Screw Compressor Packages
Grasso SP2

Operating Manual (Translation of the original text)
P_271511_4
COPYRIGHT

All Rights reserved.
No part of this documentation may be copied or published by means of printing, photocopying, microfilm or otherwise without prior written consent of

- GEA Refrigeration Germany GmbH

herein after referred to as the manufacturer. This restriction also applies to the drawings and diagrams contained in the documentation.

LEGAL NOTICE

This documentation has been written in all conscience. However, the manufacturer cannot be held responsible, neither for any errors occurring in this documentation nor for their consequences.
SYMBOLS USED IN THIS MANUAL

Danger!
Stands for an immediate danger which leads to heavy physical injuries or to the death.

Warning!
Stands for a possibly dangerous situation which leads to heavy physical injuries or to the death.

Caution!
Stands for a possibly dangerous situation which could lead to light physical injuries or to damages to property.

Hint!
Stands for an important tip whose attention is important for the designated use and function of the device.
# TABLE OF CONTENTS

1 DESCRIPTION OF DESIGN AND FUNCTION ................................................................. 9  
1.1 Installation in explosive atmospheres, installation zones 1 und 2 .................................. 9  
1.2 Main components .................................................................................................... 10  
1.3 Mode of operation .................................................................................................... 11  
1.4 Refrigerant circuit ..................................................................................................... 11  
1.5 Oil System ................................................................................................................ 11  
1.5.1 Oil separation ........................................................................................................ 11  
1.5.2 Oil Cooling ............................................................................................................ 12  
1.5.3 Oil filter ................................................................................................................ 12  
1.5.4 Oil pump .............................................................................................................. 12  
1.5.5 Oil injection .......................................................................................................... 12  
1.5.6 Oil circuit, miscellaneous ..................................................................................... 12  
1.6 Safety devices .......................................................................................................... 12  
1.7 Monitoring devices ................................................................................................... 13  
1.8 Capacity control solenoids ....................................................................................... 14  
1.9 Start-up ..................................................................................................................... 15  

2 OPERATING INSTRUCTIONS ...................................................................................... 16  
2.1 Use in explosive atmospheres, installation zones 1 and 2 .......................................... 16  
2.2 Important information for the operator ..................................................................... 16  
2.3 Transport and storage ............................................................................................. 16  
2.4 Installation ................................................................................................................ 17  
2.4.1 Rigid installation ................................................................................................. 17  
2.4.2 Vibration Isolation and Insulation to prevent transmission of structure-born noise, Type  
LM ..................................................................................................................................... 17  
2.4.3 Vibration Isolation and Insulation to prevent transmission of structure-born noise, Types  
AM and SLM ................................................................................................................. 17  
2.5 Assembly .................................................................................................................. 17  
2.5.1 Connecting the pipes ......................................................................................... 17  
2.5.2 Connecting the electric cables .......................................................................... 18  
2.6 Start-up procedure .................................................................................................... 18  
2.6.1 Leak test .............................................................................................................. 18  
2.6.2 Drying, vacuum ................................................................................................... 18  
2.6.3 Oil charge ........................................................................................................... 19  
2.6.4 Checking the failure monitoring ......................................................................... 19  
2.6.5 Checking the direction of rotation of the oil pump motor ..................................... 20  
2.6.6 Adjustment of oil pressure .................................................................................. 20  
2.6.7 Checking the oil circuit monitoring while the compressor is running .................. 20  
2.6.8 Checking the failure shutdown when the temperature is exceeded .................... 21  
2.6.9 Checking the direction of rotation of the drive motor ......................................... 21  
2.6.10 Mounting the coupling ....................................................................................... 21  
2.6.11 Charging refrigerant ......................................................................................... 22  
2.6.12 Operating position of valves ............................................................................. 23  
2.6.13 Checking the water circuits ............................................................................. 26  
2.6.14 Initial start-up ..................................................................................................... 26  
2.6.15 Checking the adjustment of the control slide ..................................................... 26  
2.6.16 Checking the control slide adjustment times ...................................................... 26  
2.6.17 Checking the oil circuit monitoring while the unit/ chiller is running .................... 27  
2.6.18 Checking the oil cooling with water cooled oil cooler ....................................... 27  
2.6.19 Checking the oil cooling with refrigerant cooled oil cooler ................................. 27  
2.6.20 Checking the oil cooler ..................................................................................... 27  
2.6.21 Adjusting the amount of injection oil and the oil temperature ......................... 27  
2.6.21.1 Screw compressor packages without refrigerant injection ............................... 28  
2.6.21.2 Compressor units with refrigerant injection ................................................... 28  
2.6.22 Screw compressor package standstill for a longer period ................................... 29  

5
2.10.3 Measures during shutdowns

2.10.3.1 Monthly measures during standstill

2.10.3.2 Four weeks before restarting

2.11 Putting back into service after approx 1 year

3 MAINTENANCE INSTRUCTION

3.1 Use in explosive atmospheres, installation zones 1 and 2

3.2 General Information

3.3 Maintenance work

3.3.1 Changing suction filter

3.3.2 Oil draining, oil filling, oil change

3.3.2.1 Importance of oil change

3.3.2.2 Oil change, maintenance work

3.3.2.3 Changing the oil

3.3.3 Replace oil filter

3.3.4 Coupling maintenance

3.3.5 Oil pump maintenance

3.3.6 Check of the tightening torque on the adjusting elements of the fixing base.

3.3.7 Changing the oil fine separation cartridges

3.3.8 Venting the refrigerant circuit

3.3.9 Finding and fixing leakages

3.3.10 Charging and topping up with refrigerant

3.3.10.1 Charging refrigerant

3.3.10.2 Draining the refrigerant

3.4 Steps to be followed before starting the system after major repairs

3.4.1 Repair information

3.4.2 Pressure test, tightness test

3.4.3 Vacuum Test

3.5 Repair work

3.6 Instructions regarding failures, their causes and remedies
# TABLE OF FIGURES

<table>
<thead>
<tr>
<th>Fig.</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Standard Screw Compressor Package Grasso SP2</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>Vacuum required to remove moisture from refrigerating plants</td>
<td>19</td>
</tr>
<tr>
<td>3</td>
<td>Motor direction of rotation</td>
<td>21</td>
</tr>
<tr>
<td>4</td>
<td>Stop valve open</td>
<td>23</td>
</tr>
<tr>
<td>5</td>
<td>Stop valve closed</td>
<td>23</td>
</tr>
<tr>
<td>6</td>
<td>Check valve</td>
<td>23</td>
</tr>
<tr>
<td>7</td>
<td>Shuttatable check valve</td>
<td>23</td>
</tr>
<tr>
<td>8</td>
<td>Control valve</td>
<td>24</td>
</tr>
<tr>
<td>9</td>
<td>Shuttatable check valve</td>
<td>24</td>
</tr>
<tr>
<td>10</td>
<td>Solenoid valve</td>
<td>24</td>
</tr>
<tr>
<td>11</td>
<td>Change-over valve</td>
<td>24</td>
</tr>
<tr>
<td>12</td>
<td>Oil pressure control valve</td>
<td>24</td>
</tr>
<tr>
<td>13</td>
<td>Overflow valve, safety valve</td>
<td>25</td>
</tr>
<tr>
<td>14</td>
<td>Pressure controlled check valve</td>
<td>25</td>
</tr>
<tr>
<td>15</td>
<td>Quick acting valve, spring-loaded</td>
<td>25</td>
</tr>
<tr>
<td>16</td>
<td>Charging valve, drain valve</td>
<td>25</td>
</tr>
<tr>
<td>17</td>
<td>Service valve</td>
<td>25</td>
</tr>
<tr>
<td>18</td>
<td>Oil temperature limiter</td>
<td>26</td>
</tr>
<tr>
<td>19</td>
<td>Temperature controlled control valve</td>
<td>26</td>
</tr>
<tr>
<td>20</td>
<td>Solenoid valve plate with throttle screws</td>
<td>27</td>
</tr>
<tr>
<td>21</td>
<td>Oil separator (figure shows oil separator with diameter 711) for Grasso SP2</td>
<td>36</td>
</tr>
</tbody>
</table>
1 DESCRIPTION OF DESIGN AND FUNCTION

1.1 Installation in explosive atmospheres, installation zones 1 und 2

Danger!

The same functional and design characteristics apply to the maintenance instructions for the use of SCPs in potentially explosive atmospheres as described in the respective applicable operating manual. In addition to this, the following extensions apply:

1. All components relevant for the use of SCPs in relation to their use in potentially explosive atmospheres (concerns both electrical and non-electrical components) are separately designed and documented – see product description!

2. Extension to the method of working

   The use of SCPs is extended to use in potentially explosive atmospheres, including the compression of process gases (only compression for the purposes of pressure increase). The SCPs are not suitable for pumping potentially explosive mixtures. This means, when the compressor is in intake condition, the pumped liquid must not contain any oxygen. The intake condition always refers to pressure layers in the overpressure range.

