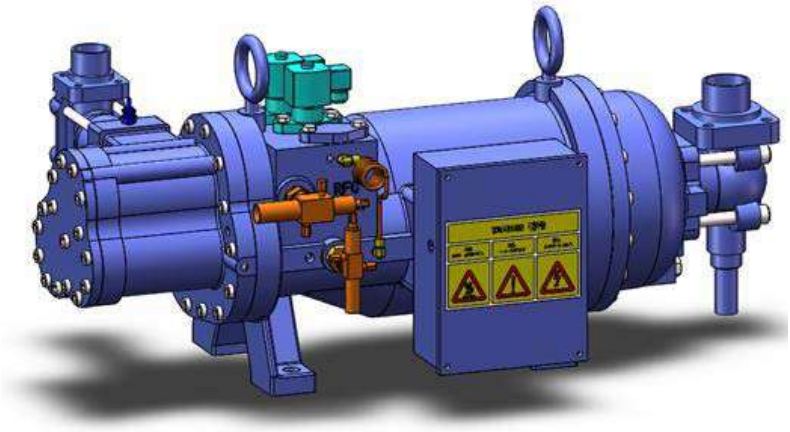
R F C

# SL series screw refrigeration compressor

# technical manual



Zhejiang Daming Refrigeration Technology Co., Ltd.

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## 1. Summary

### 1. 1 Product introduction:

SLG&SLD series products are low-temperature special screw refrigeration compressors carefully developed by RFC in recent years to integrate low-temperature refrigeration market applications and customer needs, and learn from the experience of domestic and foreign counterparts. The product is designed with excellent performance, simple structure and convenient use. It focuses on the application needs of the low temperature market and is widely used in agriculture, fishing, meat, food industry, process cooling, freeze drying and other industries.

There are 32 models of SLG&SLD semi-hermetic screw compressors. SL series compressors from 30HP to 300HP (displacement volume at 50Hz: 102, 128, 145, 158, 188, 205, 235, 248, 293, 354, 416, 520, 641, 812, 908, 1006m³ /h), each type of compressor has two different built-in volume ratios, which are suitable for occasions with low evaporating temperature and medium and high evaporating temperature respectively. Therefore, the user can choose the ideal compressor according to the actual application, so as to obtain the best compression efficiency.

SL series compressors all use external oil separators. The use of external oil separators can provide greater flexibility in design and structural arrangement. In the parallel combination system of multiple compressors (from 2 to 6 units) ) can only use a common oil separator. In addition, the use of oil cooling has broadened the compressor application limits so that it can operate under harsh operating conditions.

A complete set of accessories required for the oil return line (from the oil separator to the compressor) is available as standard. In addition all matching oil separators and oil coolers are also available.

Due to the minimal vibration and no exhaust pulsation, the use of shock absorbers and flexible nozzles is not necessary. Plus, the lower noise concentrated in the mid-to-high frequencies is very easy to isolate.

The characteristics of SL series compressors are: the oil-injected twin-screw design is adopted, the male rotor is directly connected to the motor (2 poles, about 2960 rpm), and the perfect rotational motion makes it run extremely smoothly. The rotor profile is asymmetrically designed (the number of teeth of the male rotor is 5, and the number of teeth of the female rotor is 6). .

Oil pressure driven spool valve cooling capacity control enables the compressor to have high compression efficiency under partial load, making SL series compressors especially suitable for those occasions that need to work under partial load for a long time.

The cycle efficiency (COP) can be further achieved by using an economizer (ECO) cycle that increases the refrigerant liquid subcooling

### 1.2 model nomenclature

S **Semi-hermetic**

L **Refrigeration**

D **D: low temperature G: high temperature**

210 **Displacement (m3/h)**

60 **Motor nominal power (HP)**

Y **Step adjustment (Step Control)**

D **Single stage compression (single stage)**

1 **Version**

**Refrigeration** **Displacement (m3/h)**

S L D 210 -60 Y D 1

**Semi-hermetic** **low temperature** **Motor nominal power (HP)**

Compressor rated power: 380V-3-50HZ, if customers need other special voltage and frequency, please contact RFC.

### 1.3 Product Series

SL series compressor displacement specification table

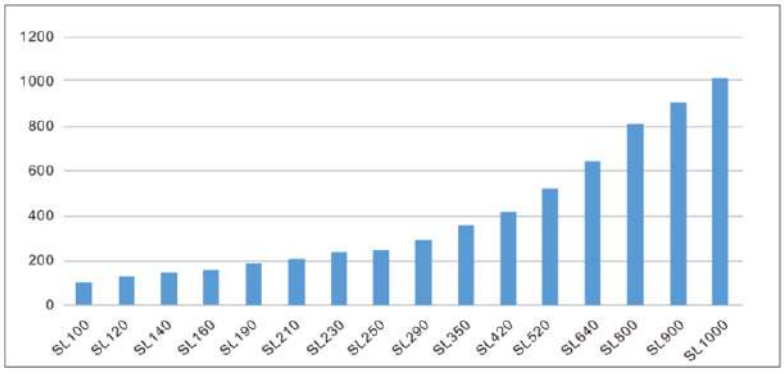



Figure 1-A SL series compressor displacement specification table

## 1.4 Introduction

The rotors are located in a horizontally arranged compression chamber with a suction port (on the motor side) and a discharge port, with extremely small gaps between the rotors and between the rotors and the housing by means of direct injection onto the rotor profile. The oil film formed by the lubricating oil performs dynamic sealing. The formation of the compression process is that the motor drives the rotor to rotate, causing the volume to gradually decrease; the multiple compression chambers formed between the rotor and the casing due to the rotation of the rotor move along the axial direction of the rotor while the volume gradually decreases. Small.

The basic process of compression can be divided into three stages: suction, compression and exhaust

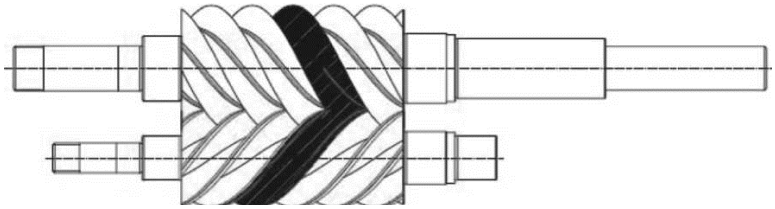


Figure 1-B Compression principle of screw compressor

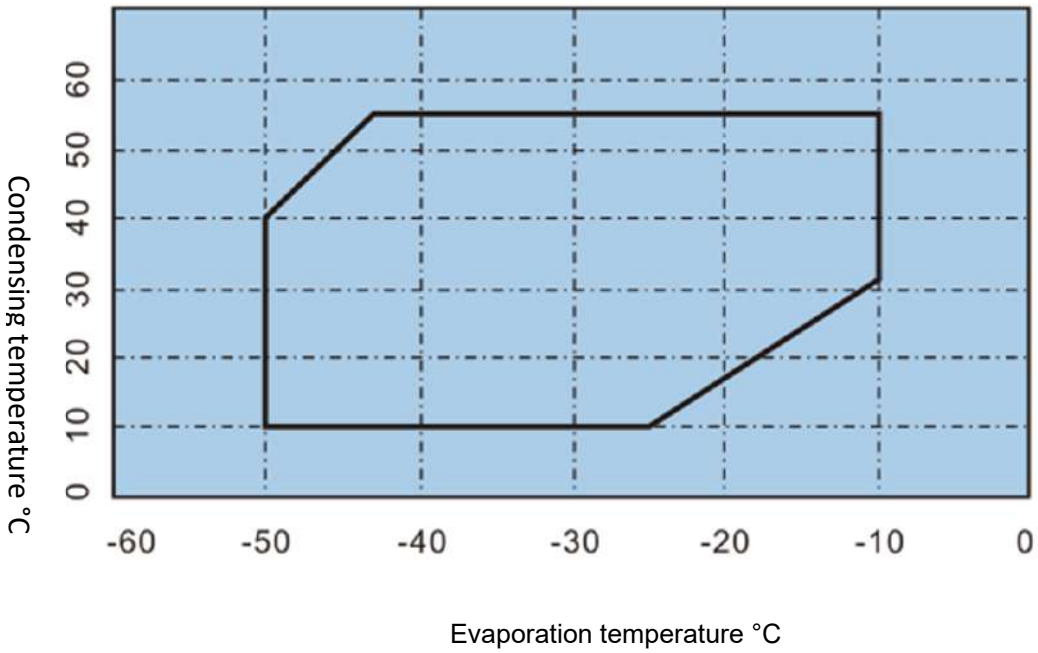
**1.5 design specification**

| model | Exhaust volume 50Hz | Motor nominal power | Weight | exhaust pipe diameter | Suction pipe diameter | ability adjustment | protection module | Standard Motor | star/delta starting current | Maximum operating current |
|---|---|---|---|---|---|---|---|---|---|---|
| | m'/h | Hp/Kw | Kg | mm | mm | | | | A | A |
| SLD100-25 | 102 | 30/22 | 245 | 45 | 57 | 50% , 70% , 100 **adjust** | INT 69 | 380V/3/ 50Hz- 460V/ 3/60HZ | 131 | 42 |
| SLG100-35 | | 40/30 | 255 | | | | | | 134 | 56 |
| SLD120-30 | 128 | 30/22 | 245 | | | | | | 131 | 42 |
| SLG120-40 | | 40/30 | 255 | | | | | | 134 | 56 |
| SLD140-40 | 145 | 40/30 | 255 | | | | | | 134 | 63 |
| SLG140-50 | | 50/37 | 275 | | | | | | 139 | 78 |
| SLD160-50 | 158 | 50/37 | 260 | | | | | | 179 | 75 |
| SLG160-60 | | 60/45 | 280 | | | | | | 182 | 85 |
| SLD190-50 | 188 | 60/45 | 405 | 57 | 76 | | | | 182 | 90 |
| SLG190-65 | | 70/52 | 430 | | | | | | 193 | 104 |
| SLD210-60 | 205 | 60/45 | 410 | | | | | | 182 | 95 |
| SLG210-70 | | 70/52 | 440 | | | | | | 195 | 108 |
| SLD230-70 | 235 | 70/52 | 420 | | | | | | 193 | 112 |
| SLG230-80 | | 80/60 | 450 | | | | | | 298 | 126 |
| SLD250-75 | 248 | 75/57 | 430 | | | | | | 230 | 118 |
| SLG250-90 | | 90/68 | 460 | | | | | | 318 | 144 |
| SLD290-80 | 293 | 80/60 | 535 | 67 | 89 | | | | 298 | 126 |
| SLG290-100 | | 100/75 | 570 | | | | | | 338 | 158 |
| SLD350-100 | 354 | 100/75 | 545 | | | | | | 338 | 157 |
| SLG350-120 | | 120/89 | 590 | | | | | | 366 | 187 |
| SLD420-125 | 416 | 120/89 | 670 | 76 | 89 | | | | 416 | 187 |
| SLG420-150 | | 145/108 | 690 | | | | | | 453 | 228 |
| SLD520-160 | 520 | 160/120 | 1030 | 89 | 108 | 25% , 50% , 75%, | | | 543 | 251 |
| SLG520-180 | | 180/135 | 1060 | | | | | | 595 | 284 |
| SLD640-200 | 641 | 200/143 | 1050 | | | | | | 678 | 301 |
| SLG640-220 | | 210/157 | 1090 | | | | | | 767 | 331 |

