of a separate oil filling pump. The required oil level is indicated in the IMM.
4. Re-install all accessories such as coupling, V-belt guard etc.
5. Open the shut-off valves.
6. Check the start-stop procedure.
7. Check all safeties and controls.
8. Re-install the main fuses.
9. Start up the compressor.
10. Check running condition.

Note:

The job isn't finished until the paper work is done! Complete the service report, e.g. Grasso report 00.89.062.

2.6 DRAINING AND CHANGE OF OIL

To top up oil see Section 2.4.1, Page 33, Oil changing procedure:

i. Evacuate the compressor (refer to Section 2.5, Page 33).

ii. Drain the oil via the oil charging/drain valve. Remove the cover of one or more service openings on the compressor side.

iii. Clean the inside of the crankcase with a non-fibrous cloth (do not use cotton waste!).

iv. Replace the service cover(s) with a new seal.

v. Charge crankcase with clean oil in accordance with the procedure.

2.7 REPLACEMENT OF OIL FILTERS

General

The frequency of exchanging oil discharge filter, oil suction filter and compressor suction gas filter(s) depends on the condition of the refrigeration system. Besides the maintenance schedules, it is recommended to exchange all filters when the compressor is overhauled and also in case the refrigeration plant has been modified.

Hint!

An oil discharge oil running-in filter is factory mounted. This oil filter must be exchanged after max. 100 running hours. This oil filter cannot be cleaned.

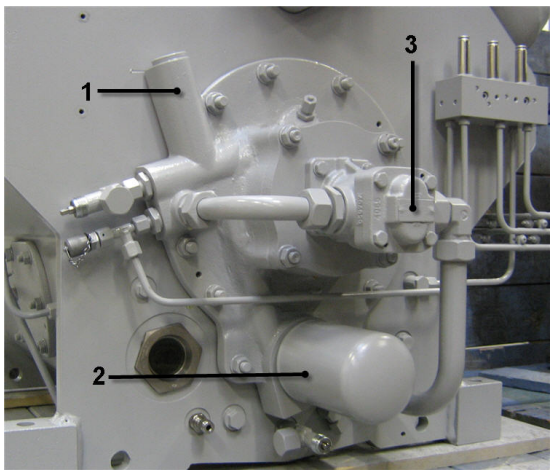

Fig.13: Oil control pressure regulator (1), oil discharge filter(2), oil pump (3)

Oil discharge filter

Hint!

Use the special tool for (dis)mounting the oil discharge filter element

Evacuate the compressor prior to exchange any filters.

2.8 DISMANTLING, INSPECTION AND RE-ASSEMBLY OF SUCTION AND DISCHARGE VALVES

Hint!

A high working temperature and rapid temperature variations shorten the life time of the valves, which, for this reason, require regular inspection.

The suction and discharge valves of a refrigeration compressor are parts that are heavily loaded both mechanically and thermally. Wear and life time of the valves strongly depend on the working conditions of the compressor. It is recommended that valve condition is regularly checked.For dismantling, inspection and re-assembly of the valves, refer to the relevant paragraph of the Compressor Service Instruction Manual.

Hint!

In order to reduce the downtime involved in the valve inspection, it is recommended to have as many complete valve assemblies in stock as there are cylinders on the compressor.These valves can be exchanged with the original valves; in this case, these original valves can be inspected and repaired or replaced if necessary later.

2.9 COMPRESSOR PURGING

Procedure to purge the compressor (after maintenance jobs):

STATUS:

Stop valves of suction, discharge and oil return line are still closed (refer to Section 2.5, Page 33) and compressor is filled with oil (refer to Section 2.6, Page 35).

i. Connect a vacuum pump to the evacuation/purging valve(s) and evacuate as prescribed by local regulations. For the location of these valves refer to the "Product Information".

ii. When evacuation is completed open the discharge stop valve.

iii. Watch suction and discharge pressure.

Hint!

If suction pressure increases quickly, the discharge valve assy is leaking.

iv. Start compressor.

v. Slowly open suction stop valve.

vi. Open the stop valve in the oil return line of the oil separator (if present).

vii. For two stage compressor only;

vii.a Two-stage system A/B: open liquid supply to interstage cooler.

vii.b Two-stage system C/D: refer to the plant manual.

viii · If a Self-Limiting Automatic Purger is not installed, purge the refrigerating system (refer to the plant manual).

2.10 TROUBLESHOOTING TABLE GRASSO RECIPROCATING COMPRESSORS

The troubleshooting table shown overleaf may be helpful to quickly trace and remedy failures that interfere with the proper operation of the compressor. It is emphatically pointed out that the cause of a failure must often be sought in the refrigeration installation itself. Therefore, it is necessary besides this table also to consult the plant manual.

Troubleshooting		
FAULT	**CAUSE**	**REMEDY**
A Discharge pressure too high	1. Discharge stop valve not fully open	Open fully
	2. Discharge pressure gauge defective	Repair or replace
	3. Non-condensables in the system	Purge with a Automatic Purger
B Discharge temperature too high	1. Discharge pressure too high	See A
	2. Too many cylinders cut out	Cut in more cylinders
	3. Suction pressure too low	See D
	4. Excessive superheat of suction gas	Eliminate excessive superheat
	5. For two-stage compressors: interstage cooling does not operate properly	Repair
	6. Room temperature too high	Ventilate engine room better
	7. Discharge valve defective	Repair or renew
	8. Pressure relief valve is leaking	Repair or renew
C Suction pressure too high	1. Capacity control does not operate	Repair
	2. Compressor capacity too small	Refer to plant design
	3. Suction pressure gauge defective	Repair or renew
	4. One or more suction valves defective	Renew suction valve rings
	5. One or more discharge valves defective	Repair or renew
	6. Pressure relief valve is leaking	Repair or renew
D Suction pressure too low	1. Suction stop valve not fully open	Open fully
	2. Suction gas strainer blocked	Renew
	3. Injection control not adjusted correctly	Re-adjust control
	4. Too little refrigerant in installation	Top-up with refrigerant
	5. Suction pressure gauge defective	Renew
E Crankcase frosted or wet *6	⚠ **Warning!** **Stop compressor and contact installation engineer**	
	1. Liquid refrigerant in crankcase due to:	
	1a. Room temperature too low	Provide for crankcase heating or, if provided, check it for proper operation
	1b. Oil return from separator contains liquid refrigerant	Consult plant manual
	1c. Installation operates too wet	Re-adjust installation and provide for superheat
	1d. Liquid separator too small	Consult plant manual
F	1. Oil pressure for valve lifting mechanism too low	See J