   The owner operator and the system builder must use monitoring devices reflecting the respective state of the art standards, to positively monitor and ensure this effect.

3. Safety equipment extension

   If oil heaters are used in potentially explosive atmospheres (see also component specifications in the product description) additional, separate oil level monitoring is absolutely necessary to ensure a minimum oil level above the heating elements. To this end, a separate oil level switch is used in each use case according to the necessary explosion protection specifications – see also the component specifications in the product description.
### 1.2 Main components

(Example: Package of Group IV)

<table>
<thead>
<tr>
<th>LP</th>
<th>Low Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP</td>
<td>High pressure</td>
</tr>
<tr>
<td>Vi</td>
<td>Internal volume ratio</td>
</tr>
</tbody>
</table>

Screw compressor packages of the Grasso SP2 series consist of the following main assemblies and components:

<table>
<thead>
<tr>
<th>010</th>
<th>Screw compressor LP</th>
</tr>
</thead>
<tbody>
<tr>
<td>015</td>
<td>Compressor drive motor LP</td>
</tr>
<tr>
<td>020</td>
<td>Oil separator</td>
</tr>
<tr>
<td>030</td>
<td>Oil cooler</td>
</tr>
<tr>
<td>035</td>
<td>Oil fine filter</td>
</tr>
<tr>
<td>040*</td>
<td>Oil pump</td>
</tr>
<tr>
<td>045</td>
<td>Suction filter</td>
</tr>
<tr>
<td>055</td>
<td>Check valve - suction side</td>
</tr>
<tr>
<td>060**</td>
<td>Check valve – pressure side</td>
</tr>
<tr>
<td>095</td>
<td>Coupling LP</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>180</th>
<th>Control device &quot;Grasso System Control&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1010</td>
<td>Screw compressor HP</td>
</tr>
<tr>
<td>1015</td>
<td>Compressor drive motor HP</td>
</tr>
<tr>
<td>095</td>
<td>Coupling HP</td>
</tr>
<tr>
<td></td>
<td>Safety devices</td>
</tr>
<tr>
<td></td>
<td>Common base frame for all components</td>
</tr>
<tr>
<td></td>
<td>Hydraulic adjustment for capacity control of LP compressor</td>
</tr>
<tr>
<td></td>
<td>Hydraulic adjustment for capacity control of HP compressor</td>
</tr>
<tr>
<td></td>
<td>Vi-adjustment HP-compressor</td>
</tr>
<tr>
<td></td>
<td>pressure and temperature sensors</td>
</tr>
<tr>
<td>I</td>
<td>Refrigerant inlet</td>
</tr>
<tr>
<td>II</td>
<td>Refrigerant outlet</td>
</tr>
<tr>
<td>III</td>
<td>Connection of intermediate pressure/ subcooler/ standby operation</td>
</tr>
<tr>
<td>IV</td>
<td>Connection for safety valve combination</td>
</tr>
<tr>
<td>V</td>
<td>Connections for cooling water</td>
</tr>
</tbody>
</table>
1.3 Mode of operation

Screw compressor packages are refrigeration system components and serve to compress refrigerants such as ammonia or R22 (other operating media like R134a, R404a or R507 on request).

The application is performed at higher compression ratios

\[ \Pi \left( \frac{p}{p_0} \right) > 6 \]

1.4 Refrigerant circuit

The LP screw compressor takes in refrigerant vapour through the suction check valve and suction filter and compresses it to intermediate pressure. The HP screw compressor compresses to discharge pressure and feeds the refrigerant through the oil separator and the discharge check valve into the plant.

The suction check valve prevents any sudden pressure compensation with the intake line after the SCP has been shut down.

The discharge check valve (HP compressor) prevents the refrigerant from condensing back into the oil separator.

The suction filter prevents dirt particles carried by the suction flow from penetrating into the compressor. The filter element is characterized by a very large filtering area being accomplished by a star-like folding of the element. The filter has a fineness of 120 µm.

Gas vibrations, which may occur in the pressure chamber of the HP compressor if there are high pressure ratios in the low delivery area, can be avoided by means of a gas vibration protection device. This consists of a pressure compensation line between the oil separator and the working area of the HP compressor (at pressure ratio \( \pi > 8 \)).

1.5 Oil System

The screw compressors operate oil-flooded. During the compression process, refrigerating machine oil is supplied to the compressor for lubrication, sealing, noise reduction, and absorption of part of the compression heat. After the compression process, the oil is separated again from the refrigerant in the oil separator.

1.5.1 Oil separation

The refrigerant/oil mixture is fed into the first part of oil separator via the HP-compressor pressure pipe. There, the first step of oil separation is performed by a combined agglomerator/ demister. At the same time, these part of the oil separator serves as oil collector.
In the second part of the oil separator, the fine separation of the aerosol oil portion from the refrigerant is performed by means of replaceable fine oil separation cartridges. The oil separated in the fine section of the oil separator is returned to the additional oil injection device of the HP-compressor.

Between first and second stage of oil separation is located an additional oil reservoir (in cause of technology). This oil will return via orifice internal.

1.5.2 Oil Cooling

Before returning to use into the compressor, the oil which has heated up in the compressor has to be cooled down to a temperature ensuring a sufficient oil viscosity. The **Standard** package always has a water cooled oil cooler (for non-corrosive water).

1.5.3 Oil filter

After cooling, the oil passes into the oil filter which holds back solid particles from the full oil flow. Due to its large surface, the star-folded glass fibre element has a high absorbing capacity and thus a long operating lifetime. The relative filter fineness is 10-15 μm.

After the oil filter the oil is distributed to the injection- and functional oil connections respectively of the compressors.

1.5.4 Oil pump

HP compressor packages with antifriction bearings have an oil pump integrated within the HP compressor. The internal oil pump delivers functional oil to the HP compressor. The LP compressor is completely supplied with oil without pump.

HP compressor packages with sliding bearings have an external oil pump. The external oil pump runs for pre- and during compressors operation.

Oil pump sucks the oil from receiving part in oil separator via oil cooler and oil filter and pumps it to bearings, balance piston, shaft seal and capacity control device of compressor.

1.5.5 Oil injection

The injection oil is fed to the compressors without a pump via the combined stop/ check control valves. The required compressor discharge temperature (LP, HP) is set via the oil injection regulating valves.

1.5.6 Oil circuit, miscellaneous

The screw compressor package is fitted with an oil drain and refilling stop valve which may be connected to a separate oil pump or receiver.

Vent valves are fitted to the suction and oil filters for maintenance and repair purposes.

Before oil filter changing, please drain the oil filter housing.

1.6 Safety devices

The following safety devices are fitted to every Standard screw compressor package Grasso SP2:

- **Safety devices to prevent the discharge pressure from being exceeded** (Discharge pressure transducer 1105)
  
  The compressor control device switches off the drive motor when the discharge pressure limit has been exceeded.
  
  Limit value \( p = p_{\text{max}} - 2 \text{ bar} \) (see parameter list)

- **Safety device to prevent the differential pressure between the oil pressure after oil pump (pressure transducer 110) and the compressor discharge pressure (pressure transducer 1105) from falling too low oil circuit monitoring**
  
  The compressor control device switches off the drive motor when the pressure difference between oil pressure after oil pump and compressor discharge pressure falls below the specified limit value.
  
  - HP-compressor Series SH, MC
    
    limit value \( \Delta p \leq 0.5 \text{ bar} \)
  
  - HP-compressor Series LT
    
    limit value \( \Delta p \leq 1 \text{ bar} \)

- **Safety device to prevent the discharge temperature from being exceeded** (LP-compressor) (resistance thermometer 120)

\[ p_{\text{max}} \] is the maximum working pressure of the HP side of the plant, especially of the oil separator.
The compressor control switch off the drive motor (LP compressor) when the discharge temperature limit has been exceeded.

Limit value \( t = \) see parameter list

- Safety device to prevent the discharge temperature from being exceeded (LP-compressor) (resistance thermometer 1120)

The compressor control device switches off the drive motor when the discharge pressure limit has been exceeded.

Limit value \( t = \) see parameter list

- Safety device to prevent the oil temperature from being exceeded (resistance thermometer 125)

The compressor control device switches off the drive motor when the discharge pressure limit has been exceeded.

Limit value for \( \text{NH}_3 \): \( t_{\text{oil}} = \) see parameter list

Limit value for \( \text{R}22 \): \( t_{\text{oil}} = \) see parameter list

The minimum oil viscosity for safe compressor operation is > 7 cSt at the compressor bearings. With refrigerant soluble oils, it should be guaranteed that the minimum oil viscosity is maintained depending on the discharge pressure and temperature, oil temperature, as well as the type of oil. The oil temperature for \( \text{R}22 \) is thus only a standard value.