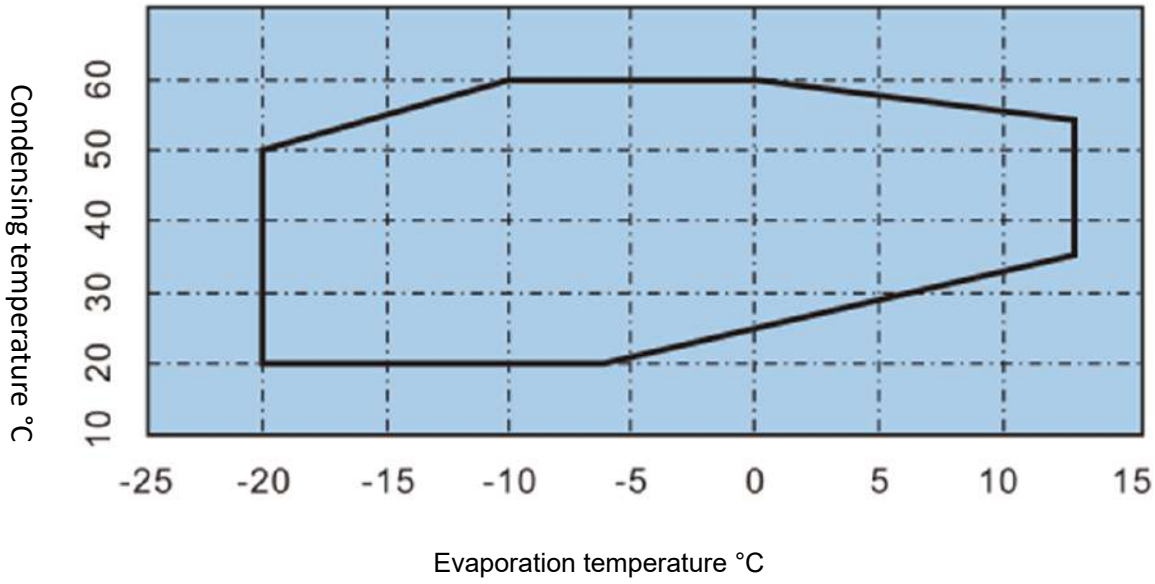
Note: Please confirm the rated current of the compressor under the design conditions according to the RFC selection procedure, and confirm the maximum operating current value according to the limit conditions to select the contactor, power cord and fuse protection components。

### 1. 6 Operating Range Chart

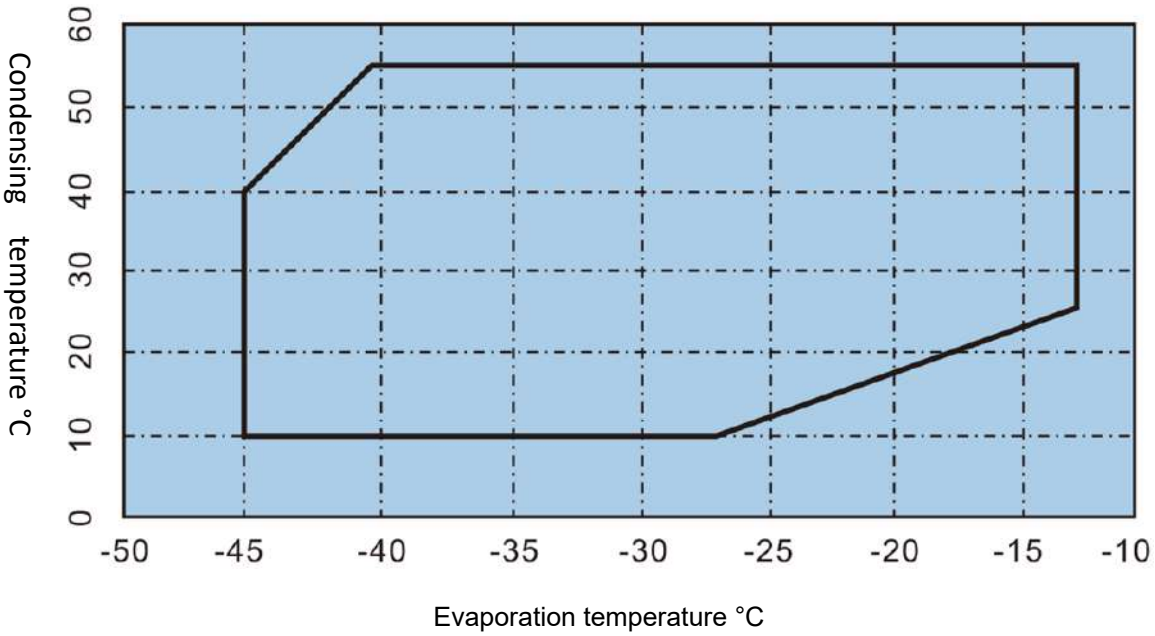
SLD series R22



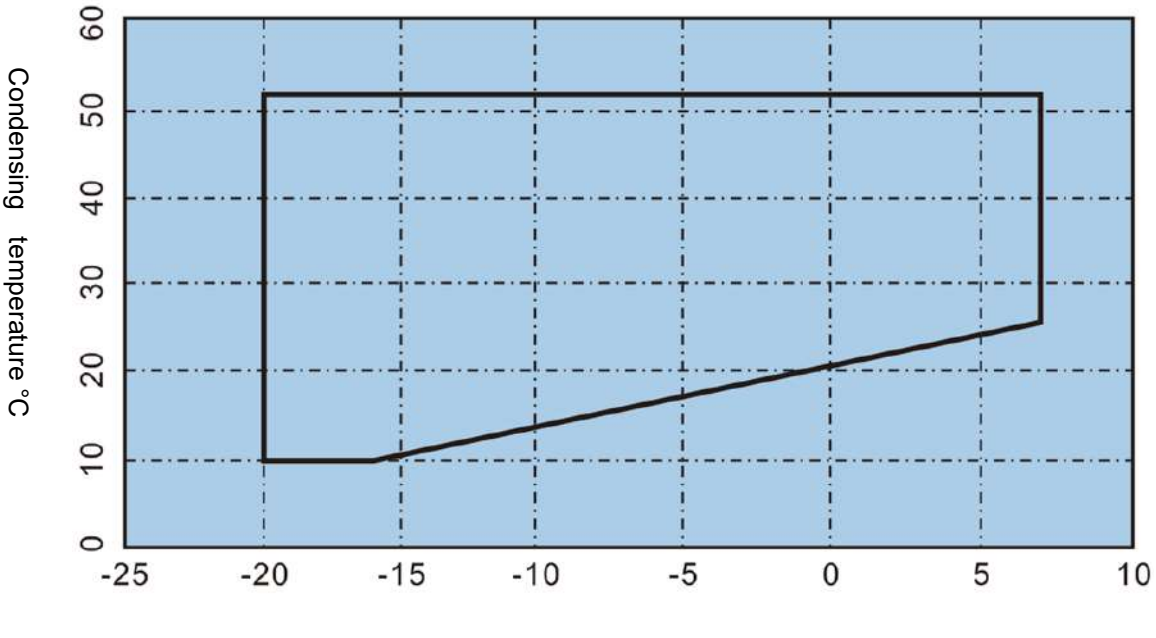

SLG series R22



SLD series R404A/R507




SLD series R404A/R507



## 2. Refrigerated oil management

### 2.1 The role of refrigeration oil in compressors

In SL series compressors, refrigeration oil has the following functions:

a. An oil film is formed between adjacent compression cavities and between the compression cavities and the shell to reduce the leakage of refrigerant gas during the compression process and improve the compressor efficiency.

b. An oil film is formed in the bearing to ensure the normal operation of the bearing.

c. Absorb and take away the compression heat generated by the refrigerant gas during the compression process and the friction heat generated by the bearing during the mechanical movement, so as to reduce the compressor discharge temperature.

d. Control of cooling capacity regulating slide valve.

### 2.2 SL compressor specified refrigeration oil

| The refrigerant | R22 | R404A/R507 |
|---|---|---|
| Refrigeration Oils ( Refrigeration Lubricant) | 6100 (AB100) | 6170 (POE170) |
| Density | 0.868 | 0.98 |
| Flash Point | 196 | 170 |

Table 2-1 Technical parameters of refrigeration oil ( Refrigeration Lubricant)

**Note:**

**1) RFC only recognizes specified refrigeration oil;**

**2) The minimum starting oil temperature of the compressor is 30□;**

**3) 6100 ( this item No is from company's order system), equals to AB100 refrigeration oil ( Refrigeration Lubricant);**

**4) 6170 ( this item No is from company's order system), equals to POE170 refrigeration oil ( Refrigeration Lubricant);**

**5) The detailed parameters of refrigeration oil ( Refrigeration Lubricant) on the Table 2-1 will vary with different brands of refrigerants and lubricants**

**2.3 Refrigerant oil replacement requirements**

When filling the compressor with refrigeration oil, ensure that the system is clean. After the system runs for 2000 hours for the first time, it is recommended to replace the refrigeration oil again to ensure the long-term normal operation of the compressor.

Lubricating oil can easily absorb moisture in the air, so long-term exposure of lubricating oil to the air should be avoided;

To ensure that the water content in the system is kept to a minimum, it is recommended that the system be heated and evacuated for as long as possible after the system is replaced with new oil;

Lubricating oil pollution will cause oil circuit blockage, so the external oil circuit system must be installed with an oil filter, and a differential pressure switch must be installed before and after the filter. When the differential pressure reaches the set value (1.5Bar), the oil filter must be replaced;

The compressor runs at a high discharge temperature (95~110□) for a long time, which is easy to accelerate the deterioration rate of the lubricating oil. Please check the performance of the lubricating oil regularly and shorten the oil change interval appropriately;

The acidification of the lubricating oil will directly affect the life of the motor. When the PH of the lubricating oil is less than 6, it is recommended to replace the oil and accessories such as the filter drier. If the compressor motor burns, it will produce acidic harmful substances and burnt debris, which will be brought into the system together. During processing, the oil filter element and lubricating oil must be replaced several times until the cleanliness and acidity of the oil circuit meet the requirements.