6 In case of R744 applications only, crankcase can be frosted or wet, during normal operating conditions.

Troubleshooting		
FAULT	**CAUSE**	**REMEDY**
All cylinders inactive while compressor is operating	2. Incorrect wiring of capacity control	Refer to the "Product Information”
G Too high oil consumption	1. Type of oil not according to oil lubrication oil table (too thin oil)	Change oil type
	2. Compressor operates unloaded too frequently	Refer to design calculations
	3. No return from oil separator *7	Check the operation of float valve in oil separator
	4. Restriction plug at the bottom of suction chamber in cylinder clogged	Clean plug
	5. Worn out oil scraper ring(s)	Replace ring(s)
	6. Loss of oil due to leakage	Repair
	7. Leaking shaft seal (max. 1 cc/hr)	Repair shaft seal Refer to Section 2.2
	8. Oil level in crankcase too high	Drain/Refill with oil
	9. Oil separator is not initially filled with oil	Refer to section “Initial oil charge”
H Too high oil pressure during normal operation at working temperature	1. Lubricating oil pressure regulator not adjusted properly or defective	Re-adjust or renew
	2. Defective oil pressure and/or suction pressure gauge (if present)	Repair or replace
J Too low lubricating oil pressure	1. Too little oil in crankcase	Top up oil
	2. Disturbed oil circuit: Oil suction and/or discharge filter is dirty	Renew the element of oil suction filter and/or oil discharge filter
	3. Lubricating oil pressure regulator not adjusted properly or defective	Re-adjust or renew
	4. Liquid refrigerant in crankcase	See E
	5. Defective oil pressure and/or suction pressure gauge (if present)	Repair or renew
	6. Worn bearings	Renew bearings
K Too low or no control oil pressure (Not or Grasso 5HP)	1. Failure of control oil pressure regulator in oil pump	Re-adjust or renew regulator
	2. A lack of oil in oil system	Add oil to the system
	3. Oil pump defect	Repair or renew oil pump

7 During the initial start-up, the oil separator (if present) consumes oil before the first oil will be returned.

3 MAINTENANCE

3.1 Spare parts manual

Hint!

A complete spare parts overview is available as a separate manual. Download the parts list manual via internet (DocNav) or consult Grasso.

3.2 Post start-up maintenance

After the compressor has run for the initial 100 operating hours:

i. Drain the oil and refill the compressor with the correct amount of fresh oil.

ii. Replace the running oil discharge filter element with the “permanent“ filter element in accordance with the filter replacement instructions.

iii. Inspect suction gas filter (refer to the Compressor Service Instruction Manual).

iv. Exchange or clean oil suction filter element.

v. Check the compressor shaft seal for leakage. If excessive (more than 1 cc/hr) replace the seal.

vi. 1) Retighten the coupling mounting bolts with the torque settings as given by the coupling manufacturer.

2) Verify and if necessary, correct the tension of the V-belts as given in the Grasso instruction 0087516.

vii. Verify and if necessary, correct the torque settings of all foundation bolts as given in Compressor Service Instruction Manual.

3.3 First maintenance

Hint!

For complete conditional service schedules and service intervals, refer to Guideline for Conditional maintenance.

After the refrigerating plant has been modified, the suction gas filter(s), the oil filters and the oil must be changed.

Maintenance	Number of operating hours	
	100 [8]	**> 100**
Renewal of oil discharge filter	X	refer to Guideline for Conditional Maintenance
Inspection of suction gas filter(s)	X	
Inspection of oil suction filter (strainer)	X	

8 Time dependent on pollution.

Maintenance	Number of operating hours	
	100 [8]	**> 100**
Oil analysis [9]	X	
Inspection leakage shaft seal	X	

3.4 SMS FACTOR

General

The following maintenance has to be distinguished:

1. Grasso Maintenance Monitor (GMM) is applied

   Maintenance A, B and C, service intervals are determined on measured values of GMM

2. GMM is not applied:

   Service intervals according to Service and Maintenance Schedules (SMS) tables in combination with operating conditions

⚠ Warning!

GMM is not used: The running hours mentioned in the SMS tables should only be used as a reference for maintenance intervals.

The number of running hours mentioned in the SMS tables have to be adjusted accordingly depending on the operating conditions of the compressor (speed, evaporating temperature, condensing temperature, refrigerant, start frequency, capacity control steps, etc.. This means that the service intervals could be significantly different.

The running hours mentioned in the tables are based on a single stage compressor running at -10°C/+35°C, NH_3 at nominal speed. In this case the SMS factor = 1, in all other cases the maintenance intervals have to be adjusted accordingly.

3.5 Legend

⚠ Warning!

These operations cover routine maintenance and are meant as a guide only. Lack of maintenance, frequency of stop/starting, extreme operating conditions etc could lead to accelerated wear.

General;

The service and maintenance schedules use the codes as explained in the table below;

8 Time dependent on pollution.
9 Consult your oil supplier.

Actions		
Legend for service and maintenance schedules (SMS)		
Item	**Code/Actions**	**Description**
1	IC	Inspection / Alternatively renewal - correcting / Testing
2	IV	Inspection Visual / Alternatively electrical testing
3	RE	Renewal
4	ME	Measure
5	CL	Clean

3.6 Description Maintenance ABC when GMM is applied

The information in this section has to be used when GMM is applied.

Hint!

This section is only valid in case the Grasso Maintenance Monitor (GMM) is applied.