- Safety devices to prevent the oil pressure from being exceeded (pressure transducer 395), oil filter monitoring

which measures the oil pressure directly after the oil filter. The compressor control device switches off the drive motor when the differential pressure limit between discharge pressure and oil pressure after oil filter has been exceeded.

Limit value \( \Delta p = 2 \text{ bar} \).

The pressure transducer (395) can be equipped optionally with stop valve (420).

- Compressor drive motor safety devices

  Rated current limitation (016) and (1016), which is realised by the respective compressor control. When the rated motor current is exceeded, the compressor capacity control slide is driven in the MIN direction until the motor current reaches an allowable level. The normal output control then comes back into force.

  Thermistor (017) and (1017) which shuts down the compressor drive motor if its winding temperature limit has been exceeded.

- Check valve - suction side (055)

  Check valve - suction side protects the screw compressor package from a sudden pressure equalisation with the suction line after shut down.

- Check valve - discharge side (060)

  is intended for a fast pressure build-up within the oil separator and a proper oil supply to the compressor. In addition, the refrigerant is prevented from back condensation into the oil separator.

1.7 Monitoring devices

The following operating values will be continually monitored in a standard screw compressor package:

- Suction pressure LP
- Suction pressure HP
- Discharge pressure
- Oil pressure oil circuit monitoring
- Suction temperature LP
- Discharge temperature LP
- Discharge temperature HP
- Oil temperature
- Absolute primary slide position LP
- Absolute primary slide position HP
- Motor current LP
- Motor current HP
- Number of running hours
- Difference between oil and discharge pressures (oil circuit monitoring)
- Set point of controled value in °C
- Real point of controled value in °C
- Controlled value suction pressure LP
- Oil pressure after oil filter
- Differential pressure of oil pressure after oil filter and discharge pressure (oil filter monitoring) - optional -

---

2 other refrigerants on request
1.8 Capacity control solenoids

All screw compressors used in the package series are fitted with a continuous capacity control with a range of 10 -100%.

The capacity is adjusted by shortening the compressor stroke. The defining factor for the compression process is the effective rotor length; this is altered by a hydraulically operated control slide.

The position of the control slide is indicated by the position transducer. The display can indicate the slide position relative to its full load position in percent.

The hydraulic slide adjustment is controlled by four solenoid valves which are contained in one block. Mostly are 6 solenoid valves enough (in one block) for capacity control of both compressors.

The control slide travel speeds in the MIN and MAX directions should be approximately the same during operation to ensure better compressor control (see parameter list).
1.9 Start-up

For start up of an Two-Stage Package in any case the HP compressor runs at first.

When starting the screw compressor package with HP compressors having sliding bearings, the oil pump for prelubrication and building up a sufficient oil pressure to shift the control slides starts first.

One of the start-up requirements for the HP compressor drive motor is that the control slide of the HP-compressor be in its MIN end position. If the control slide of the compressor is not in its MIN end position, the command to reduce capacity is given and the control slide is driven to its MIN end position.

The slide of HP-compressors series SH and MC will taken to MIN with a spring.

The switch-on conditions for the compressor drive motor (LP) are:

- MIN end position of the control slide,
- HP compressor runs,
- The value picked up by the pressure transducer “start-up unlocking/discharge pressure LP compressor” (intermediate pressure) lies under the limit value given in the Technical Data.
- there are no other fault messages.

The two compressors are adjusted separately when they are running.

<table>
<thead>
<tr>
<th>HP compressor</th>
<th>SV Y1</th>
<th>SV Y2</th>
<th>SV Y3</th>
<th>SV Y4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity +</td>
<td>open</td>
<td>closed</td>
<td>closed</td>
<td>open</td>
</tr>
<tr>
<td>Capacity -</td>
<td>closed</td>
<td>open</td>
<td>open</td>
<td>closed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HP-compressor alternative</th>
<th>SV Y5</th>
<th>SV Y6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity +</td>
<td>closed</td>
<td>open</td>
</tr>
<tr>
<td>Capacity -</td>
<td>open</td>
<td>closed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LP compressor</th>
<th>SV Y1</th>
<th>SV Y2</th>
<th>SV Y3</th>
<th>SV Y4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity +</td>
<td>open</td>
<td>closed</td>
<td>closed</td>
<td>open</td>
</tr>
<tr>
<td>Capacity -</td>
<td>closed</td>
<td>open</td>
<td>open</td>
<td>closed</td>
</tr>
</tbody>
</table>
2 OPERATING INSTRUCTIONS

2.1 Use in explosive atmospheres, installation zones 1 and 2

**Danger!**

The same regulations apply to the operating instructions for screw compressor packages in potentially explosive atmospheres as described in the respective applicable operating manual.

In addition to this, the following extensions apply:

1. In addition, the legal safety regulations apply for the people responsible for operating the screw compressor package, and must be conformed with respect to the transport, assembly, operation and maintenance and if necessary the replacement of sub-assemblies, etc. in potentially explosive atmospheres.

The operator directives must be complied with in this context – see also section: Safety instructions for compressor, Appendix E and Screw compressor package, Appendix E. Both documents are an integral part of the documentation.

2. The relevant electrical engineering regulations for installations in potentially explosive atmospheres, especially EN 60079-10, apply to the installation and connection of electrical components. Appropriate, prescribed cabling material must be used.

3. The entire screw compressor package must be earthed by the operator.

2.2 Important information for the operator

The screw compressor package must be only be operated by trained and qualified personnel who are familiar with the contents of the operating manual for GEA Refrigeration Germany GmbH screw compressor packages.

The safety regulations for refrigeration plants must always be observed in order to prevent damage to the screw compressor package and injury to the operating staff.

**Hint!**

The screw compressor package is operated via the control panel of the control unit. If the control is included in the scope of delivery, the operating staff must be familiar with the contents of the complete documentation of the control unit. The documentation for the control unit is an integral part of the product documentation.

2.3 Transport and storage

Screw compressor packages are high-quality products which must be handled with due care during transport. Protect the equipment from impacts and put it down carefully.

When transported by crane, the screw compressor unit must have the same position as in operation. Do not use lifting points other than those provided for this purpose.

**Warning!**

It is forbidden to utilise fittings or pipes for attaching the screw compressor unit.

Position the screw compressor unit on the transport vehicle such that it is prevented from sliding and tilting. The competent staff member or the company is responsible for ensuring transport safety.

The storage area of screw compressor units must be roofed, plain and paved and secured against access of unauthorised persons. The unit must be protected against knocks and impacts.

Turn the shaft of the compressor at least every four weeks (approx. 10 rotations).
At the same time, check the nitrogen filling and recharge to the specified overpressure of 2 bar if required. Dry nitrogen with a residual moisture of ≤ 300 ppm is used for this purpose.

**Warning!**

Screw compressor packages must be adequately protected from external influences during transport and storage. This usually concerns prolonged standing times out of doors before installation and start-up of the refrigeration plant. The manufacturer recommends the use of plastic sheeting to cover the whole product.

The venting slits of the electric motors must always be covered!

---

### 2.4 Installation

#### 2.4.1 Rigid installation

The frame of the screw compressor unit/ liquid chiller is placed on foundation bolts on a prepared foundation. The frame must be levelled with suitable shims such that the coarse alignment (radial and angular misalignment ≤ 0.25 mm) at the coupling is attained again. Then tighten the foundation bolts.

#### 2.4.2 Vibration Isolation and Insulation to prevent transmission of structure-born noise, Type LM

Unloading of the package with mounted antivibration devices must be carried out in a regular (symmetrical) way to prevent damage or overload of the antivibration isolators.

Levelling must be made step by step or cross wise from outside to inside of the package as well as with regular tighten torque.

The frame of the screw compressor unit shall be aligned with the levelling bolts until the coarse alignment (radial and angular misalignment ≤ 0.25 mm) at the coupling is attained again.

Before tightening the insulator fixing screws check, if the insulator bodies are free above the spring (predominantly out of rubber) don't rest on the foundation.

#### 2.4.3 Vibration Isolation and Insulation to prevent transmission of structure-born noise, Types AM and SLM

Please consider very carefully especially the erection and levelling instructions.

---

### 2.5 Assembly

All pipes and electric cables must be connected so that no mechanical tension occurs.

#### 2.5.1 Connecting the pipes

Purge the nitrogen filling of the screw compressor unit by opening the vent valves before connecting the pipes.

Establish all pipe connections so that the transmission of thermal expansion and vibration to the screw compressor unit is limited as far as possible.

Bellow expansion joints made of steel and flexible metal tubes can be used for refrigerant and oil lines, bellow expansion joints made of rubber for water connections.

Provide all pipe connections with fixed points arranged immediately at the unit.