**warn:**

**If it is found that the customer does not use the lubricating oil specified by RFC,**

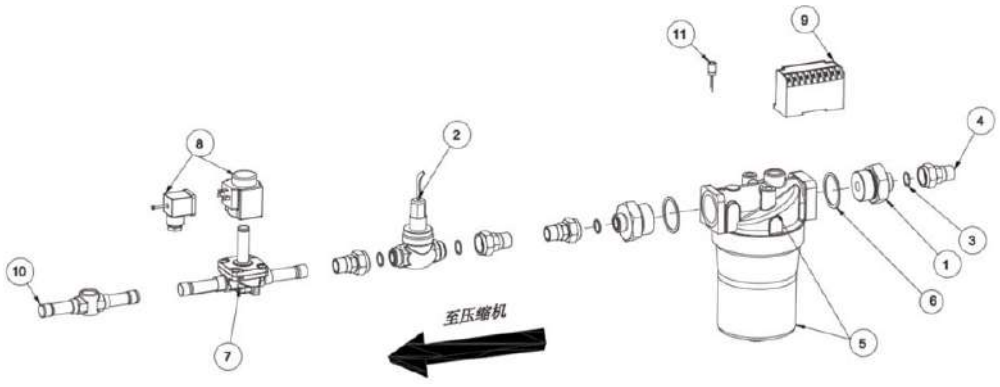
**2. 4 External oil circuit system**

The SL compressor needs to be equipped with an oil cooler, and the heat exchange of the oil cooler is obtained according to the RFC selection procedure. RFC requires that the design pressure drop of the external oil circuit system pipeline is not more than 1bar, so as not to affect the normal lubrication of the compressor.

The external oil circuit components are as follows:

| serial number | Part Number | describe | quantity |
|---|---|---|---|
| 1 | 5119892 | Adapter | 2 |
| 2 | 6180345 | Oil flow switch FYL-08 | 1 |
| 3 | 6191090 | Teflon gasket | 4 |
| 4 | 6114474 | Active joint 1"-14UNS welding end D=16 | 4 |
| 5 | 7100357 | Oil Filter FOF-5/8" | 1 |
| 6 | 6120210 | Aluminum spacer OD.50xID.42x1.5 | 2 |
| 7 | 6180335 | Solenoid valve 032F1228 | 1 |
| 8 | 5103330 | Solenoid valve coil 230V50/60HZ | 1 |
| 9 | 5181250 | Motor protection module INT69VS 230V | 1 |
| 10 | 6140635 | Oil sight glass 5/8" | 1 |
| 11 | 6180334 | capacitance | 1 |

External oil circuit diagram



## 3. Start, stop and cooling capacity control

### 3.1 Cooling capacity control

3.1.1 SL100~420 compressors adopt three-stage energy regulation, the minimum load is 50%, and its control solenoid valve logic is as follows:

| compressor load | 50% solenoid valve | 75% solenoid valve |
|---|---|---|
| Minimum load (start) | power ups | power outage |
| 70% load | power outage | power ups |
| 100% load | power outage | power outage |

Table 2-2

**3.1.2** SL520~640 compressors use four-stage energy regulation, the minimum load is 25%, and the minimum load is only used for startup. The logic of its control solenoid valve is as follows:

| compressor load | 25% solenoid valve | 50% solenoid valve | 75% solenoid valve |
|---|---|---|---|
| Minimum load (start) | power ups | power outage | power outage |
| 50% load | power outage | power ups | power outage |
| 75% load | power outage | power outage | power ups |
| 100% load | power outage | power outage | power outage |

**Notice：**

1) Careful and extensive testing is strongly recommended for less than 50% load conditions. Continuous operation below 50% load should be avoided unless adequate measures are taken to prevent:

Poor oil return due to low return air flow rate.

Excessive exhaust temperature due to poor motor cooling and reduced efficiency (especially at high pressure ratios)

Motor overheating due to low power factor at low loads (especially when supply voltage exceeds rated voltage)

2) Since the cooling of the motor may not be guaranteed at the 25% minimum cooling capacity level, the minimum cooling capacity level can only be used for the start and stop phases of the compressor.

**Suggest：**

To avoid overheating of the motor, the operating time below 50% of the cooling capacity should not exceed 5 minutes.

Do not drop the compressor directly from full load to minimum load. If unloading is necessary, the compressor should run for at least 3 minutes at 50% load regulation. When the compressor load is suddenly reduced to the minimum cooling capacity, a large amount of refrigerant may return to the compressor, causing liquid slam; if the energy regulation of the compressor is out of sync with the actual load change, please check and set the control parameters again.

**3.2 Efficiency at Partial Load and Considerations：**

In order for the compressor to have high efficiency at part load, the size and shape of the axial and radial discharge ports have been optimized in the design.

When the compressor works at part load, the discharge temperature will rise (mandatory measures should be taken to control the discharge temperature within the specified range), and its efficiency is slightly lower than that at full load.

The exhaust temperature will rise rapidly if:

Condensing pressure rises;

evaporative pressure drop;

Suction superheat rises.

**3.3 Compressor start and stop**

It is recommended that the compressor run at the minimum load cooling capacity level for at least approximately 25 seconds during startup and shutdown.

The sequence of starting and stopping is shown in Figure 3-1, which is suitable for all stage-adjusted screw compressors; meanwhile, noise caused by temporary reversal caused by the backflow of a large amount of refrigerant during shutdown can be avoided.

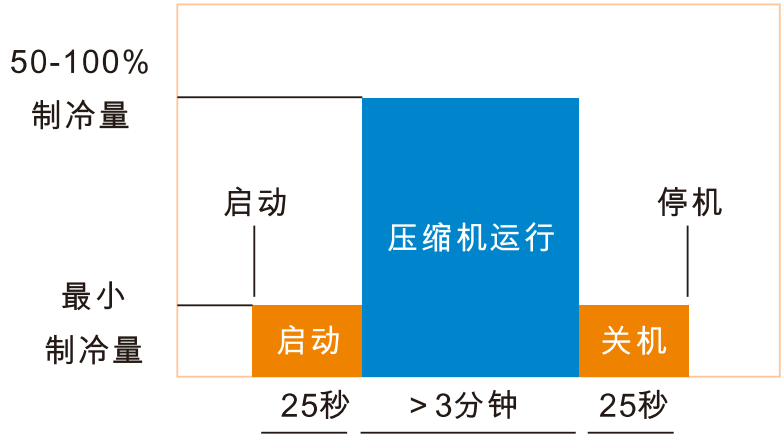



Figure 3-1 Control requirements for compressor startup and shutdown

Requirement：

In order to ensure that the compressor starts with the minimum load and consider the safety of the compressor, the compressor should control the start and stop of the compressor according to the requirements of the above figure 3-1

## 4. Electrical articles

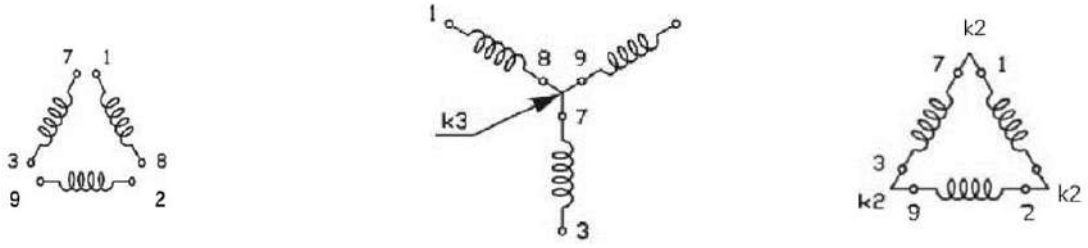
### 4.1 motor

4.1.1 Overview

In order to reduce the starting current, the SL compressor motor adopts the star-delta starting method.

The standard motor of SL series compressors is a 3-phase asynchronous 2-stage Y/△ winding type (rotation speed is 2950r/min at 50Hz), and the applicable voltage is 380V/3/50HZ or 460V/3/60HZ. If you need other special electrical system, please contact RFC.

The operating current and input electric power under different working conditions can be calculated by the Lefkang selection software. The main electrical parameters such as star




Y/△ structure Star structure Triangular structure

Figure 4-1 Internal structure of Y/motor

In order to reduce the resistance torque at start-up to avoid overloading the motor at start-up, the compressor should start at minimum load.

In Figures 4-2 and 4-3, the three-phase electrical wiring diagram of the Y/△ motor and the time sequence diagram of the contactor closing are given. The compressor should be set as follows during the startup process:

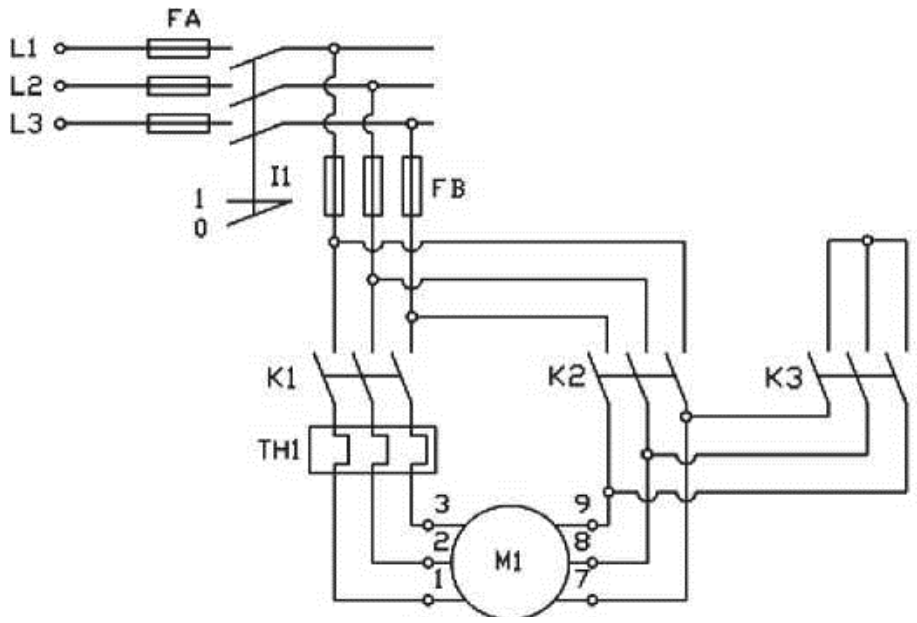



Figure 4-2 Three-phase electrical wiring diagram of Y/△ motor

*For star-delta motors, the start-up time of star (closing contactors K1 and K3) should not exceed 1.5 seconds (0.8~1 second recommended); on the other hand, when switching to delta operation (closing contactors K1 and K2) ), when the K3 contactor is disconnected, the K2 contactor must be closed within a delay of 35~50 milliseconds:

*For partial winding motors, within 1 second of closing the start contactor K1 (0.6 seconds recommended), then close the running contactor K2

**4.2 protective device**

4.2.1 Motor thermistor

There are 6 PTC thermistors linked in series buried in the motor windings to prevent the motor from burning out due to high temperature. The three thermistors are set at the suction end of the motor, and the cut-off temperature is 100°C, and the other three are set at the other end of the motor, and the cut-off temperature is 120°C.