General

The following maintenance has to be distinguished;

1. Small maintenance, Maintenance A, Yearly inspection
2. Medium maintenance, Maintenance B
3. Large maintenance, Maintenance C

Description maintenance A;

1. Replace/clean oil discharge filter, clean oil suction filter
2. Visual inspection of cylinders and crankcase
3. Visual inspection of cylinder no. 1
4. Check compressor running conditions
5. Check/test safety equipment

Description maintenance B;

1. Maintenance A +
2. Replace suction and discharge valve rings and springs (“top end“ overhaul)
3. Inspection of pistons and cylinder liners

Description maintenance C;

1. Maintenance B +
2. Major inspection/overhaul;

   Depending on requirements and expectations, required actions have to be taken. (complete disassembly, replacement of bearings, inspection/ replacement of all main components like crankshaft, cylinder liners, pistons, ...)

3.6.1 Compressor

General remarks about check list;

1. Check list for compressor only; all other components have to be maintained according to their specific manuals (IMM and SIM).
2. All items of the list below marked “check“, have to be checked visually and checked for proper working.
3. Some components have to be measured.

   For measuring details refer to SIM.
4. Measuring means also that visual inspection is required.
5. Visual inspections:

   The visual inspections during maintenance are of importance; measurements should be carried out at the moment that visually abnormalities are detected. The result of the inspection determines whether one or more parts have to be replaced. For more detailed information refer (SIM) and Installation and Maintenance Manual (IMM).
6. Oil and oil return systems:

   The quality of the oil effects the oil consumption and the life time of the moving parts. For oil return systems or systems in which soluble oil is being used, we advise to check (or have checked) the quality of the oil every 5000 hours and - if necessary - to renew the oil and/or filters. If there is no oil analysis available, we advise to renew the oil. By regularly carrying out oil analyses and registering them in a log, aberrations will be noticed in an early stage, which may prevent or reduce resultant damage(s).

   Note 1:

   When renewing the oil, in the crankcase the oil in the oil separator and the oil return or oil rectifier system (if fitted) has to be renewed.

   Note 2:

   Pre-lubricate the compressor before re-starting. Used or filtered oil should NEVER be added to a compressor under any circumstance. Use only new oil as selected from the Grasso oil table. Oil charging via the suction line of the compressor is not allowed.

Grasso Maintenance Monitor (GMM) is applied				
Maintenance compressor			**Description**	
A	**B**	**C**		
Check	Check	Check	Capacity control	Solenoid valve and coils
	Check	Replace		Seals of cap control piston / lifting mechanism
Check	Check	Check	Compressor housing	Oil return orifice (LP and) HP
Check	Check	Check	Crankcase heater	
		Measure	Crankshaft	Main (and intermediate) bearings, running surface
Visual inspection			Connecting rod	Cylinder located nearest to the shaft-end of the compressor:

Grasso Maintenance Monitor (GMM) is applied				
Maintenance compressor			**Description**	
A	**B**	**C**		
	Visual inspection	Measure		Big and small end bearing, running surface
Clean	Clean	Clean	Compressor housing	Inside and outside
Visual inspection	Measure		Cylinder liners	Cylinder located nearest to the shaft-end of the compressor
		Measure		All cylinder liners
Check	Check	Check	Drive	Coupling alignment
Check	Check	Check	Interstage cooler	Inspections and injection valves
Clean	Clean	Clean	Filters	Oil suction filter
Replace.	Replace	Replace		Oil discharge filter
Check	Clean	Clean		Suction gas
Check	Check	Check	Oil	Oil analysis recommended
If hygroscopic oil is applied: Replace	Replace	Replace		Oil refreshment compresssor, oil separator and oil system
	Visual inspection	Visual inspection		Oil pump element, oil control and lubrication pressure regulator
Check	Check	Check		Lubrication and control system
Check	Clean	Clean		Oil separator, test oil return system
Clean	Clean	Clean		Oil cooler fan / heat exchanger
	Visual inspection	Replace	Piston	Rings
	Visual inspection	Measure		Gudgeon pin
	Visual inspection + TEST	Visual inspection + TEST	Relief valve(s)	
Check	Check	Check	Shaft seal	Oil & Refrigerant leak range
Visual inspection			Compressor valves	Cylinder located nearest to the shaft-end of the compressor: Suction and discharge valves, springs, damper rings
Check	Replace	Replace		Suction and discharge compressor valves
		Check	Thrust bearing	Running surface

3.6.2 Package components

Checklist package components	
	Description/checkpoint
1	Drive guard
2	V-belts and alignment
3	Coupling alignment
4	Oil level float switch on compressor and oil separator

Checklist package components	
	Description/checkpoint
5	Pressure safety switches
6	Pressure gauges
7	Thermostats and thermometers
8	Electrical control system
9	Oil return protection and oil return system
10	Electric motor and thermistors (Consult motor manufacturer)
11	Base frame, vibration dampers and bolts
12	Piping
13	Interstage cooler, interstage injection
15	Oil cooler (oil side and air side) and fan
16	Thermo-Master

3.7 Grasso V 300 .. 1800 (T), WITHOUT GMM

The schedule below has to be used when GMM is not applied.

Hint!

In case Grasso Maintenance Monitor (GMM) is applied, the maintenance intervals will be based on actual measured values. If GMM is applied, refer to Section 3.6, Page 42

Service and maintenance schedules Grasso V 300 .. 1800 (T), excl. GMM										
Item	Description	Actions								Checkpoint
		Running hours * 1000[10]								
		0.1	Yearly	3	6	-		-	-	
				9	-	12		-	-	
				15	-			18	-	
				21	-	-	24	-	-	
				27	30	-		-	-	
				33	-	-		-	36	
1	Oil	CL	RE	CL	RE	RE	RE	RE	RE	Oil suction filter
2		RE[11]	RE	RE	RE	RE	RE	RE	RE	Oil discharge filter
3		-	ME	ME	ME	ME	ME	ME	ME	Oil analysis
4		RE	RE	-	RE	RE	RE	RE	RE	Oil refreshment (If hygroscopical oil is used replace this always after each opening of compressor or installation)
5	Oil pump	-	IC/CL	-	IC/CL	IC/CL	IC/CL	IC/CL	IC/CL	Housing and element
6		-	IC/CL	-	IC/CL	IC/CL	IC/CL	IC/CL	IC/CL	Control and lubrication oil pressure regulator
7a	Crankshaft	-	-	-	-	-	-	IC/ME	IC/ME	Main and intermediate bearing bushes

10 Check after every maintenance job the settings and working of all safety devices, regulators and the running conditions according to the Service Instruction Manual (SIM)

11 A running-in oil discharge filter is factory mounted. This running-in filter has to be replaced after max. 100 running hours by a permanent filter. One permanent filter is supplied together with the compressor.