Connect the following:

- suction line
- standby operation line
- intermediate pressure/- subcooler line
- discharge line
- water cooled oil cooler water connection,
- alternative: Connection for refrigerant, when a refrigerant cooled oil cooler is used if units are subject to acceptance by TÜV (the Technical Surveyance Board) then also:
  - integrate overflow valve in the suction line if a safety valve on oil separator is used
  - connect safety valve to bleed line
if refrigerant-cooled oil coolers are used, then connect
- Refrigerant feed line from h.p. receiver (note geodetic height above oil cooler)
- Evaporated refrigerant line to condenser
if an economizer is used, then connect
- economizer suction line to supercharging connection

2.5.2 Connecting the electric cables

Connect the following:
- compressor drive motor
- control device current supply if present
- Oil heater
- Oil Pump

2.6 Start-up procedure

The following procedures should be completed in the sequence in which they are described:

2.6.1 Leak test

**Hint!**
See type plate for permissible operating pressure.

The necessary safety precautions should be taken before performing the leak test.

An approx. 3-hour pressure drop test with dry nitrogen is used for the test. **Test pressure: 7 bar**

A pressure drop of 2% is allowed during the 3 hours. Fluctuations in the ambient temperature must be taken into account.

**Caution!**
Checking devices which could be damaged by the specified test pressure must be removed or blocked before the leak test is performed.

A record should be kept of the pressure test, noting the pressure in the pipes tested, the ambient temperature and the outside temperature in the shade at hourly intervals.

The removed measuring and control instruments should be reinstalled after completion of the leak test and if there are no leaks in the package/chiller.

**Test strategy**

Dry nitrogen is used as the test medium. After reaching the test pressure, the pressure drop is measured via the differential pressure measurement. This may only change by 0.02 bar within an hour. If the display device does not indicate a leakage through foam formation, the system is sealed.

**Testing devices**

A pressure gauge with an accuracy of 0.5% over the entire measuring range, with a digital resolution of 0.01 bar must be used for the measurement.

The testing described here is based on pressure gauges with pressure gauge and LEAK mode from Keller.

**Display devices**

A foaming agent must be used as the means to indicate leakages. A solution of 50 parts water and 1 part detergent can be used as the foaming agent. Leaks are detected through formation of foam. A leak detection spray can be used in problem areas.

**Carrying out the test**

1. Wet all connecting joints (welded seams, flange connections, screw fastenings, etc.) with foaming agent. Remedy any leaks detectable from the noticeable formation of foam.

2.6.2 Drying, vacuum

After the leak tightness test has been completed, the plant must be evacuated and undergo a vacuum test for 3 hours. Evacuation is used to remove air and moisture from the plant.

A vacuum pump must be used for evacuation. The permissible increase in vacuum is maximum 6.66 mbar over a period of 3 hours.
fig.2: Vacuum required to remove moisture from refrigerating plants

<table>
<thead>
<tr>
<th>X</th>
<th>Room or Wall temperature in °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>Vacuum in mbar</td>
</tr>
<tr>
<td>A</td>
<td>Vacuum required to remove moisture from refrigerating plants</td>
</tr>
</tbody>
</table>

Measured values have to be checked and recorded hourly after reaching the required vacuum. After the vacuum pressure, the temperatures in the machine house and the outdoor temperature in shade must be entered in the log. After the vacuum test, the pressure compensation must be carried out with NH₃.

**Warning!**

Shut the oil pump during evacuation!

See also "Evacuation on refrigerant side" in the chapter "Maintenance work".

### 2.6.3 Oil charge

The vacuum present in the unit/ chiller before pressure compensation may be utilized for oil charging. Use the mounted oil pump after the pressure compensation and for refilling with oil, otherwise a separate oil recharging pump is required.

**Warning!**

Check the oil grade to be charged. See contract/project or manufacturer’s recommendation.

The connection of the oil draining/oil charging shut-off valve (420) must be connected with the oil charging tank.

Before charging with oil, switch the valves to the operating position.

Open stop valve (oil charging) until the oil level has reached at the top of the oblong sight glass in the oil separator sump.

The oil separator is generally charged with oil via the oil cooler.

When charging with oil for the first time, oil must be charged via the service valve (135) too. To this end, the stop valve (065) must then be closed.

**Warning!**

Due to the use of selected components, the refrigerating machine oils tend to absorb more moisture. Therefore, when charging a compressor the oil should be allowed to come into contact with air for a short time only. The contents of an opened drum have to be used up within one working day, provided the drum is properly closed between charging.

Check the purity and moisture content of fresh-oil!

### 2.6.4 Checking the failure monitoring

1. Disconnect the incoming feeder of the compressor driving motor from the supply mains for checking the safety devices (e.g. remove LV/HBC fuse links).
2. Check assembled pressure transducers and resistance thermometers for correct wiring. Loosen therefore the relevant contacts. Status signal "Broken wire <sensor XXX>" appears on GSC display. Check the correct status signal on GSC display after recreating the contact. Further information is given in the GSC controls manual.
3. Check limit values. **See parameter list!**
4. Switch on the unit/ chiller.
5. Check the switching function of main switch and star-delta contactor.
6. "Failure Oil circuit monitoring" has to be signalled after a starting delay time of 20 sec.
7. Check the excitation of the solenoid valves of the adjusting device for capacity control in the MINI-MUM direction.
8. Simulate the minimum end position of the control slide.

9. Check the switching function of the solenoid valves by actuating the pushbutton switches for capacity increase and capacity decrease:
   - capacity ↑ - SV1 and SV4 are excited
   - capacity ↓ - SV2 and SV3 are excited
   or alternative for HP-compressors with Vt control:
   - capacity ↑ - SV6 is excited
   - capacity ↓ - SV5 is excited

10. Check the "Failure Oil circuit monitoring". The compressor driving motor must be switched off after 6 s.

11. Set the motor current limitation acc. to nominal motor data.

2.6.5 Checking the direction of rotation of the oil pump motor

The oil pump is started with the driving motor electrically blocked (service). The stop valves are in the operating position.

The direction of the arrow given for the oil pump must correspond to the direction of rotation of the oil pump motor.

Caution!
Since the slide ring shaft seal of the oil pump is dependent on the direction of rotation and can be damaged when this direction is wrong, checking must be reduced to a very short running period (less than 2 seconds).

The adjusted differential pressure between the oil pump pressure side and the unit final pressure is checked with the oil pump rotating in the correct direction. It must not fall below the prescribed set value in the P+I diagram.

While the compressor is not running and the oil has not yet reached the operating temperature, the differential pressure can be slightly higher than the indicated value.

The differential pressure can be changed by rotating the spindle on the oil pressure control valve. (The differential pressure is increased by turning it inwards and vice versa).

2.6.6 Adjustment of oil pressure

Danger!
The oil pressure being set too high or too low may result in serious compressor damage or even total breakdown of the compressor after even a short period of operation!

Before the compressor drive motor and therefore the unit can be started, the oil pressure must be set correctly by adjusting the oil pressure regulating valve (075).

For adjustment solely the oil pump must be started. For units with the control GEA Omni, digital output must be forced for this.

The set value of the oil differential pressure should be taken from the P+I flow chart of the specific project.

Oil differential pressure = oil pressure item (110) - discharge pressure item (105)

The differential pressure can be changed by rotating the spindle on the oil pressure regulating valve (the differential pressure is increased by turning it inwards and vice versa). To do so, the seal on the oil pressure control valve (075) must be removed.

In comparison to normal operation conditions, the oil differential pressure can be slightly higher if only the oil pump is operated or if the operating temperature is not reached yet (with the valve open to the same degree).

In this case, the oil differential pressure should be readjusted (according to the value in the P+I flow chart) after start of the unit and reaching of the operation temperature.

2.6.7 Checking the oil circuit monitoring while the compressor is running

1. Oil pump is running.
2. Throttle the stop valve (065).
3. If the differential pressure falls below a preset value for longer than 6 sec., the unit must be switched off.

Differential pressure alarm value = see parameter list
2.6.8 Checking the failure shutdown when the temperature is exceeded

1. Set the prescribed limiting values under the actual values in the "Sensor values" menu.
2. Check the limiting values on the display of the controller.
   **Limit value = see parameter list**
3. Check the alarm message on the compressor control system.
4. Reset the limiting values changed under 1 to the original values.

2.6.9 Checking the direction of rotation of the drive motor

**Warning!**
The coupling must not yet connect the motor and compressor!

- Secure the electric switchgear so as to prevent the compressor drive motor from being switched on accidentally.
- With the control slide in the MIN or MAX position, it should be possible to rotate the compressor shaft easily and smoothly by hand. When checking the direction of rotation of the compressor driving motor pay attention to the conditions for switching the compressor on.

<table>
<thead>
<tr>
<th>fig.3: Motor direction of rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
</tbody>
</table>

- The compressor drive motor is started directly and then switched off again by forcing the digital outputs.

**Hint!**
Prior to the start-up of the compressor drive motor, the manufacturer's information, e.g. on the lubrication of the motor, must be followed at all costs.