The cold resistance value of the thermistor chain (below 40°C) must be less than 1800Ω: if any one of the thermistors reaches the critical temperature, the resistance value of the resistance chain increases exponentially, and the electronic protection module SE-E will action, cut off the power supply. The resistance value can be measured between the T1 and T2 terminals located on the terminal block.

**Note: When measuring the resistance of the thermistor, the measurement voltage should not be higher than 3V.**

4.2.2 protection module

The protection module INT 69 is supplied as a standard accessory with the following

functions:

1) Monitor motor and exhaust temperature;

2) Monitor the rotation direction of the motor;

3) Monitor the power supply for phase loss;

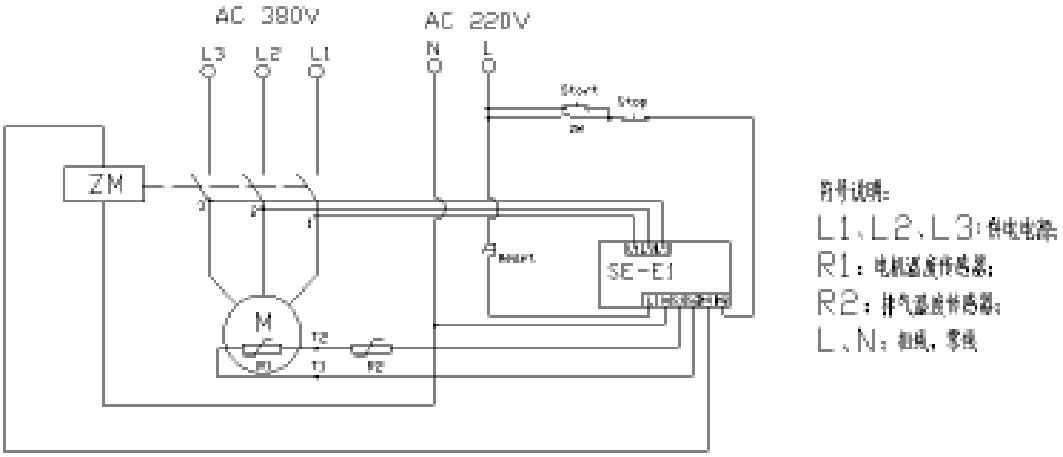



Figure 4-3 Protection module wiring diagram

4.2.2.1 temperature monitoring

Motor temperature and exhaust gas temperature are monitored by PTC sensors. The exhaust gas temperature sensor is installed near the exhaust shut-off valve. This sensor is connected in series with the motor thermistor. The reset of the controls is automatically reset after an alarm and requires a power disconnection of at least 2 seconds.

Note: Before restarting the compressor after an alarm, the operator must carefully check the motor and discharge temperature, and confirm that the PTC resistor chain resistance value is less than 3KQ.

4.2.2.2 Phase loss monitoring

The phase loss signal is monitored not only when the compressor is started, but during the entire operation of the compressor. If a phase loss is detected, the power supply to the compressor will be cut off within 1.5 seconds. Then every 5 minutes, the compressor will automatically restart. However, if there are 3 consecutive phase loss within 30 minutes or 10 consecutive phase loss within 24 hours, the electronic protection module will be locked and can only be reset manually and needs to be disconnected from the power supply for at least 2 seconds.

Normally, the INT 69 module is installed in the junction box of the compressor. However, in the following cases, the module can also be installed in the main control box away from the compressor, but the following points should be noted:

1) The connecting cables to the motor terminals should be carefully checked and connected in the specified phase sequence:

L1 is connected to terminal 1; L2 is connected to terminal 2; L3 is connected to terminal 3; the motor rotation direction is monitored with a phase monitor.

2) The connection between INT 69 module and PTC sensor should use shielded cable or paired stranded wire alone to prevent magnetic field induction.

3) Add an additional 4A fast blow fuse between the protection module "L1/L2/L3" terminal and the motor terminal 1/2/3.

4.2.3 Oil flow switch

The oil flow switch is installed in the oil circulation circuit between the oil separator and the compressor, and is used to timely monitor whether the lubricating oil circulation is normal.

**4.3 Power supply**

Power Requirements:

Standard motor power supply: 380V-3-50Hz/460V-3-60Hz (other power supplies can be customized according to customer requirements);

Allowable voltage range: within ±10% of the rated voltage for instantaneous operation;

Long-term operation within ±5% of rated voltage;

Allowable voltage unbalance between L1-L2-L3: ±2%;

Maximum voltage drop during startup: 10% of rated voltage;

Allowable frequency range: rated frequency ±2%;

Allowable current unbalance: <5% (R-S-TH phase unbalance current)

<12%(unbalanced current between six terminals 1-2-3-7-8-9)

Current unbalance calculation:

Proceed as follows:

First contactor current I1-I2-I3

Second contactor current I7-I8-I9

Each phase supply current:

IR=I1+I7

IS=I2+I8

IT=I3+I9

R-S-T three-phase unbalanced current:

IW=(IR+Is+IT)/3

SB%=Max((IR, Is, IT)-IM)/IM ×100%

SB%<5%

1-2-3-7-8-9 Unbalanced current among six terminals:

IM=(I1+ I2+ I3+ I7+ I8+ I9)/6

SB%=Max((I1, I2, I3, I7, I8, I9)-IM)/IM ×100%

SB%<12%

**4. 4 Electrical accessories selection**

he size of cables, fuses and contactors should be selected according to the maximum working current (FLA) of the motor under normal operating conditions.

When using a star-delta winding motor, the size of the delta and main contactors must be at least 75% of the maximum operating current (FLA), and the size of the star contactor must be at least 40% of the maximum operating current (FLA).

**5. Main accessories and accessories**

**5.1 Suction filter**

The compressor is equipped with a suction filter, which can be inspected and cleaned after disassembling the suction shut-off valve (or suction side end cover) (Figure 5-A) one-way valve

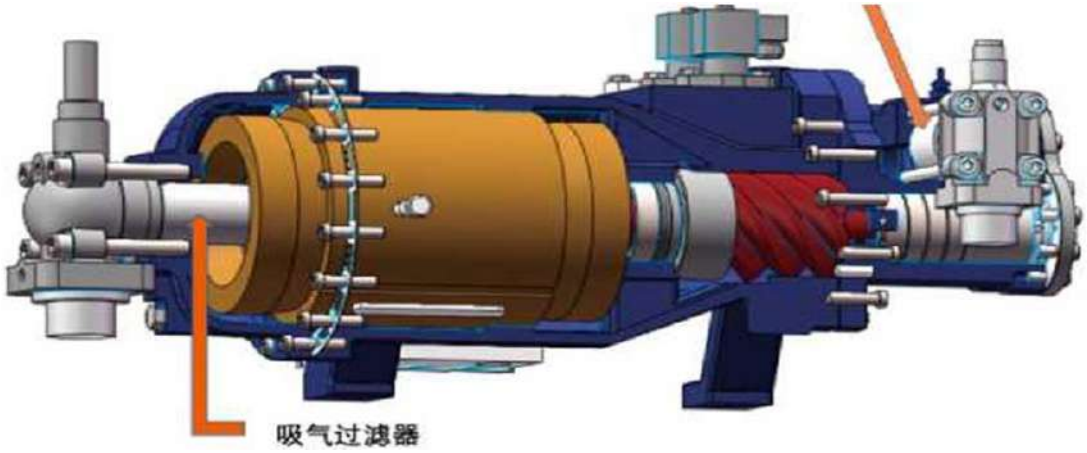



Figure 5-A Suction Filter and Check Valve Location

Figure 5-B Suction filter

Figure 5-C Check valve

**5. 2 one-way valve**

When the compressor is stopped, since the refrigerant gas will return from the condenser to the compressor, the rotor will rotate in the opposite direction to balance the pressure; for this reason, the general standard configuration of the compressor is equipped with a one-way valve valve (Figure 5-A, Figure 5-C) to prevent rapid backflow of excess high pressure gas.

**Note: When the compressor stops, a sound will be heard. This sound is unique to the rotor reversal. The sound duration should not exceed 3S. Otherwise, check whether the check valve needs to be replaced.**

**5. 3 Rubber shock pad**

The installation method of the rubber shock absorber is shown in Figure 5-D.

The deformation of the rubber shock pad after the self-locking bolt is tightened is about 0.5mm lower than that in the relaxed state.

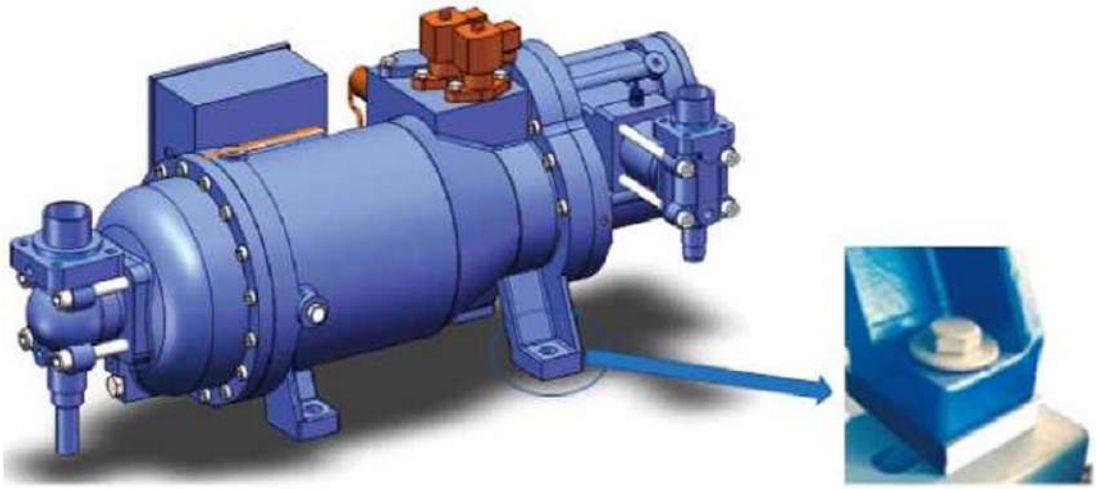


Figure 5-D Rubber shock pad installation

### 5.4 Accessories in the oil circulation circuit

SL series compressors provide oil circuit accessories, including oil filter (Figure 5-E), oil flow switch (Figure 5-F), oil circuit solenoid valve (Figure 5-G), sight glass (Figure 5-G) -H), oil connection head, etc.