Service and maintenance schedules Grasso V 300 .. 1800 (T), excl. GMM										
Item	**Description**	**Actions**								**Checkpoint**
		Running hours * 1000[10]								
		0.1	**Yearly**	**3**	**6**	**-**		**-**	**-**	
				9	**-**	**12**		**-**	**-**	
				15	**-**			**18**	**-**	
				21	**-**	**-**	**24**	**-**	**-**	
				27	**30**	**-**		**-**	**-**	
				33	**-**	**-**		**-**	**36**	
7b		-	-	-	-	-	-	IC/ME	IC/ME	Running surfaces main and intermediate bearings crankshaft
8		-	IC/ME	-	IC/ME	IC/ME	IC/ME	IC/ME	IC/ME	Running surfaces con. rods
9	Shaft seal	-	IC	IC	IC	IC	IC	IC	IC	Oil/refrigerant leakage
10	Conrod	-	IC/ME	-	IC/ME	IC/ME	IC/ME	IC/ME	IC/ME	Big and small end bearings
11	Pistons	-	IC	-	IC	IC	IC	IC	IC	Piston
12		-	IC	-	IC	IC	IC	IC	IC	Piston rings
13		-	IC/ME	-	IC/ME	IC/ME	IC/ME	IC/ME	IC/ME	Gudgeon pin
14	Thrust bearing	-	IV/ME	-	IV/ME	IV/ME	IV/ME	IV/ME	IV/ME	Running surfaces/Axial play
15	Capacity control	IC/IV	IC/IV	IC/IV	IC/IV	IC/IV	IC/IV	IC/IV	IC/IV	Solenoid valves and coils
16		-	RE	-	RE	IV	IV	RE	RE	Seals of cap. control piston
17		-	IC	-	IC	IC	IC	IC	IC	Cap. Control mechanism
18	Compressor housing	IC/IV	IC/IV	IC/IV	IC/IV	IC/IV	IC/IV	IC/IV	IC/IV	Crankcase heater
19		CL	CL	-	CL	CL	CL	CL	CL	Crankcase
20		-	-	-	-	IC	IC	IC	IC	Non return valves LP/ Restrictions HP
21		-	IV	-	IV	IV	IV	IV	IV	Relief valves

10 Check after every maintenance job the settings and working of all safety devices, regulators and the running conditions according to the Service Instruction Manual (SIM)

Service and maintenance schedules Grasso V 300 .. 1800 (T), excl. GMM										
Item	**Description**	**Actions**								**Checkpoint**
		Running hours * 1000[10]								
		0.1	**Yearly**	**3**	**6**	**-**		**-**	**-**	
				9	**-**	**12**		**-**	**-**	
				15	**-**			**18**	**-**	
				21	**-**	**-**	**24**	**-**	**-**	
				27	**30**	**-**		**-**	**-**	
				33	**-**	**-**		**-**	**36**	
22		RE[12]	IC/CL	IC/CL	IC/CL	IC/CL	IC/CL	IC/CL	IC/CL	Suction gas filter
23	Discharge valves	-	IC	-	IC	RE	RE	IC	RE	Valves, springs and damper rings
24		-	IC/CL	-	IC/CL	IC/CL	IC/CL	IC/CL	IC/CL	Stroke limitor/ Discharge valve seat
25	Suction valves	-	IC	-	IC	RE	RE	IC	RE	Valves, springs and damper rings
26	Cylinder liners	-	IV	-	IV	IV	IV	IV	IV	Cap. Control lifting mechanism
27		-	IV/ME	-	IV/ME	IV/ME	IV/ME	IV/ME	IV/ME	Dimension and running profile
28	Drive	IC	IC	IC	IC	IC	IC	IC	IC	Alignment
29		IC	IC	IC	IC	IC	IC	IC	IC	V-belts
30	Electric motor	Refer to specifications of motor manufacturer								
31	Optionals	IC	IC	IC	IC	IC	IC	CL/IC	CL/IC	Oil level switch
32		IC	IC	IC	IC	IC	IC	IC	IC	Safety switches
33		IC	IC	IC	IC	IC	IC	IC	IC	Gauges
34		IC	IC	IC	IC	IC	IC	IC	IC	Thermostats
35		IC	IC	IC	IC	IC	IC	IC	IC	Thermometers
36		IC	IC	IC	IC	IC	IC	IC	IC	Electrical control system
37		IC	IC	IC	IC	IC	IC	CL/IC	CL/IC	Valve oil return protection
38		IV	IV	IV	IV	IV	IV	IV	IV	Thermistors
39		IC	IC	IC	IC	IC	IC	IC	IC	Vibration dampers and bolts

10 Check after every maintenance job the settings and working of all safety devices, regulators and the running conditions according to the Service Instruction Manual (SIM)

Service and maintenance schedules Grasso V 300 .. 1800 (T), excl. GMM										
Item	Description	Actions								Checkpoint
		Running hours * 1000[10]								
		0.1	Yearly	3	6	-		-	-	
				9	-	12		-	-	
				15	-			18	-	
				21	-	-	24	-	-	
				27	30	-		-	-	
				33	-	-		-	36	
40		IC/ME	IC/ME	IC/ME	IC/ME	IC/ME	IC/ME	IC/ME	IC/ME	Intermediate cooler and injection valve
41		CL	CL	-	CL	CL	CL	CL	CL	Oil separator refreshing oil and cleaning/testing of float valve
42		-	IC	IC	IC	IC	RE	IC	IC	Heavy duty thrust bearing
43		CL	CL	CL	CL	CL	CL	CL	CL	Oil cooler, air side
44		RE	RE	-	RE	RE	RE	RE	RE	Oil cooler, oil side, refrigeration oil
45		Refer to specifications of motor manufacturer								Oil cooler, electic motor (fan)
46		ME	ME/CL	ME/CL	ME/CL	ME/CL	ME/CL	ME/CL	ME/CL	Cylinder head water cooling system

10 Check after every maintenance job the settings and working of all safety devices, regulators and the running conditions according to the Service Instruction Manual (SIM)

12 A running-in suction gas filter is factory mounted. This running-in filter has to be replaced after max. 100 running hours by a permanent filter. One permanent filter is supplied together with the compressor

4 APPENDIX; Product Information (PI)

4.1 GRASSO MAINTENANCE MONITOR

Hint!