- If the direction of rotation of the motor is incorrect, it should be corrected while the electric switchgear is secured to prevent the motor from being switched on accidentally. Then the motor must work for at least 1 hour, unencumbered and free from errors. This is important in order to dry out residual moisture in the motor (caused during transport or storage).
- The coupling protection must be in place during this start-up period as required by the labour safety regulations.
- After checking the direction of rotation of the drive motor, the coupling may be connected with the motor.

2.6.10 Mounting the coupling

1. The electric switchgear is secured to prevent it from being switched on accidentally.
2. Mount the coupling while observing the instructions of the separate documentation.
3. The values for radial and angular deviations given in the coupling documentation must be checked and corrected if necessary. The axis distance between the compressor drive motor and the compressor must be checked.
4. The real values have to record at data sheet of coupling documentation. Please send back a copy of the filled data sheet to:

GEA Refrigeration Germany GmbH
Holzhauser Straße 165
13509 Berlin
Fax: +49 (0)30 - 43 592 759

**Caution!**
Observe the maintenance instruction!
Regrease the coupling at the prescribed intervals if scheduled in the maintenance instruction for the coupling!
2.6.11 Charging refrigerant

**Warning!**

In order to charge the refrigerant, the compressor must be ready for operation!

1. Connect the refrigerant reservoir to the filling valve.
2. Open the charging valve.
3. Carefully open the container valve and perform a pressure compensation.
4. Close the valve.
5. Check the plant for leaks again.
6. Start the compressor.
7. Open the container valve.
8. Draw refrigerant into the circuit at a low compressor capacity.
9. Close the reservoir valve when the suction pressure nears the required values. Let the compressor continue to run until the refrigerant has been completely distributed in the circuit. Based on the values, you can now assess whether additional refrigerant has to be charged or not.

**Hint!**

If necessary, repeat refrigerant charging until suction pressure reaches the required value.

10. In case of a separate refrigerant circuit for oil coolers:
    Keep the injection valve into the compressor closed to increase the discharge temperature during the filling process in order to better assess the refrigerant quantity in the oil circuit.
11. After the charging process has been completed, close the charging valve and cylinder valve.
12. Drain and dismantle the charging line.
2.6.12 Operating position of valves

For the positions of the manually controllable fittings for the operation of the package/chiller, see the P+I diagram.

The layout and symbols used in the P+I diagram comply with the specifications of EN 1861, July 1998 Issue.

**Caution!**

The valves must be in operating position prior to the start-up of the package / chiller. Trouble-free operation is only possible in this manner!

---

Stop valve open during normal operation

fig.4: Stop valve open

---

Stop valve closed during normal operation

fig.5: Stop valve closed

---

Check valve during normal operation

fig.6: Check valve

---

Shuttable check valve open during normal operation

fig.7: Shuttable check valve
Control valve *adjusted*:
- Start-up
- when operating conditions change

Shutable check valve with integrated control function *open* during normal operation

Controlled by the controller (e.g. GEA Omni)

Change-over valve (3-way valve), opened from below in arrow direction

Operating position: *shut*
\[ \Delta p \ x, x \pm x \text{ bar} \] control pressure to be set vis-à-vis reference pressure (see P+I diagram)

**Caution!**
An oil pressure being set too high or too low may result in serious compressor damage or even the total breakdown of the compressor after just a short period of operation!
fig. 13: Overflow valve, safety valve

fig. 14: Pressure controlled check valve

fig. 15: Quick acting valve, spring-loaded

fig. 16: Charging valve, drain valve

fig. 17: Service valve

Overflow valve, safety valve

controlled self-sufficient

manually operated if necessary

- ½" connections
- with cap

- Connection Rp ¼"
- For pressure gauge and pressure transmitter
2.6.13 Checking the water circuits
Check whether the cooling and cold water pumps are running and the shut-off fittings in the cooling water circuit are in their operating positions.
While the unit/chiller is operating under project conditions, adjust the cooling water control so that the condensing and oil temperature lies within the permissible range.

2.6.14 Initial start-up
After carrying out the aforementioned works, the SCP can be commissioned in accordance with the operating manual of the control device.
1. Switch on the control voltage of the control device.
2. Remedy and acknowledge existing fault messages.
3. Select manual operating mode.
4. Turn on SCP.

2.6.15 Checking the adjustment of the control slide
1. Switch on the unit/chiller. The HP-compressor starts at first. The LP-compressor starts after intermediate pressure release.

2. Select operating mode "1 (manual + manual)".
3. The maximum end position (100% for HP-compressor and LP-compressor) must be reached and signalled on operating pushbutton switch (capacity increasing).
4. The minimum end position (0% for HP-compressor and LP-compressor) must be reached and signalled on operating pushbutton switch (capacity decreasing).
5. Vent the adjusting device by moving the control slide (for HP-compressor and LP-compressor) to and for about ten times.

2.6.16 Checking the control slide adjustment times
While the unit/chiller is running, determine the adjustment times needed when the control slide is continually moved from the maximum end position to the minimum end position and back. For the automatic system to run smoothly, the adjustment times in either direction must be approximately the same.

4 Solenoid valve-block

<table>
<thead>
<tr>
<th>Minimum adjustment time</th>
<th>30 sec.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimum adjustment time</td>
<td>60 sec.</td>
</tr>
</tbody>
</table>

The adjustment times are matched by means of throttle screws mounted on the solenoid valve plate.
fig.20: Solenoid valve plate with throttle screws

| Rotate in clockwise direction | adjustment time ↓ |
| Rotate in anti-clockwise direction | adjustment time ↑ |
| Influencing towards Maximum | DS5 |
| Influencing towards Minimum | DS6 |

Alternative for 6 Solenoid valve-block

HP-compressor

| Influencing towards Maximum | DS12 |
| Influencing towards Minimum | DS9 |

LP-compressor

| Influencing towards Maximum | DS10 |
| Influencing towards Minimum | DS8 |

Perhaps to adjust DS 7 in case of full opening DS 10 and increasing the adjustment time.

2.6.17 Checking the oil circuit monitoring while the unit/ chiller is running

1. Switch on the unit/ chiller.
2. Throttle stop valve (300).
3. Oil filter monitoring

If the difference pressure (discharge pressure – oil pressure after oil filter) is longer than 6 sec below the limit value of 2 bar, the compressor unit/ chiller must be switched-off.

4. Oil circuit monitoring

If the difference pressure (oil pressure after oil pump – discharge pressure) is longer than 6 sec below the limit value of 1 bar (HP-compressor type P ... XF) or below the limit value of 0,5 bar (HP-compressor type C ... N) the compressor unit/ chiller must be switched-off.

2.6.18 Checking the oil cooling with water cooled oil cooler

Adjust the water volume so that the oil temperature lies within the permissible range (at operating point).

Standard value oil temperature = see parameter list

2.6.19 Checking the oil cooling with refrigerant cooled oil cooler

Adjust a stable circuit by means of the valve in the refrigerant line coming from the receiving tank so as to achieve that the oil temperature lies within the permissible range.

Standard value = see parameter list

2.6.20 Checking the oil cooler

Guide value for oil temperature = see parameter list

Oil cooling with water-cooled oil cooler

The water volume must be regulated so that the cooling water volume corresponds to the project value. The inlet and outlet temperatures must be checked. The oil temperature adjusts automatically via the 3-way valve.

Checking the oil cooling with refrigerant-cooled oil cooler

No regulating or checking required.

2.6.21 Adjusting the amount of injection oil and the oil temperature
2.6.21.1 Screw compressor packages without refrigerant injection

The amount of injection oil and the oil temperature directly influence the discharge temperature of the compressor. The amount of injection oil is adjusted under operating conditions through the injection oil control valve.

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>Discharge Temperature t</th>
<th>Maximum Temperature tmax</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH₃/HP</td>
<td>t ≥ t_{oil} + 20K 30K</td>
<td>95°C</td>
</tr>
<tr>
<td>NH₃/LP</td>
<td>t ≥ t_{oil} approx. 45 ... 60°C</td>
<td>80°C</td>
</tr>
<tr>
<td>Freon/HD</td>
<td>t ≥ t_{oil} + 15K</td>
<td>80°C</td>
</tr>
<tr>
<td>R22/LP</td>
<td>t ≥ 45 ... 60°C</td>
<td>80°C</td>
</tr>
</tbody>
</table>

2.6.21.2 Compressor units with refrigerant injection

The oil temperature is changed by setting the injection oil control valve. The more the shut-off valve is throttled, the more the oil temperature decreases. If the oil temperature becomes too low or reaches the lower range, the setpoint for the discharge temperature should be set higher accordingly. In the first setting of the oil circuit, the control valve for injection oil is opened approximately half a turn.

The discharge temperature is then regulated to the value indicated in the parameter list by means of the thermostatic expansion valve.