SL100~230 compressors provide 16mm pipe diameter oil path accessories diagram (see Figure 5-J);

SL250~640 compressors provide 22mm pipe diameter oil path accessories diagram (see Figure 5-K).

Figure 5-E Oil Filter

Figure 5-F Oil Flow Switch

Figure 5-G Oil circuit solenoid valve

Figure 5-H Oil sight glass

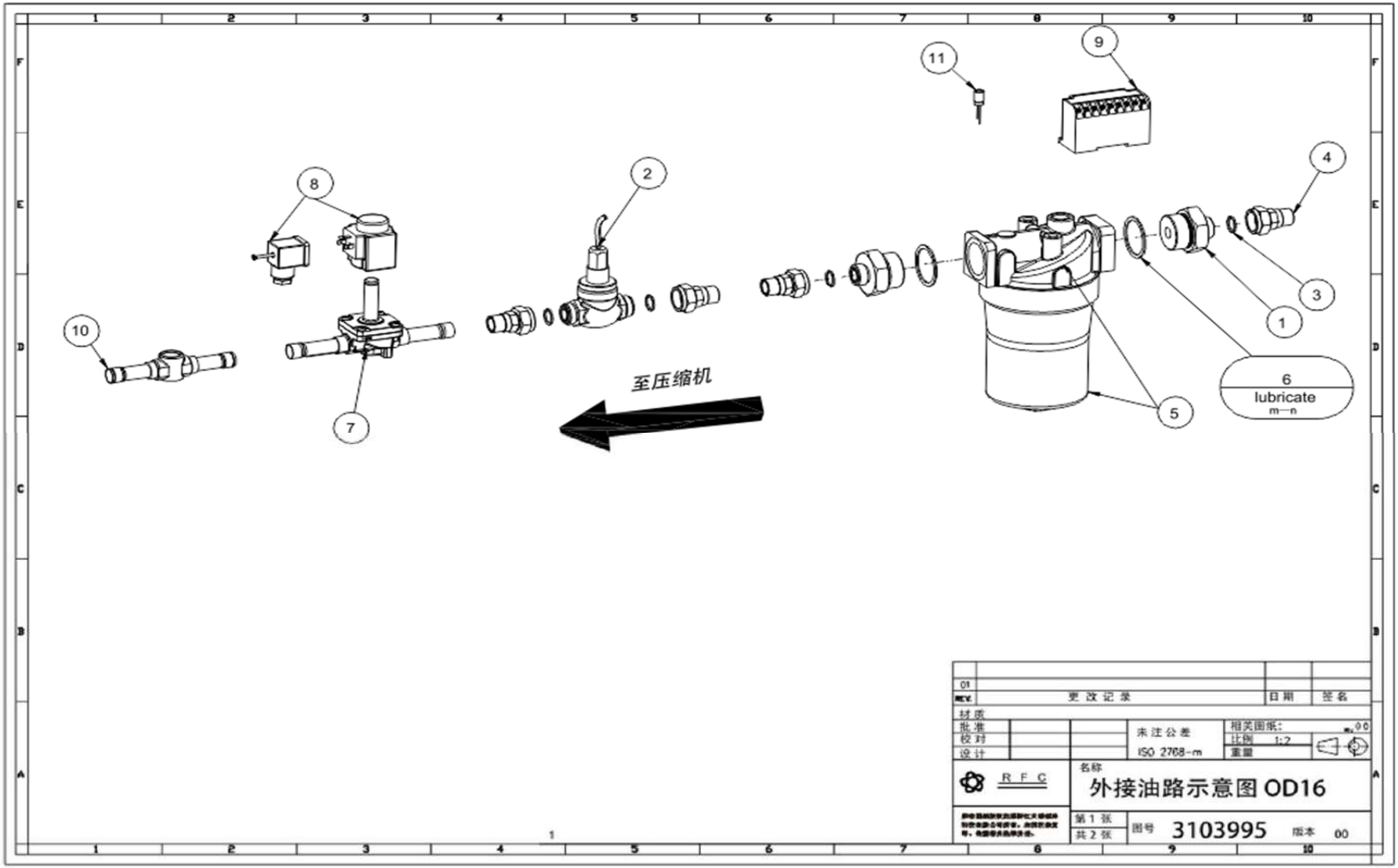
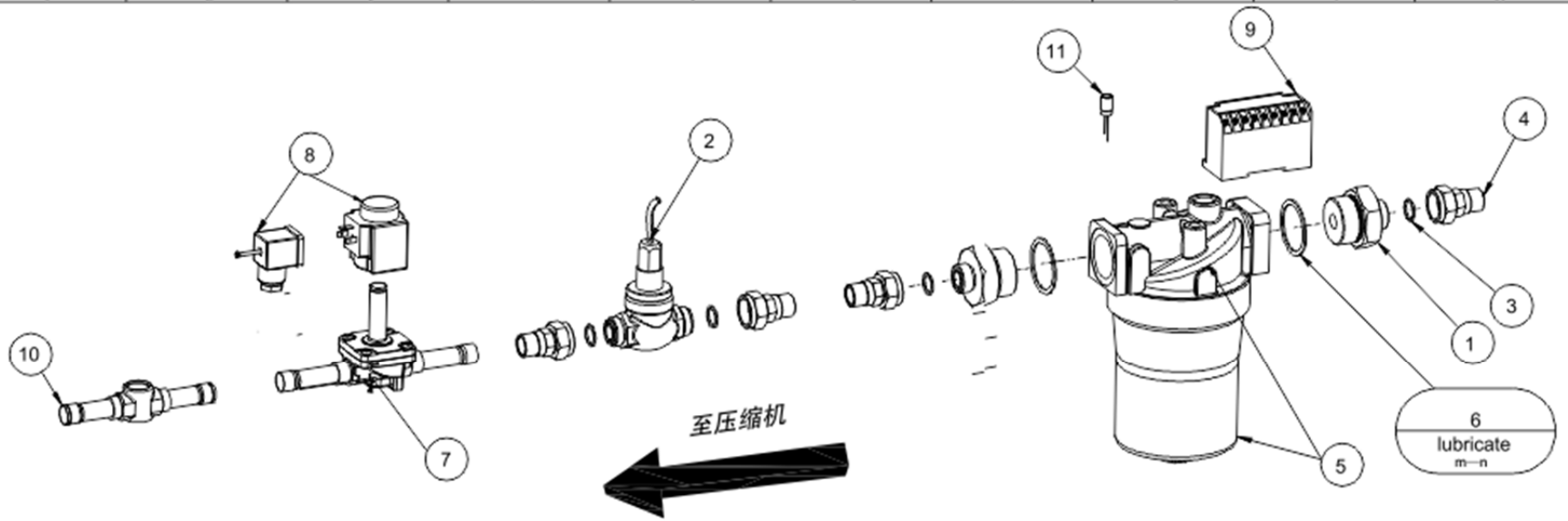