In case the GSC-TP is included, the GMM hardware is not required, since the GSC-TP includes the GMM software.

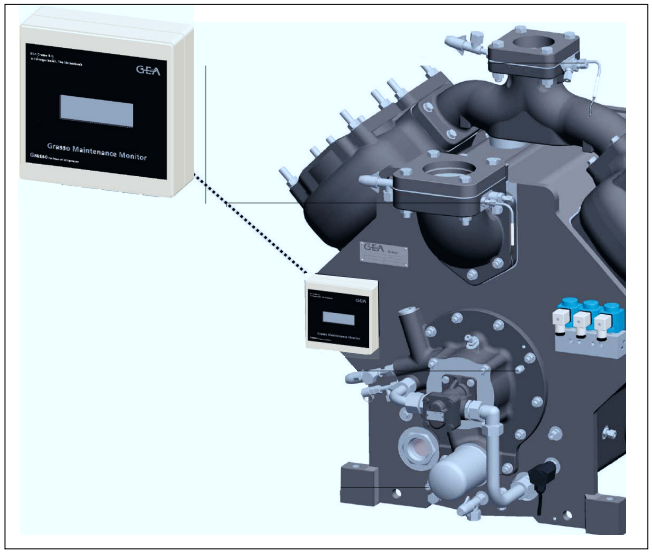

Fig.14: Grasso Maintenance Monitor

GMM connections	
1	Ethernet
2	Power input (10 .. 30 VDC)
3	Compressor speed sensor
4	Discharge temperature sensor
5	Oil temperature sensor

The Grasso micro processor controlled maintenance monitor is a unique standalone device for flexible maintenance. This equipment strongly recommended to fit on V series compressors to be able to tune the maintenance to the actual running conditions. In other words: “On time maintenance”

This results in (nearly) all cases in longer service intervals and significantly less maintenance costs. For industrial refrigeration compressors this is a unique development. To maintain the highest level of reliability, even with extended service intervals, this series is fitted with the best possible components available.

This standalone device works independent from compressor controls like the Grasso GSC OP/TP and must be seen as an addition on the normal compressor control. In separate documents the complete maintenance philosophy and how to handle is explained in detail.

Besides this practical instrument Grasso is able to make, in advance, an analyses based on a theoretical profile of the compressor and the running conditions. In this way an indication of the running costs (Total Costs of Ownership, TCO) can be produced.

4.2 GENERAL LIMITS OF OPERATION GRASSO V

When operating the compressor, none of the limits of operation as stated in the table below must be exceeded. *13

The diagrams overleaf represent the overall fields of application in which the individual operation limits are taken into account.

General limits and fields of operation				
REFRIGERANT				**NH_3**
Compressor speed	n	Grasso V 300(T) .. 600(T)	min.	500 min^{-1} for direct drive 600 min^{-1} for V-belt drive
		Grasso V 700(T) .. 1800(T)		500 min^{-1} for direct drive 700 min^{-1} for V-belt drive
		Grasso V 300(T) .. 600(T)	max.	1500 min^{-1}
		Grasso V 700(T) .. 1800(T)		1200 min^{-1}
Suction pressure = evaporating pressure =crankcase pressure	p_o/t_o	Grasso V	min.	0.3 bar(a) -55 °C
		Grasso V 300(T) .. 600(T)	max.	8.5 bar(a) 19 °C
		Grasso V 700(T) .. 1800(T)		7.0 bar(a) 13 °C
Suction superheat	delta-t	Grasso V	min.	>0 °C
Superheat LP suction		Grasso VT		
Actual suction temperature	t_a	Grasso V(T)	min.	-50 °C
Discharge pressure = condensing pressure tc = saturated condensing temperature *14 * 15	P_s *16/ t_c	Grasso V 300(T) .. 600(T)	max.	26.0 bar(a) 60 °C
Discharge pressure = condensing pressure *17 *18		Grasso V 700(T) .. 1800(T)		24.0 bar(a) 56 °C

13 In practice, it is not so much the individual operation limits as combinations of them that are decisive for the conditions under which a compressor may operate. To check the various possibilities in this respect, use should be made of the "fields of application").

14 This pressure is also the maximum allowable pre-set value of the HP safety switch.

15 CAUTION!: When adjusting the HP and/or LP safety switch, care should be taken that the pressure difference $\Delta p=(p_C-p_o)$ never exceeds 26.0 bar(g).

16 “Ps“ is mentioned on type plate of the compressor

17 This pressure is also the maximum allowable pre-set value of the HP safety switch.

18 CAUTION!: When adjusting the HP and/or LP safety switch, care should be taken that the pressure difference $\Delta p=(p_C-p_o)$ never exceeds 19.0 bar (g).

General limits and fields of operation				
REFRIGERANT				**NH_3**
Design pressure	PS_s *19	Grasso V(T)	-	26.5 bar(a) This pressure deviates from the so called max. discharge pressure=condensing pressure (allowed during operation) as stated in the table.
Discharge temperature	t_e	Grasso V	max.	+170 °C This is the actual discharge temperature, measured directly in the gas flow just before the discharge connection. The given value also applies to the LP stage of two-stage compressors.
Discharge temperature LP		Grasso VT		
Pressure ratio per stage (p_c/p_o or p_c/p_m or p_m/p_o) Pressure ratio limits are not absolute but arbitrary values based on practical considerations	j	-	min.	1.5
			max.	10
Pressure difference	delta-p	Grasso V 300(T) .. 600(T)	max.	(p_c - p_o) <= 25.5 bar
				The standard built-in overflow safety valve(s) (p_c - $p_{ambient}$) <= 25.5 bar
		Grasso V 700(T) .. 1800(T)	max.	(p_c - p_o) <= 19.0 bar
				The standard built-in overflow safety valve(s) (p_c - $p_{ambient}$) <= 25.5 bar
Oil temperature in crankcase	t_{oil}	°C	min.	>10°C and > $T_{saturated\ crankcase\ pressure\ at\ stand\ still}$ + 15 K Indicated minimum value is the lowest oil temperature at which the compressor is allowed to be started.
			max.	< 70 °C, depending on type of oil The maximum oil temperature depends on the operating conditions of the compressor and the oil type used. A minimum actual oil viscosity of 10 cSt in the bearings is always required.