**Guide value for compressor end temperature:** \( t_e = 60 + 10°C \) (for NH₃)

Other refrigerants on request.

2.7 Normal Start-up

The system is designed for automatic chilling and is controlled by the compressors being switched on and off and their capacity being adjusted to requirements.

The system is designed for automatic chilling and is controlled by the compressors being switched on and off and their capacity being adjusted to requirements. The relevant information on starting up the system can be found in the documentation on the compressor control device.

If the system is run manually, it must be operated from the refrigerator room having particular regard for point Repair Work and Maintenance.

1. Move the valves into the operating position.
2. The oil level in the oil separator must be within the permissible range.
3. The cooling and cold water pumps must be in operation.
4. Check the cooling water/refrigerant supply of the oil coolers.
5. The oil heater in the oil separator can be switched on while the compressor unit/chiller is not running. It is then automatically switched off when the unit/chiller is started and switched on when it is shut down. If the ambient temperature is below 5°C, the oil heater must be switched on at least one hour before the compressor unit/chiller is started.
6. The motor current limitation has to set according to motor nominal data.
7. Start the unit/chiller in accordance with the operating instructions of the compressor unit control device.

2.8 Adjusting the compressor capacity

The capacity of the compressor can be adjusted automatically or controlled by hand.

**Hint!**

See documentation of control device.
2.9 Installation in explosive atmospheres, installation zones 1 und 2

Danger!
The same regulations apply to the decommissioning/restarting SCPs in potentially explosive atmospheres as described in the respective applicable operating manual.

In addition to this, the following extensions apply:

Measures applicable for the restarting of the SCP after 4 weeks and in particular after 1 year:

1. Check the secure fit of the coupling on the compressor and motor shaft.
2. Check the secure fit of the threaded connections and coupling protection.

2.10 Switching off

2.10.1 Temporary Shut-down

If the compressor unit is shut down temporarily, the valves do not need to be operated; they remain in their operating positions. If there is a possibility of the temperature in the evaporator to rise above the cooling water temperature, the cooling water supply must be interrupted or the shut-off valve on the compressor suction side must be closed.

If it is possible that the temperature in the evaporator rises above the ambient temperature of the compressor unit, the compressor suction-side shut-off valve must be closed.

2.10.2 Screw compressor package standstill for a longer period

- Close the shut-off valves (or shuttable check valves) in economizer suction line.
- Cut-off the refrigerant supply to the thermosyphon oil cooler.
- Close the manual cut-off valve of the refrigerant injection.
- Switch off the oil heater.
- Ensure you cover the venting slots of the electric motors!

2.10.3 Measures during shutdowns

Even though the screw compressor package/chiller is under overpressure, check the moisture content of the refrigerant and lubricating oil in case it is shut-down for a period longer than half a year. The moisture content must not differ substantially from the initial values.

2.10.3.1 Monthly measures during standstill

- Check that the screw compressor package/chiller is constantly under overpressure. Check the screw compressor package/chiller for leaks using a leak detector.
- Start the oil pump for approx. 5 minutes.
- Manually rotate the compressor shaft (min. 10 revolutions).

2.10.3.2 Four weeks before restarting

- Check the moisture content and ageing condition of the refrigerating machine oil. Analyse the oil for this purpose. Compare the results of the analysis with the values for fresh oil. We recommend an oil change after 1 year (ammonia as refrigerant) (see Maintenance Instructions).
- Check the insulation resistance of the drive motors (see the operating manual for the electric motor).
- Switch on the oil pump.
- Check the screw compressor package/chiller for leakages.
2.11 Putting back into service after approx 1 year

- Change the oil filter inserts (see Maintenance Instructions).
- The heater has to be switched on at least one hour before starting the unit/chiller.
- Open the shut-off valves on the intake side and the discharge side (or shuttable check valves).
- Open the intermediate pressure supply.
- Open the shut-off valves (shuttable check valves) in the economizer suction line.
- Open the oil cooler water circuit.
- Open the refrigerant supply to the thermosyphon - oil cooler.
- Open the manual shut-off valve of the refrigerant injection.
- Remove all non-condensable gases are removed by venting. To this end, check the condensing pressure and temperature (see parameter list).
- Check the oil collection sump and empty if necessary.
- Switch on the compressor and observe the operating instructions of the electrical switchgear. Make a unit/chiller function checkout for testing the sensor and actor technologies (ready for operation and indicating precision).
3 MAINTENANCE INSTRUCTION

3.1 Use in explosive atmospheres, installation zones 1 and 2

**Danger!**

The same regulations apply to the maintenance instructions for SCPs in potentially explosive atmospheres as described in the respective applicable operating manual.

In addition to this, the following extensions apply:

1. In addition, for the persons responsible for maintaining the SCP, the legal safety regulations concerning the installation of the SCP in potentially explosive atmospheres with respect to the maintenance of the individual components or sub-assemblies or their complete replacement apply.

2. The maintenance may only be carried out in agreement / with the knowledge and release of the operator.

3. The maintenance and replacement regulations resulting from the operating manual for the components are to be complied with.

4. Appropriate special tools approved for the potentially explosive atmosphere must be used.

5. Only original spare parts may be used. Otherwise, any claim of warranty is void or, in case of damage, the operator is liable for this.

6. Each maintenance inspection (see maintenance book) must also include the checking of the secure fit of the threaded connections for the coupling safety hood.

3.2 General Information

The unit/ chiller must be serviced by appropriately trained operating staff only. For all maintenance work, you must comply with the maintenance instructions. Moreover, all health & safety and fire prevention regulations and the safety regulations for refrigeration systems must also be observed.

The attached maintenance manual contains all the maintenance instructions and certifications for the first 10 years of performance of the unit/ chiller. The maintenance certificates are completed and signed as part of the inspection and maintenance by authorized fitters as evidence of the work done. During the warranty period, these validated maintenance certificates also serve as a precondition for a possible warranty claim put to GEA Refrigeration Germany GmbH.

For any repairs that may be required, contact the service department of GEA Refrigeration Germany GmbH.

**Warning!**

Perform all maintenance work carefully to keep the package/ chiller in good working order. Warranty claims will be rejected if the customer failed to follow the Maintenance Instructions.

**Caution!**

Pay attention to maintenance check-list!

<table>
<thead>
<tr>
<th>Parameter to be checked</th>
<th>Every 24 to 72 hrs</th>
<th>Weekly</th>
<th>Monthly</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suction temperature</td>
<td>X</td>
<td></td>
<td></td>
<td>Minimum superheat must not be less than 5 K. minimum suction temperature -60°C</td>
</tr>
<tr>
<td>intermediate temperature, discharge temperature LP</td>
<td>X</td>
<td></td>
<td></td>
<td>standard discharge temperature between 60°C and 80°C, maximum discharge temperature 95°C</td>
</tr>
<tr>
<td>Parameter to be checked</td>
<td>Every 24 to 72 hrs</td>
<td>Weekly</td>
<td>Monthly</td>
<td>Remark</td>
</tr>
<tr>
<td>--------------------------------------------------------------</td>
<td>--------------------</td>
<td>--------</td>
<td>---------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>intermediate temperature, intermediate input LP</td>
<td></td>
<td>X</td>
<td></td>
<td>Minimum superheat must not be less than 5 K. minimum suction temperature -20°C</td>
</tr>
<tr>
<td>discharge temperature HP-compressor</td>
<td></td>
<td>X</td>
<td></td>
<td>Minimum superheat must not be less than 25 K. Maximum final discharge temperature 95°C</td>
</tr>
<tr>
<td>Oil temperature</td>
<td></td>
<td></td>
<td>X</td>
<td>See parameter list! The viscosity must not be less than 7 cSt at max. speed (rpm).</td>
</tr>
<tr>
<td>Oil pressure</td>
<td></td>
<td>X</td>
<td></td>
<td>The oil pressure after oil filter must not be more than 2 ...4 bar below the HP compressor discharge pressure. The oil pressure must be at least 1 bar above the final compression pressure of the HP-compressor, a faulty oil pressure may be caused by a clogged oil filter.</td>
</tr>
<tr>
<td>Discharge pressure</td>
<td></td>
<td>X</td>
<td></td>
<td>See project value (parameter list). Determine the superheat on the pressure side by comparison with the final discharge temperature.</td>
</tr>
<tr>
<td>Oil level in oil separator</td>
<td></td>
<td>X</td>
<td></td>
<td>An oil level must be visible in the sight glass at all times. If the oil level is below the bottom third of the sight glass, recharge oil.</td>
</tr>
<tr>
<td>Oil heater</td>
<td></td>
<td></td>
<td>X</td>
<td>While compressor is stopped, the heater must automatically start up. If the thermostatic cutout (limiter) switches off the heater, this may be an indication of an oil shortage.</td>
</tr>
<tr>
<td>Setting the safety devices</td>
<td></td>
<td></td>
<td>X</td>
<td>See set values in the parameter list.</td>
</tr>
<tr>
<td>Capacity control</td>
<td></td>
<td>X</td>
<td></td>
<td>Solenoid valves must switch audibly when the capacity is adjusted. Check in operating mode &quot;1 (manual + manual)&quot;.</td>
</tr>
<tr>
<td>Number of operating hours</td>
<td></td>
<td>X</td>
<td></td>
<td>Cf. maintenance schedule for necessary maintenance/servicing work.</td>
</tr>
<tr>
<td>Oil pump collection sump</td>
<td></td>
<td>X</td>
<td></td>
<td>Empty oil pump collection sump.</td>
</tr>
</tbody>
</table>
### Parameter to be checked