Figure 5-K 22mm diameter oil circuit accessories diagram

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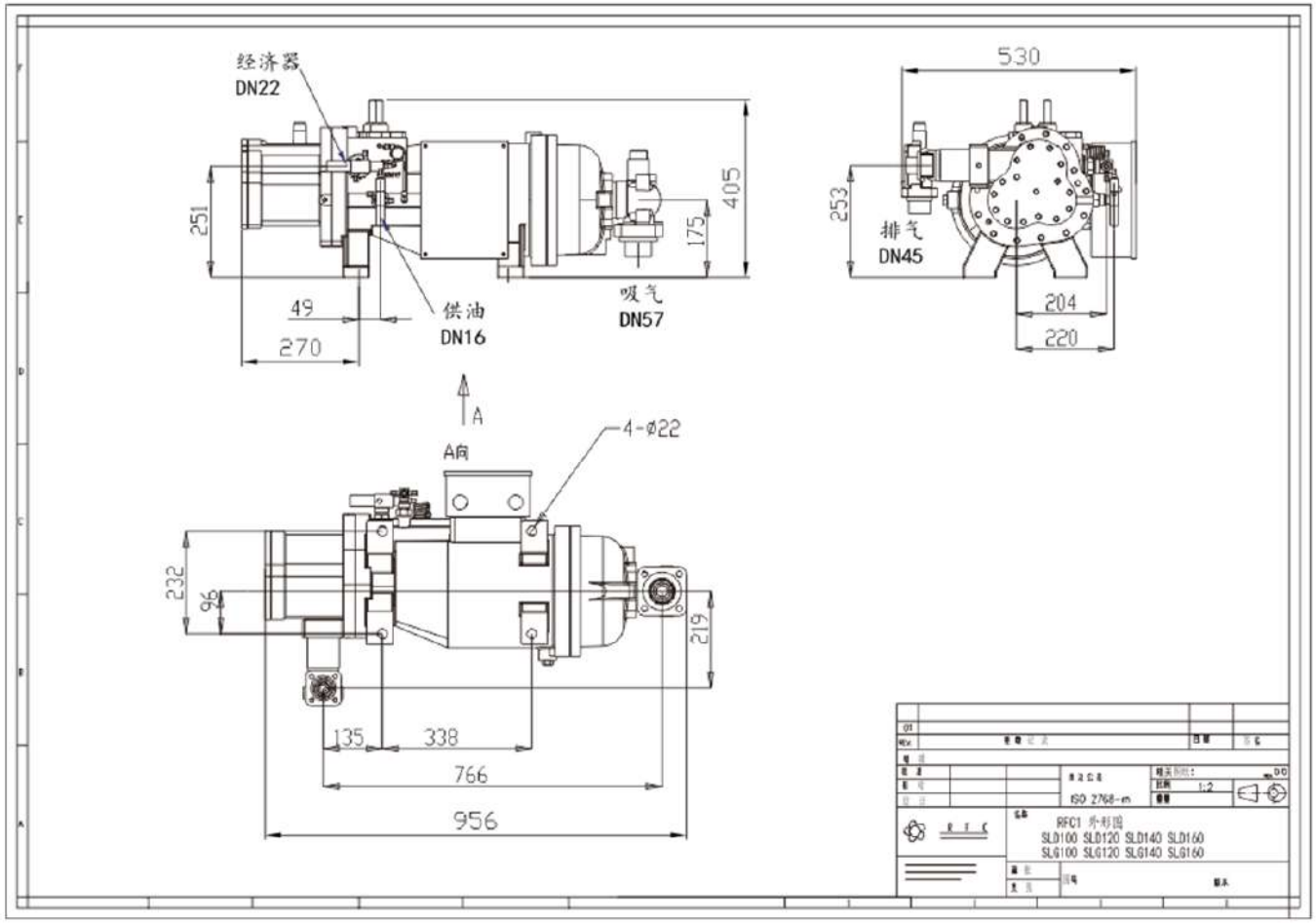
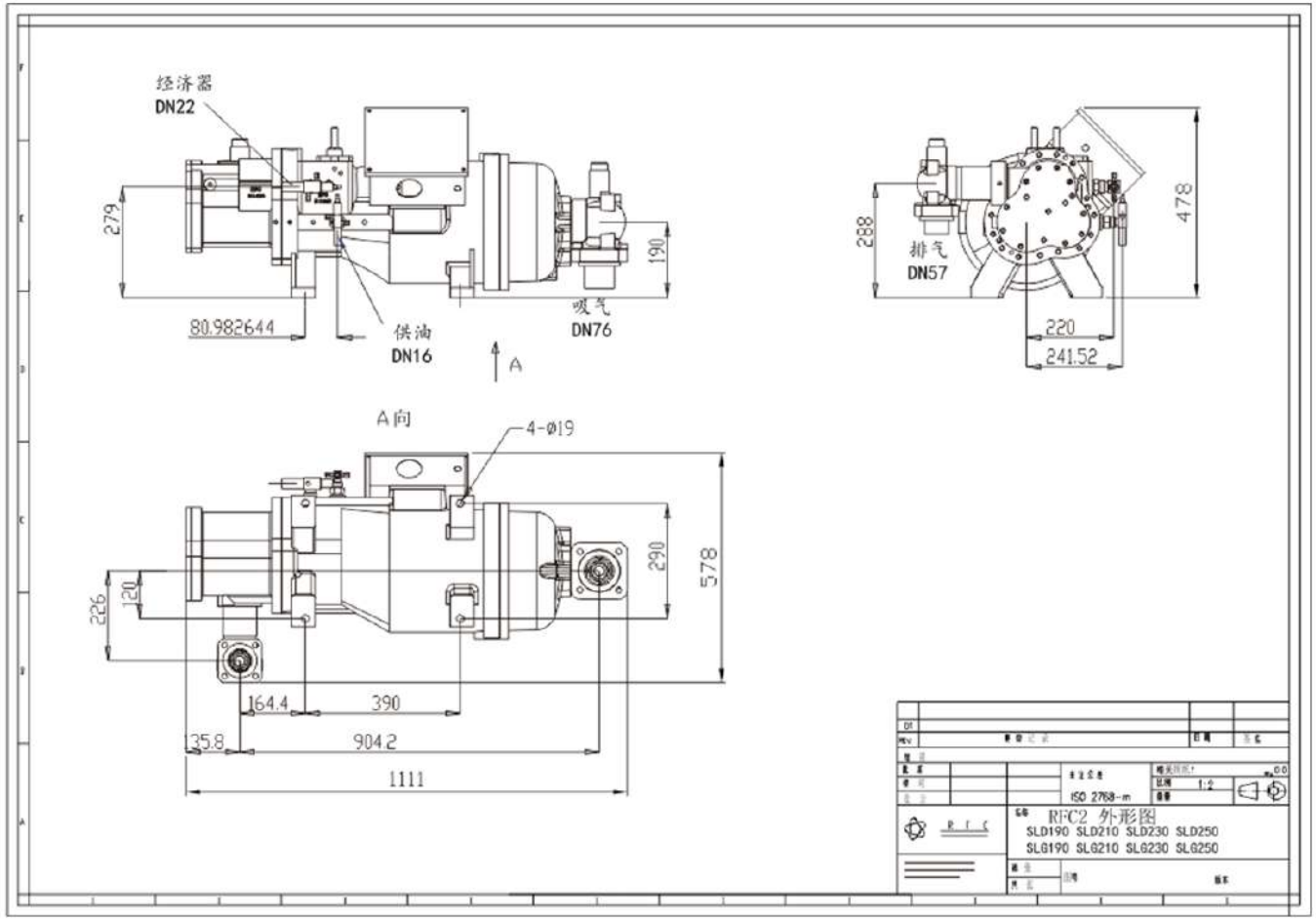
## 6. Dimensions and dimensions of women's clothing