4.3 STARTING UP OF TWO-STAGE COMPRESSORS

Procedure for starting from compressor standstill

In the case of two-stage compressors it is very important that immediately after the period of automatic fully unloaded start (ensured by the corresponding three-way solenoid valve in the control pressure supply line from the oil pump; only one or more H.P. cylinders become operative, viz. only those cylinders of which the suction valve lifting mechanism is directly and permanently connected to the

19 “PSs“ is mentioned on type plate of the compressor (Possibly "Pd" is mentioned for compressors delivered before 1-Mar-2013)

control pressure supply of the oil pump via the starting solenoid valve mentioned. This means that during starting none of the three-way solenoid valves for the capacity control are allowed to be energized.

Procedure to move on to two-stage operation and to increase capacity.

Once properly started, as indicated in the previous paragraph, the compressor has to be switched over to two-stage operation with minimum capacity, followed, if and when required, by gradual stepping up to maximum capacity.

The procedure thereby to be applied depends on the installation operating conditions during starting which give rise to two distinct possibilities, viz.:

1. *The compressor is started at low evaporating temperatures,* this being approx. the (design) value during normal (full-load) operation.

   This situation occurs after the compressor has been stopped for a certain period of time because of low capacity requirements of the installation. Under these circumstances it is permitted to switch over to the two-stage part-load step of minimum capacity immediately after proper starting with H.P. cylinders in operation.

   In the case of NH_3, this is even a necessity, for otherwise the compressor would be running in single-stage under two-stage conditions, resulting in too high a discharge temperature.

2. *The compressor is started at a relatively high evaporating temperature,* that is to say much higher than under design conditions and in any case not suitable for two-stage operation.

   Such a situation may occur after a prolonged period of compressor standstill or when the compressor operates on a batch type freezing tunnel, just loaded with warm products. Under these circumstances it is not permitted to switch over to two-stage operation with minimum capacity until the H.P. cylinders already in operation have lowered (in single-stage) the evaporating temperature so that the corresponding working point at the condensing temperature t_c, lies inside the field of application of the two-stage minimum part-load step concerned. Only then, after this step has been energized, the saturation intermediate temperature t_m will be below its maximum value. Consequently, the maximum value of t_o at which it is allowed to switch over to two-stage operation, is determined by the intersection of the near-vertical line which represents the right hand limitation of the relevant field of application and the horizontal line which represents the condensing temperature t_c.

   Likewise, during further stepping up to maximum capacity, the evaporating temperature has to be pulled down by each intermediate part-load step so far that the corresponding working point at given condensing temperature lies each time just inside the field of application of the next part-load step of higher capacity, before that step is energized.

Fast pull-down part-load control steps

When using the standard capacity control steps of the two-stage compressor types, the pull-down procedure to achieve full-load operation at design conditions, as described in the previous paragraph, is rather often very time consuming. This is due to the fact that all compressor types are always started

with only one HP cylinder in operation and that the minimum LP/HP swept volume ratio for any part-load step is ϕ = 2.

Therefore, for all Grasso two-stage types a fast pull- down electric capacity control system has been developed, which allows the compressors to be started with two or more HP cylinders in operation and which includes one or more part-load steps with volume ratio ϕ = 1.

4.4 DIAGRAMS SINGLE STAGE AND BOOSTER

Solenoid valve/cylinder numbering for electric capacity control					
Compressor type	**Solenoid**				
	UNL NO	**No. 1 NC**	**No. 2 NC**	**No. 3 NC**	**No. 4 NC**
	Cylinder number / solenoid valves				
300 & 700	1	2	3	4	-
450 & 1100	(3+4)	2	(5+6)	1	-
600 & 1400	(5+6)	7	8	(2+4)	(1+3)
1800 **Before Sept. 2014**	(7+8)	5	6	(9+10)	(1+2+3+4)
1800 **From Sept. 2014**	(5+7+8)	(9+10)	(1+2)	(3+4)	6

Capacity control steps			
Compressor type	**Capacity %**[20]	**Cylinders**	**Solenoids**
V 300 & V 700	25	1	-
	50	1 + 2	1
	75	1 + 2 + 3	1 + 2
	100	1 + 2 + 3 + 4	1 + 2 + 3
V 450 & V 1100	33	(3+4)	-
	50	(3+4) + 2	1
	67	(3+4) + (5+6)	2
	83	(3+4) + (5+6) + 1	2 + 3
	100	(3+4) +2 + (5+6) + 1	1 + 2 + 3
V 600 & V 1400	25	(5+6)	-
	37	(5+6) + 8	2
	50	(5+6) + 8 + 7	1 + 2
	62	(5+6) + 8 + (1+3)	2 + 4
	75	(5+6) + (2+4) + (1+3)	3 + 4

20 Refer to the swept volume expressed as a percentage of the full-load swept volume

Capacity control steps			
Compressor type	**Capacity %**[20]	**Cylinders**	**Solenoids**
	87	(5+6) + 7 + (2+4) + (1+3)	1 + 3 + 4
	100	(5+6) + 7 + 8 + (2+4) + (1+3)	1 + 2 + 3 + 4
V 1800 **Before Sept. 2014**	20	(7+8)	-
	30	(7+8) + 5	1
	40	(7+8) + 5 + 6	1 + 2
	50	(7+8) + 6 + (9+10)	2 + 3
	60	(7+8) + 5 + 6 + (9+10)	1 + 2 + 3
	70	(7+8) + 5 + (1+2+3+4)	1 +4
	80	(7+8) + 5 + 6 + (1+2+3+4)	1 + 2 + 4
	90	(7+8) + 6 + (9+10) + (1+2+3+4)	**2 + 3 + 4**
	100	(7+8) + 5 + 6 + (9+10) + (1+2+3+4)	1 + 2 + 3 + 4
V 1800 **From Sept. 2014**	30	(5+7+8)	-
	40	(5+7+8) + 6	4
	50	(5+7+8) + (9+10)	1
	60	(5+7+8) + (9+10) + 6	1 + 4
	70	(5+7+8) +(9+10) + (1+2)	1 + 2
	80	(5+7+8) + 6 + (3+4) + (1+2)	2 + 3 + 4
	90	(5+7+8) + (3+4) + (9+10) + (1+2)	1 + 2 + 3
	100	(5+7+8) + (3+4) + (9+10) + (1+2) + 6	1 + 2 + 3 + 4