<table>
<thead>
<tr>
<th>Parameter to be checked</th>
<th>Every 24 to 72 hrs</th>
<th>Weekly</th>
<th>Monthly</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil collection sump shaft seal</td>
<td></td>
<td>X</td>
<td></td>
<td>Drain oil collection sump shaft seal.</td>
</tr>
<tr>
<td>Heat exchanger (for chillers only)</td>
<td></td>
<td>X</td>
<td></td>
<td>Visually check for leakages and replace ring gaskets if necessary. See heat exchanger documentation.</td>
</tr>
</tbody>
</table>

### 3.3 Maintenance work

#### Hint!

The documentation for the main components is a part of the product documentation. This contains important information to be considered before beginning the maintenance work.

#### 3.3.1 Changing suction filter

1. Close the pressure side stop valve on the screw compressor package / chiller.
2. Open suction-side stop valve and stop valve - bypassing check valve - suction side - and thus equalise pressure with the low pressure side.
4. Draw off residual overpressure via vent valve of suction filter or vent taking into account the safety regulations.
5. Unscrew housing cover of compressor.
6. Remove suction filter element.
7. Clean suction filter element, wash with suitable grease-dissolving cleaning agent and then blow with compressed air.
8. Replace O-ring on the suction filter element and reinsert the suction filter element.
9. Replace O-ring on the cover, firmly close the cover.
10. Evacuate the screw compressor package/ chiller using a vacuum pump.

#### Warning!

Shut off oil pump!

If evacuation is not possible, vent the screw compressor package/ chiller in the subsequent step using the vent valve mounted on the suction filter. Collect any escaping refrigerant and dispose of in accordance with the legal regulations.

11. Pressurize the screw compressor package/ chiller with a slight overpressure via the stop valve bypass check valve on the pressure side.
12. Then check all components for leakages. On successful completion, perform a complete pressure compensation with the discharge line followed by a repeated leakage test of the screw compressor package/ chiller.

#### Warning!

In addition to the usual cleanliness, work on the suction filter requires special care because the compressor is completely unprotected against coarse dirt particles during this work.

#### 3.3.2 Oil draining, oil filling, oil change

#### 3.3.2.1 Importance of oil change

Aged oil demonstrates an increasing loss of ability to lubricate. Because of this, all rotating components of the compressor are endangered. The filter elements become prematurely clogged and must be cleaned and replaced at shorter intervals.

The oil in the screw compressor package/chiller must be changed:
– when the operating time of the oil charge has reached the technically specified oil change interval,

**Warning!**

**Oil change intervals**

**Oil change with ammonia as the refrigerant after every 5,000 operating hours or after 1 year at the latest.**

**Oil change with freon as the refrigerant after 10,000 operating hours or after 2 years at the latest.**

– if the oil becomes unacceptably contaminated due to a major accident (e.g. water penetration into the refrigerant circuit).

The degree to which oil in refrigeration plants has aged must be checked by analysis and in comparison of the data with those of fresh oil. Oil ageing can also be judged from the darkening of the oil colour and the deposits found in the oil filters. If the degree of ageing cannot be assessed reliably by laboratory analysis and the results of visual examination, it is advisable to change the oil at the following intervals (see maintenance checklist).

The assessment of the condition of the refrigerating machine oil by means of a general visual inspection (contamination) or laboratory analysis must be carried out:

– after 5000 operating hours:
  – or
– at the end of one year's operation
  – or
– after remedying major damage.
  – or
– if the oil is dark coloured or very cloudy.

### 3.3.2.2 Oil change, maintenance work

Take oil samples for analysis and comparison with the fresh oil data at regular intervals. Check the colouration of the oil visually and assess the degree of contamination.

Depending on the results, the user must decide whether to approve the postponement of filling the oil until the next assessment date or whether to have the oil changed.

Inadmissibly damp oil must be removed from the compressor unit/chiller immediately.

### 3.3.2.3 Changing the oil

1. The screw compressor package/chiller must be run for at least half an hour to reach its operating temperature before the oil can be changed.

2. First shut down the screw compressor package/chiller as described in the operating instructions.

3. Open the stop valve in the bypass line around the check valve on the suction side and the stop valve on the suction side to equalise the pressure between the screw compressor package/chiller and suction line. If screw compressor packages operated in parallel or other separate chillers are present, the refrigerant should preferably be drawn off at a pressure which is approx. 1 to 3 bar above atmospheric pressure. Then re-close the stop valves bypass and the suction-side stop valve. Otherwise the pressure can be reduced by opening the vent valve on the suction filter and then disposing of the refrigerant as specified by law.

4. Then drain the used oil through the oil draining/oil charging valves and dispose of it (Caution! hazardous waste!). Once this has been done, re-close the valve and if possible continue to draw off the refrigerant with a compressor connected in parallel or a disposal device until atmospheric pressure is almost reached.

5. Otherwise depressurise the screw compressor package/chiller by opening the vent valve on the suction filter, taking into account the safety rules for refrigeration systems.

6. Open the drain plugs and valves on the oil cooler, oil separator and OMC block to drain any residual oil. Then re-close the drain plugs and valves.

7. Replace the filter element of the oil filter; replace and/or clean the filter element of the suction filter combination.

8. Evacuate the screw compressor package/chiller using a vacuum pump.

**Warning!**

**Shut off the oil pump!**

9. Pressurise the screw compressor package/chiller with a slight overpressure via the stop valve bypass check valve on the pressure side.
10. Then check all components for leakages. On successful completion, perform a complete pressure compensation with the discharge line followed by a repeated leakage test of the screw compressor package/chiller. The oil charge oil and start-up of the screw compressor package/chiller must be accomplished in accordance with the operating instructions.

3.3.3 Replace oil filter
1. Switch the unit/chiller off.
2. If the oil filter is very dirty it may be necessary to replace it outside the normal maintenance schedule.
3. To change the oil filter insert, close the following valves in accordance with the P+I diagram:
   - (300) stop valve - oil filter inlet
   - (305) combined stop/check valve - oil filter outlet
4. Equalise pressure with the atmospheric pressure.
5. Drain oil.
6. Dismantle oil filter cover.
7. Remove the oil filter element and properly dispose of manner if it is highly soiled.
8. Carefully insert a new oil filter element. Do not forget the gasket!
9. Close the oil filter cover.
10. Reopen valves in accordance with item 3.
11. After the pressure has been equalised, vent oil filter via the vent valve.

3.3.4 Coupling maintenance
1. Switch the screw compressor package/chiller off.
2. Secure the electric motor against accidentally being switched on.
3. Visually inspect the disk packs.
4. Check the tightening torques of the fit screws.
5. Check the alignment of the electric motor and correct it according to the steel lamination coupling documentation, if required.

6. Re-grease the coupling (if provided for in the maintenance instructions for the coupling).

3.3.5 Oil pump maintenance
Assuming correct installation in accordance with the conditions of use and correct fitting, gear pumps have the design prerequisites for long and fault-free operation.
The gear pumps require a minimum of maintenance which is, however, indispensable for fault-free operation since experience has shown that a high percentage of the faults and damage which occur are attributable to the ingress of dirt and inadequate maintenance.
The maintenance intervals have been defined in the maintenance checklist (part of the product documentation).
An oil leakage of up to one drop/minute is required for the lubrication of the shaft seal and is permissible.
The shaft seal is maintenance-free. If the oil leakage is too great, replace it according to the oil pump documentation.

**Hint!**
The regular examination of all operating data, such as pressure, temperature, power consumption, degree of filter fouling, etc., helps in the early detection of potential failure!

3.3.6 Check of the tightening torque on the adjusting elements of the fixing base.
The tightening torques vary depending on the strength and size of the screw used. The values for tightening torques are to be taken from the applicable DIN, unless otherwise specified.