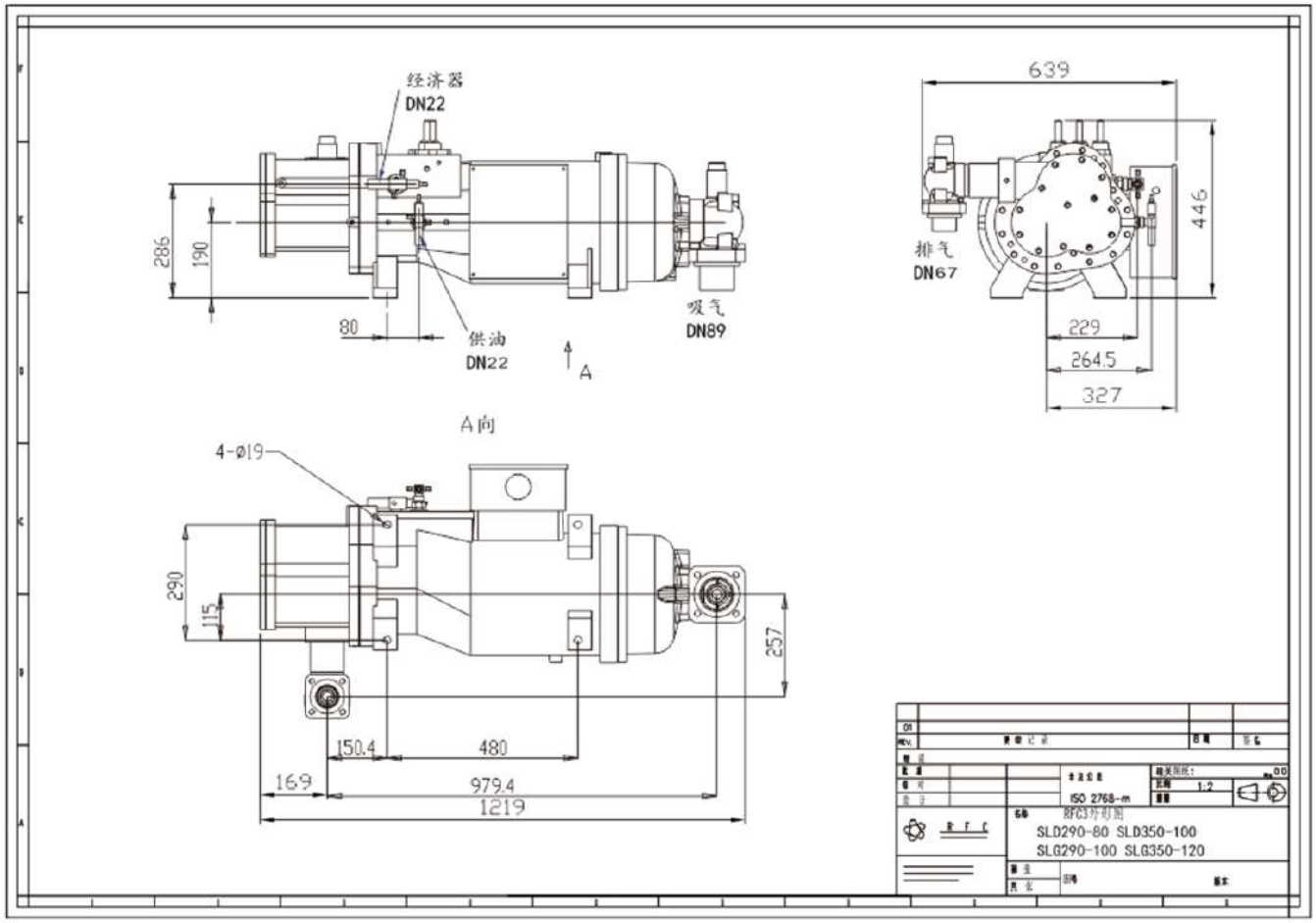
### 6.1 RFC1 series outline drawing



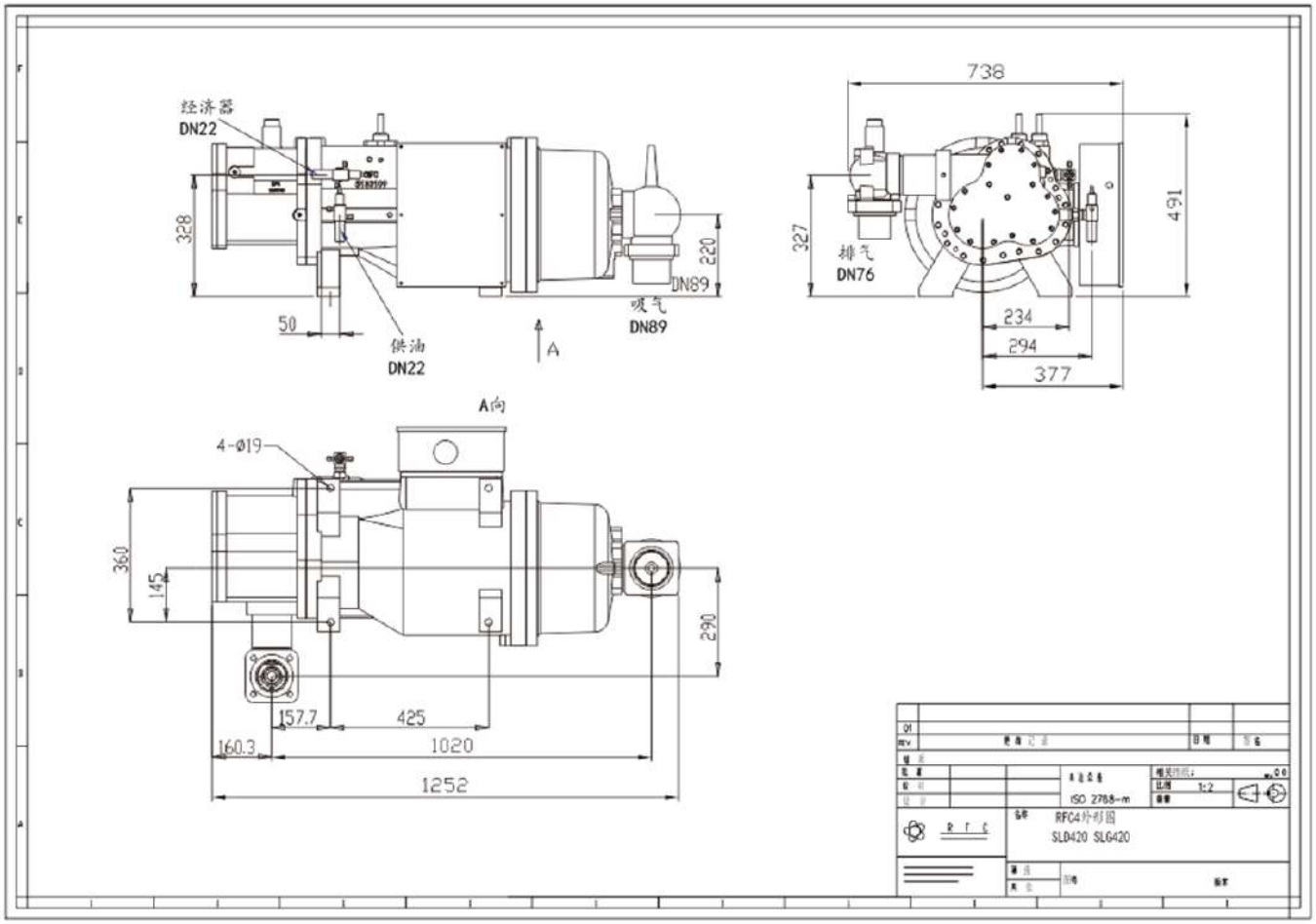
## 6.2 RFC2 series outline drawing



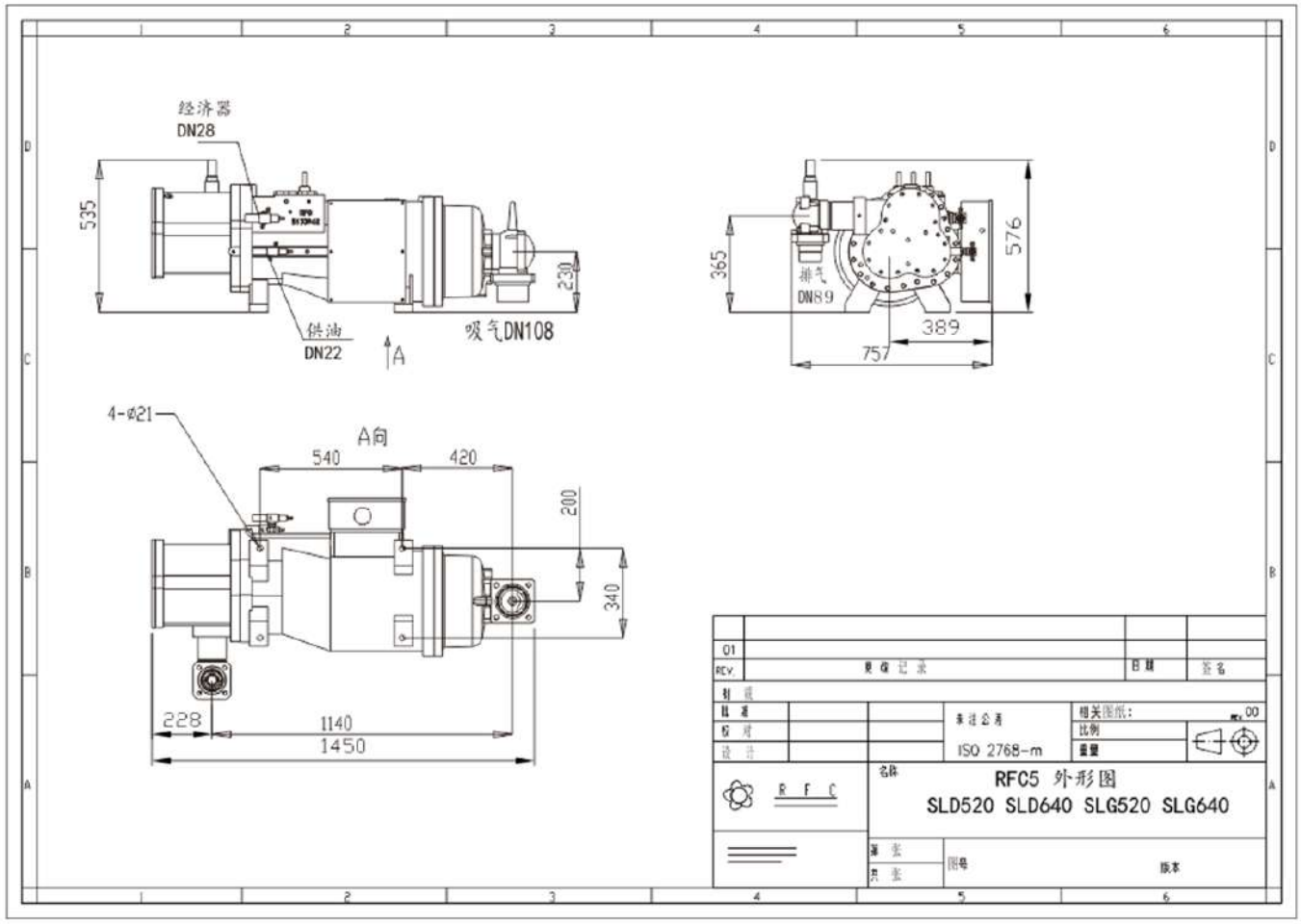
### 6.3 RFC3 series outline drawing



## 6.4 RFC4 series outline drawing



## 6.5 RFC5 series outline drawing



## 7. System application

### 7.1 Overview

The content of this chapter is proposed for the reliable and safe operation of the RFC screw compressor, if there is any violation of the principles, suggestions or questions mentioned in this chapter. Please contact RFC first!

For screw compressors, users can compose a system in a similar way to piston compressors. It's just that the oil circuit has its particularity and needs special attention.

Due to the structural characteristics of the screw compressor itself, it is not sensitive to liquid compression during operation and shows good reliability. However, measures should be taken to ensure that the compressor will not be filled with lubricating oil or refrigerant liquid during the shutdown period. Filling the compressor with lubricating oil or refrigerant liquid will cause uncontrollable liquid pressure during startup, and in extreme cases, the bearing will be damaged. , the compressor itself and the solenoid valve of the oil circuit, etc.

Compressors must be protected against contamination such as dirt (dirt, rust and phosphate deposits). The cleanliness of oil and refrigerant during compressor operation has a major impact on the reliability and life of the compressor.

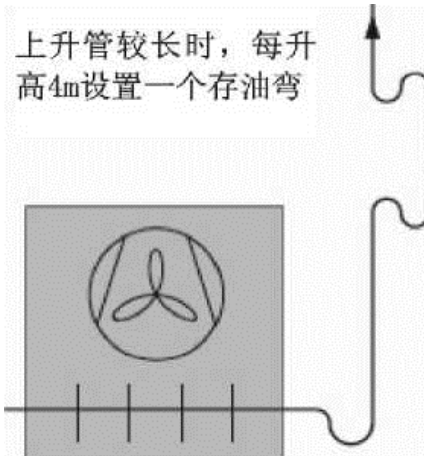
### 7.2 general principles

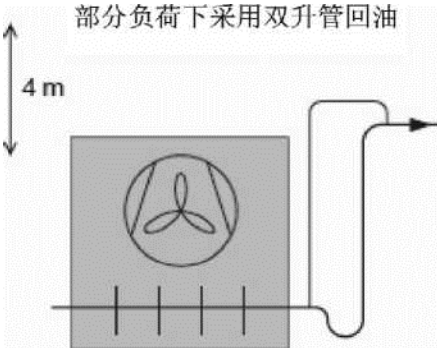
Determination of pipe diameter and oil return

For the short circuit pipeline, the diameter of the pipeline is mainly determined by the nominal size of the globe valve. However, for pipelines with multi-branch systems, such as low-temperature systems, parallel systems, systems with large load changes, and the ascending section of the pipeline, special calculation dimensions are required. The usual calculation criterion is to determine the pipeline according to the flow rate (oil return). diameter.

Considering the flow rate of oil in the return pipe, the airflow velocity in the horizontal pipe should be ≥4m/s, and the airflow velocity in the vertical pipe should be ≥8m/S.

For the longer riser pipe, an oil trap should be set every 4m (the length of the oil trap must be as short as possible to avoid excessive oil accumulation); while for a single compressor (or parallel system) partial load operation, it should be set Double riser to ensure oil return. Figure 7-A




Oil return of flooded evaporator

Flooded evaporator systems using HCFC/HFC refrigerants require independent oil return points at the evaporator or low pressure accumulator. The oil return point (preferably more than one) should be set in the range of the oil-rich layer at the liquid level. The oil return pipe should be connected to the suction pipe. The refrigerant in the oil return pipe can be treated by heat exchanger heating method. The refrigerant must be evaporated before entering the suction pipe. There is a strong change of liquid level (for example: liquid pump system) an oil drain point should be set at the lowest point or after the circulating oil pump.

Prevent compressor oil accumulation, fluid accumulation and start-up fluid

Special attention should be paid to piping layout and system configuration in the design to ensure that no liquid refrigerant or lubricating oil backflow into the compressor occurs during shutdown. For this reason, the suction and discharge ducts from the compressor should be designed to bend downward first.

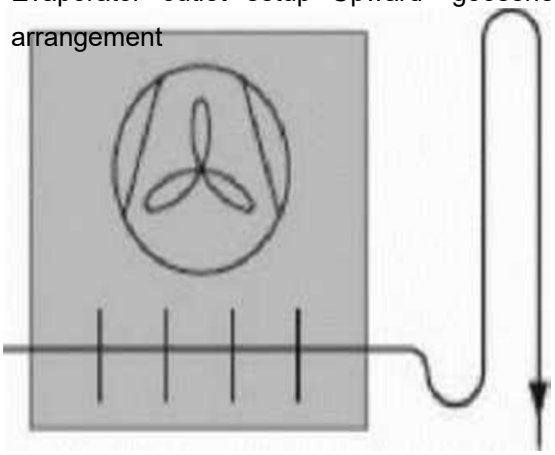
In addition, in order to prevent the compressor from starting with liquid, for the direct evaporation system, the following additional measures should be taken:

a) Use the evaporator outlet with an upward "gooseneck";

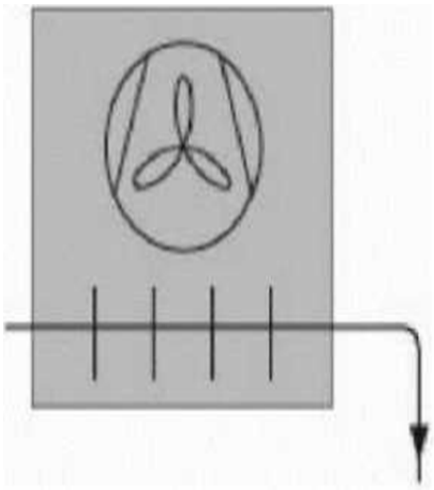
b) Install the compressor above the level of the evaporator when conditions permit;

c) Usually a solenoid valve should be provided on the liquid line before entering the expansion valve (no other parts are between the expansion valve and the solenoid valve);

Evaporator outlet setup Upward "gooseneck" arrangement



Pump down system Evaporator outlet U-pipe



Anti-vibration of compressor suction and discharge pipes

Due to the extremely low vibration and small exhaust pulsation, flexible joints and mufflers are usually not used in the exhaust pipe, but the nozzle must be sufficiently flexible and ensure that the suction and exhaust lines do not stress the compressor.