4.5 DIAGRAMS TWO STAGE

Solenoid valve/cylinder numbering for electric capacity control					
Compressor type	**Solenoid**				
	UNL NO [21]	**No. 1 NC**	**No. 2 NC**	**No. 3 NC**	**No. 4 NC**
	Cylinder number [22] **/ solenoid valves**				
300T & 700T	[4_{hp}]	1	2	3	-
450T & 1100T	[4_{hp}]	1	2, 3	5, [6_{hp}]	-

20 Refer to the swept volume expressed as a percentage of the full-load swept volume
21 UNL, Unloaded start
22 Numbers between brackets [] are HP cylinders

Solenoid valve/cylinder numbering for electric capacity control					
Compressor type	**Solenoid**				
	UNL NO [21]	**No. 1 NC**	**No. 2 NC**	**No. 3 NC**	**No. 4 NC**
	Cylinder number [22] **/ solenoid valves**				
600T & 1400T	[6_{hp}]	1, 2	3	4, [8_{hp}]	5, 7
1800T	[6_{hp}]	1, 2	7, [8_{hp}], 9	5	3, 4, [10_{hp}]

Capacity control steps					
Compressor type	**Capacity %**[23]	**Cylinders**	**Solenoids**	**Qty HP / Qty LP cylinders** [24]	**Remark** [25]**)**
300T & 700T	0	[4]	-	0.0	Starting only/ Fast pull down
	33	1 + [4]	1	1.0	Starting only/Fast pull down
	67	1 + 2 + [4]	1 + 2	2.0	-
	100	1 + 2 + 3 + [4]	1 + 2 + 3	3.0	-
450T & 1100T	0	[4]	-	0.0	Starting only/Fast pull down
	25	1 + [4]	1	1.0	Starting only/Fast pull down
	50	(2 + 3) + [4]	2	2.0	-
	50	1 + [4] +(5 + [6])	1 + 3	1.0	Starting only/Fast pull down
	75	1 + (2 + 3) + [4]	1 + 2	3.0	-
	75	(2 + 3)+ [4] + (5 + [6])	2 + 3	1.5	Starting only/Fast pull down
	100	1+ 2 + 3 + [4] + (5 + [6])	1 + 2 + 3	2.0	-
600T & 1400T	0	[6]	-	0.0	Starting only/Fast pull down
	33	(1 + 2) + [6]	1	2.0	-
	33	3 + [6] + (4 + [8])	2 + 3	1.0	Starting only/Fast pull down
	50	(1 + 2) + 3 + [6]	1 + 2	3.0	-
	50	(1 + 2) + [6] + (4 + [8])	1 + 3	1.5	Starting only/Fast pull down
	67	(1 + 2) + [6] + (4 + [8])	1 + 2 + 3	2.0	-

21 UNL, Unloaded start
22 Numbers between brackets [] are HP cylinders
23 Refer to the swept volume expressed as a percentage of the full-load swept volume of the LP cylinders
24 Each phi has its own field of application! Refer Page 56
25 For starting up procedure, refer Section 4.3, Page 52

Capacity control steps					
Compressor type	**Capacity %**[23]	**Cylinders**	**Solenoids**	**Qty HP / Qty LP cylinders** [24]	**Remark** [25]**)**
	83	(1 + 2) + (5 + 7) + [6] + (4 + [8])	1 + 3 + 4	2.5	-
	100	(1 + 2) +3 + (5 + 7) + [6] + (4 + [8])	1 + 2 + 3 + 4	3.0	-
1800T	0	[6]	-	0.0	Starting only/Fast pull down
	29	(1 + 2) + [6]	1	2.0	-
	29	(3 + 4 + [10]) + [6]	4	1.0	Starting only/Fast pull down
	43	(1 + 2) + 5 + [6]	1 + 3	3.0	-
	43	(3 + 4 + [10]) + 5 + [6]	3 + 4	1.5	Starting only/Fast pull down
	57	(1 + 2) + [6] + (7 + [8] + 9)	1 + 2	2.0	-
	71	1 + 2 + 5 + [6] + (7 + [8] + 9)	1 + 2 + 3	2.5	-
	86	(1 + 2) + (3 + 4 + [10]) + (7 + [8] + 9) + [6]	1 + 2 + 4	2.0	-
	100	(1 + 2) + (3 + 4 + [10]) + +5 + [6] + (7 + [8] + 9)	1 + 2 + 3 + 4	2.3	-

23 Refer to the swept volume expressed as a percentage of the full-load swept volume of the LP cylinders
24 Each phi has its own field of application! Refer Page 56
25 For starting up procedure, refer Section 4.3, Page 52

4.6 LUBRICATING OILS (choice and recommendations)

⚠ Caution!

In case a Grasso compressor is used inside a GEA Grasso produced chiller, the applicable oils could be limited compared with the oils mentioned in this chapter for use with NH_3 as refrigerant. The oils to be used will then be specified in the Chiller Product information.

⚠ Warning!

The choice of oil for a refrigeration compressor should be made by taking into account the entire refrigeration system design and operation as well as the operating conditions of the compressor.

For lubrication of refrigeration compressors, several brands and types of specially developed lubricating oils are on the market. The choice of oil depends not only on its good lubrication properties (viscosity) and chemical stability at the operating conditions of the compressor, but also on the operating conditions of the refrigerating plant (solidifying and floc point, solubility).

Grasso has tested and approved for use in its reciprocating-compressors the brands and types of oil as listed tables below.

The choice of the lubricating oil depends on type of refrigerant and the operating conditions of the compressor.