**Hint!**
The tightening torques for the adjusting elements should be obtained from the data sheet. The data sheet forms part of the product documentation.
3.3.7 Changing the oil fine separation cartridges

The oil fine separation cartridges generally have a service life of approximately three years. Replacement of oil fine separation cartridges is required if an increased amount of oil is splashed (oil is recharged at unusually short intervals):

**Caution!**
See oil separator documentation!

1. Close the discharge and suction side shut-off fittings.
2. Draw off refrigerant and depressurize the unit/chiller.
3. Check the pressure on the display of the control or connect a test pressure gauge.
4. Remove the screws (24) of the mounting cover (23).
5. Remove the securing wire (7).
7. Take the cartridge (4) and the integrated gasket.
8. Install the new cartridge in the reverse order.

**Warning!**
Locking wire (7) must be re-attached!

![fig.21: Oil separator (figure shows oil separator with diameter 711) for Grasso SP2](image)

3.3.8 Venting the refrigerant circuit

When air penetrates the refrigerant circuit, this makes itself felt in a fall-off in performance and the manometer on the discharge side of the compressor indicates a higher pressure compared to the condensation temperature. Any leaks must be remedied. In extreme cases, air in the circuit may interrupt the flow of refrigerant and cause the oil cooling to fail.

There are several ways of venting the system. The air or the NH₃-air mixture is vented via the vent valves of the condenser or the suction filter in water filled vessels when the package is at a standstill. If air is in the mixture, the venting ammonia is absorbed from water.

**Hint!**
Continuous venting using a Grasso purger is recommended.
3.3.9 Finding and fixing leakages

Lower refrigerant levels in the containers are due to loss of refrigerant as a result of leaks. For this reason, all pipes, connections and valve glands should be checked regularly, especially in the initial period after assembly, with a suitable indicator (litmus paper, etc.).

Leakages are revealed by a change of colour and must be sealed immediately.

The supplier is not liable for losses of refrigerant caused by a lack of or improper maintenance!

3.3.10 Charging and topping up with refrigerant

3.3.10.1 Charging refrigerant

Liquid filling is carried out:

– after the leak tightness test and evacuation of the compressor unit/chiller

or

– for recharging.

The refrigerant is introduced in liquid form via the system's refrigerant draw-in valve. The vessel containing the refrigerant should be fixed to the charging valve by means of the charging line. Ensure that the filling hose does not contain any air (e.g. by including the line in the evacuation process). The refrigerant is drawn in after slowly opening the refrigerant draw-in valve and the cylinder valve.

Once the circuit has been charged, the cylinder and refrigerant draw-in valves should be closed tight. The refrigerant charging line and the refrigerant cylinder must be removed. The system is now in normal operation.

If the refrigerant level has subsided (loss of refrigerant blown off by safety valves or leaked out during repairs), the refrigerant must be topped up with the system running. This should only be done if the system is in operation and free from leakages.

3.3.10.2 Draining the refrigerant

Caution!
Refrigerant may escape.
Protective clothing must be worn (eye protection and protective gloves).

The refrigerant must be drained:

– if the plant is overfilled,

– if the refrigerant or oil circuit is dismantled and repaired,

– for maintenance work on the oil circuit,

– if foreign gases are detected in the plant.

The liquid refrigerant can be filled into refrigerant cylinders in liquid form, or suctioned off as refrigerant vapour using an extraction device.

The cylinders into which the refrigerant is filled should be evacuated and cooled in advance. A sufficient number of cleaned, dry and sub-cooled cylinders must be made available ready for use before starting to drain the refrigerant. The weight of the empty refrigerant cylinder must be determined.

The filling line is threaded together with the refrigerant draw-in valve and the other end fixed firmly to the closed refrigerant cylinder. The charging valve is opened slowly. The valve on the refrigerant cylinder is then also opened slowly. Due to the hazards involved, you should take care to avoid spilling any refrigerant.

The refrigerant is weighed with a scale, remembering that the cylinder should only be filled to 80% of the capacity. If this percentage is not reached and there is still refrigerant in the system, the pressure in the cylinder can be reduced by venting the cylinder. When the cylinder is filled to 80%, the refrigerant draw-in valve and the cylinder valve are closed and the next cylinder is connected. Repeat this procedure until all of the refrigerant is bottled. Only one cylinder must be filled at a time.

The quantity of refrigerant filled must be documented in an appropriate log. When the refrigerant has been filled into cylinders, the charging valve should be closed.

The remnants of refrigerant are suctioned out of the system until it is completely drained. The pressure must no longer increase after the compressor has been turned off.

Connections for draining refrigerant

Draining the refrigerant circuit or parts of the circuit can be carried out via the service valves provided (see P+I diagram).

3.4 Steps to be followed before starting the system after major repairs
3.4.1 Repair information

Important features of the technology and production process must be taken into account when repairing the plant:

- complete sealing of all devices and pipes.
- Dryness and cleanliness of the entire plant.
- Use of welding methods causing only a minimum amount of dirt to collect in the plant.
- Pipes bent on a pipe-bending machine only using refrigerating oil.
- If repairing the piping system from your own stocks, we recommend that you use a pipe with NBK surface quality (annealed and descaled, mechanically or chemically descaled after annealing).
- When carrying out repairs to piping systems, care should be taken to maintain the original piping routes.
- Only pipes of sufficient material quality, which are certified according to DIN 10216-2 should be used.

3.4.2 Pressure test, tightness test

The necessary safety precautions should be taken before performing the pressure test. The pressure test is performed with dried, oil-free air, or with dry nitrogen.

To test the parts which have been repaired for tightness, they are subjected to a pressure of any above atmospheric pressure (but not higher than the allowed operation pressure of the unit/ chiller) using dry air or nitrogen for a period of 3 hours. It is permissible for the pressure to fall by 2% during the 3 hours. Consideration must be given to variations in the ambient temperature.

**Warning!**

Checking devices which can be damaged at the test pressure indicated must be removed or blocked before the pressure test is performed.

A record should be kept of the pressure test, noting the pressure in the pipes tested, the ambient temperature and the temperature outside in the shade at hourly intervals.

The removed measuring and control instruments should be reinstalled after completion of the pressure test.

3.4.3 Vacuum Test

After the pressure test has been completed, the system is evacuated and subjected to a vacuum test for 3 hours. Evacuation is used to remove air and moisture from the refrigerant circuit (see operating instructions).

3.5 Repair work

Modifications and repair work may only be carried out by qualified persons or persons with suitable training with the manufacturer's consent and must strictly comply with the rules set out in the maintenance instruction for the components concerned. Particular attention is to be paid to the aforementioned maintenance instruction.

**Danger!**

Before carrying out any maintenance or repair work the personal protective clothing must be checked.

Only use original manufacturer replacement or spare parts for repairs and to replace parts subject to wear and tear. They are available from the customer service department of GEA Refrigeration Germany GmbH at the following address:

**GEA Refrigeration Germany GmbH**
Holzhauser Straße 165
D - 13509 Berlin
Phone: +40 (0) 30 435 92 766
Phone: +40 (0) 30 435 92 759

Please remember to carry out the following steps before restarting the system following repair or maintenance:

- Check the charge of the package/chiller with service media (refrigerant, refrigerating machine oil, secondary refrigerant) and set specified fill levels (sight glasses, level indicators). Charge using the built-in charging lines and record the charge volumes in the machine's log book.
- Set all fittings according to the operating manual.
- All major technical parameters should be checked after the package/chiller is switched on until it reaches a stable operating condition.
Non-permissible operating conditions result in the shutdown of the refrigerating system or part thereof by the automatic safety system. If this happens, the causes of the shutdown must be determined and rectified.

The safety devices should be checked at least once a year and the switching values confirmed.

3.6 Instructions regarding failures, their causes and remedies

The screw compressor packages/chillers manufactured by GEA Refrigeration Germany GmbH are highly advanced, automatic and extremely efficient systems. Nevertheless, faults can occur and may complicate any continuous operation of the plant or cause a failure of a part or the entire plant.

<table>
<thead>
<tr>
<th>Table of malfunctions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fault</td>
</tr>
<tr>
<td>The suction pressure is too low, performance is reduced and the system overheats.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>The suction pressure increases, the compressor(s) frost up to impermissibly high level or make noises that suggests fluid (refrigerant) in the compressor.</td>
</tr>
<tr>
<td>The condensation pressure is too high.</td>
</tr>
<tr>
<td>The compressor(s) will not start-up after switching on or it shuts down immediately after starting again.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>The compressors do not adapt to the required capacity.</td>
</tr>
<tr>
<td>The compressors are shut off very often by the maximum pressure governor.</td>
</tr>
<tr>
<td>Fault</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>The maximum pressure governor is defective or set wrongly.</td>
</tr>
<tr>
<td>The compressors are shut off very often by the minimum pressure governor.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>When operating, the package/chiller is louder than permitted.</td>
</tr>
</tbody>
</table>
We live our values.
Excellence • Passion • Integrity • Responsibility • GEA-versity

GEA Group is a global engineering company with multi-billion euro sales and operations in more than 50 countries. Founded in 1881, the company is one of the largest providers of innovative equipment and process technology. GEA Group is listed in the STOXX® Europe 600 Index.