The oil viscosity should always be more than 10 cSt. Assumed is that the oil temperature at the bearing surfaces = 15 K above crankcase oil temperature.

A higher ISO-VG number should be chosen when refrigerant solubility in crankcase is expected.

Remarks

1. Using ISO VG100 oils to increase viscosity at high expected cranckcase-temperatures makes no sense as the friction-heat will increase that much, that the oil-temperature limit related to the minimum viscosity of 10 cSt will also be exceeded. Only in case of expected high refrigerant-concentrations in the cranckcase this viscosity-gradeoil is an alternative!
2. Using ISO VG46 oils to meet low pour point requirements is only acceptable if coupled to a high viscosity-index of at least 100, otherwise the working limits are so limited (again concerning the minimum required oil-viscosity of 10 cSt) that it can be used in medium evaporation-pressures, making no sense to use them al a low pourpoint alternative!

Hint!

Some of the oil types listed in the tables may be marketed under other names and/or designations; these oils can also be used, provided their identity can be proved beyond any doubt. Application of other/ alternavive oils is not permitted without the written consent of Grasso.

4.6.1 STRONGLY RECOMMENDED OIL TYPES

Strongly recommended oil types for Grasso reciprocating compressors			
Refrigerant used	**Brand**	**Type designation**	**Food Grade**
NH_3	GEA	PR-OLEO C-MH68A	H2
		PR-OLEO C-MH68A-FG	H1
	CPI	CP-1009-68	H2
	PETRO CANADA	Reflo 68A	H2 H2
		Reflo XL	H2
	Klüber	Summit RHT-68	H2
	TEXACO	Capella Premium 68	-
	SHELL	Clavus S-68	-
		Refrigeration Oil S2 FR-A 68	-

4.6.2 ACCEPTED NH_3 OIL TYPES

Accepted NH_3 oil types for Grasso reciprocating compressors			
Brand	**Type designation**	**ISO VG number** *[26]	**Food Grade**
AVIA	FC 46 FC 68	44 65	- -
BP	Energol LPT-F 46 Energol LPT 68	54 68	- -
CASTROL	Icematic 299	56	-
CPI	CP-1009-68	69	H2
EXXON MOBIL	Zerice S46 Zerice S68 Arctic 300	48 68 68	- - -
FUCHS	Reniso KS 46 Reniso KC 68	47 68	- -
KROON OIL	Carsinus FC 46/68	46	-
PETRO CANADA	Reflo 68A Reflo XL	58	H2 H2
GEA	PR-OLEO C-MH68A PR-OLEO C-MH68A-FG	68 68	H2 H1
Klüber	Summit RHT-68	68	H2
Kuwait Petroleum	Q8 Stravinsky C	55	-
SHELL	Refrigeration Oil S2 FR-A	68	-
SUN-OIL	Suniso 3.5 GS Suniso 4 GS Suniso 5 G Suniso 4 SA	43 55 94 57	- - - -
TEXACO	Capella WF 68 Capella Premium 68	65 67	H2 -
TOTAL	Luneria FR 68	68	-

26 Viscosity grade number designation according to ISO Standard 3448.

4.7 Pre-lubrication oil system

Why pre-lubrication?

Pre-lubrication is necessary in situations listed below, in order to provide sufficient lubricating oil at locations where this is most needed (oil pump, bearings, pistons en piston rings) to ensure that any risk on 'dry running' is minimized or even better eliminated. Dry-running of oil pump bearings pistons and piston rings will initiate and after initiation worsen the wear of the parts mentioned and eventually even damage the crank shaft and cylinder liners or even more parts.

When pre-lubrication?

1. Before initial start-up
2. Before start-up after overhauling compressor
3. Before start-up after renewal of oil
4. Before start-up after standstill period of more than 1 month

Pre-lubrication procedure

Location pre-lubrication valve, refer Figure 15, Page 60/ Figure 16, Page 61

1. Top up crankcase to the minimum required oil level
2. Connect oil filling pump to stop valve and top up oil to 50-75% level (Hand operated oil filling pump can be supplied by Grasso)

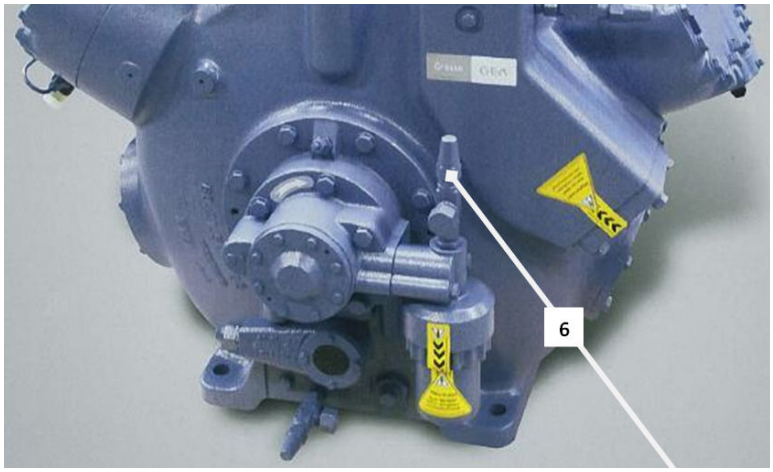

Fig.15: Grasso 5HP

6	Pre-lubrication valve

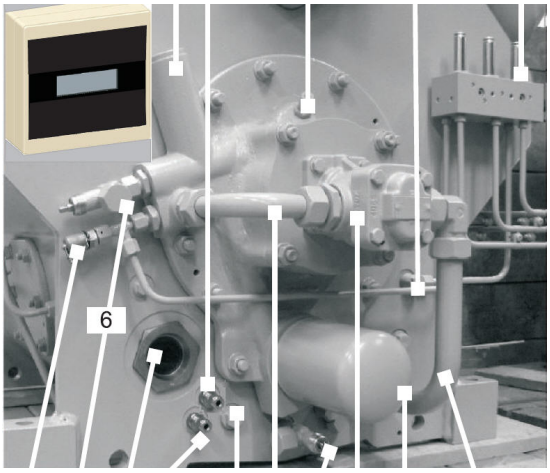

Fig.16: Grasso V

6	Pre-lubrication valve

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GEA Refrigeration

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