Oil temperature control during shutdown

An electric heater is installed on the oil separator to prevent high pressure refrigerant from diluting the oil during shutdown. The heater can be controlled by a thermostat with the temperature set to 70oCo

The compressor itself has its own suction filter. Since the refrigeration system composed of screw compressors has a huge pipe network, it is very difficult to maintain the cleanliness of the system during actual operation. Therefore, RFC strongly recommends that the compressor should be installed on the suction pipe of the compressor. Add a suction filter and clean it regularly for double protection. When the system starts to use, if it is found that the pressure drop is greater than 0.5bar, please clean it in time until the system is clean. If the filter screen is found to be damaged, please replace it in time, and clean the impurities in the pipeline. When installing, make sure that the filter is in the correct direction. It is recommended to install a stop

valve at the inlet and outlet to facilitate the replacement of the filter element.

Oil separator outlet set check valve

A one-way valve must be set at the outlet of the oil separator to prevent the backflow of the gas in the condenser and to quickly balance the pressure on the discharge side and the suction side of the compressor during shutdown and bypass. Note that the one-way valve in the compressor cannot replace the one-way valve to complete the shutdown bypass and prevent the refrigerant from dissolving in the oil during shutdown.

### 7. 3 External oil circuit system

lubricating oil cooling

When the compressor operates at a low temperature, the lubricating oil will not be cooled, and the oil temperature will be too high and will not work properly, so the system needs to be equipped with an oil cooler. The oil cooler can reduce the compressor discharge temperature and prolong the compressor life.

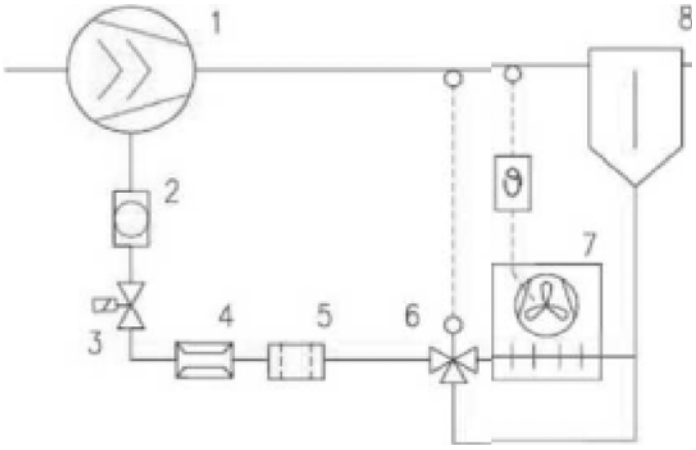
**Note: The compressor inlet oil temperature should not exceed 60□**

Oil coolers mainly include air cooling and water cooling, and the heat of oil cooling can be calculated by RFC selection software.

1) Air-cooled oil-cooled:

The oil temperature is realized by the thermostat on and off the oil cooler fan or the stepless speed regulation of the oil cooler fan. The suggested system is as follows:

legend：




1) Compressor

2) Oil sight glass

3) Solenoid valve

4) Oil flow switch

5) Oil filter

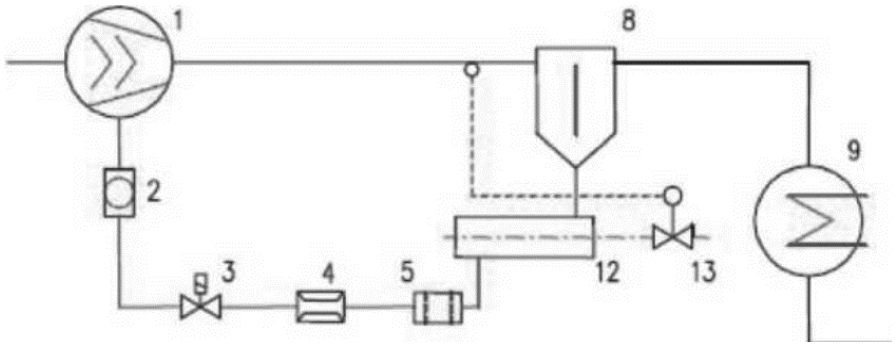
6) Three-way mixing valve

7) Air-cooled oil

2）Water-cooled oil-cooled:

Oil temperature regulation is carried out through a water volume regulating valve controlled by a temperature controller. The suggested system is as follows:

legend:




1) Compressor

2) Oil sight glass

3) Solenoid valve

4) Oil flow switch

5) Oil filter

8) Oil separator

9) Condenser

12) Water-cooled cooler

13) Water regulating valve

The configuration requirements of the external oil circuit system:

1) The oil cooler should be installed near the compressor to avoid excessive pressure drop in the oil circuit and cause poor oil supply to the compressor;

2) The installation position of the oil cooler should usually be lower than the compressor and the oil separator to prevent the lubricating oil that may exist after the shutdown from filling the compressor or flowing back into the oil separator, causing the compressor to start up or the oil level in the oil separator to be too high. overflow condition;

3) The oil cooler must be equipped with a return oil temperature control device to ensure that the return oil temperature is controlled at 40□~60□;

4) During normal operation, the difference between high and low pressure should not be lower than 4bar, and the pressure drop of the oil cooler should be less than 0.5bar; in order to ensure that the return oil temperature is within the specified range, a bypass with electromagnetic In the oil circuit controlled by the valve, if the oil temperature is too low when the compressor is running, open the bypass solenoid valve to quickly heat the oil temperature, and at the same time, it can effectively adjust the load of the oil cooler under different working conditions.

5) It is recommended to install the solenoid valve of the oil circuit at the oil inlet of the compressor to prevent the backflow of oil during shutdown or the possible oil entering the compressor during shutdown;

6) It is recommended to install a manual stop valve (ball valve) before and after the oil cooler for easy maintenance。

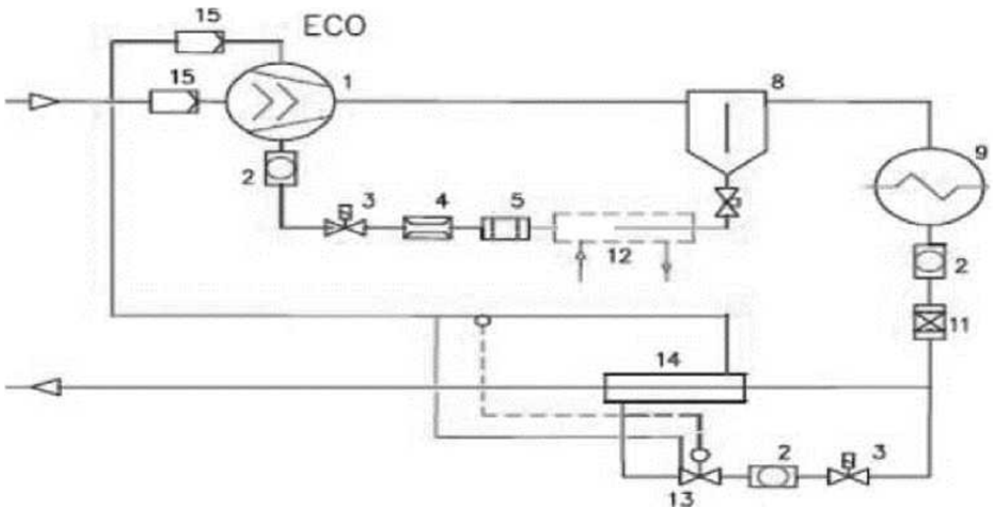
**7.4 Economizer Configuration Requirements**

Using the economizer to further subcool the refrigerant before the expansion valve of the system, the cooling capacity and efficiency of the system will be improved, especially under the conditions of high condensation and low evaporation temperature.

Economizer operation of subcooling cycle:

The economizer operation mode generally uses a heat exchanger as a liquid subcooler to achieve the purpose of subcooling the liquid refrigerator. A part of the refrigerant drawn from the condenser pipeline passes through the expansion valve of the economizer and enters the subcooler to evaporate and absorb heat, and exchange heat with the liquid refrigerant in the counterflow. The superheated saturated steam after heat absorption enters the economizer interface of the compressor. The intermediate compression section of the compressor compresses, this mode effectively increases the unit cooling capacity of the liquid refrigerant, and at the same time effectively reduces the exhaust temperature.

Filter Dryer Oil Cooler Expansion Valve Economizer (ECO) Suction Filter




1) Compressor

2) Oil sight glass

3) Solenoid valve

4) Oil flow switch

5) Oil filter

8) Oil separator

9) Condenser

11) Dry filter

12) Oil cooler

13) Expansion valve

14) Economizer (ECO)

15) Suction filter

Subcooling system with economizer circuit

7.4. 1 Economical selection：

Both plate-to-tube and shell-to-tube heat exchangers can be used as economizers. Please use the RFC selection software to select the load of the economizer.

Economic control method：

It is recommended that after the system is turned on and running stably, when the high and low pressure ratio is greater than 3 or when the low pressure side pressure reaches the set value, then turn on the economizer cycle to avoid the lubricating oil in the compressor going back to the economizer, causing additional vibration and noise, and even pipeline rupture.

Economical pipeline recommendations

1) The economizer should be installed under the compressor to prevent the liquid refrigerant in the economizer from returning to the compressor during shutdown.

2) When the operating conditions are unstable or the economizer circuit is closed, part of the oil and refrigerant will be returned to the economizer pipeline. Therefore, it is recommended to fold a U-shaped bend in the pipeline accessories of the economizer port. There is an upstream pipeline of about 150mm.

3) Under low pressure ratio conditions, the pulsating air flow in the compressor will recoil and cause abnormal vibration and noise. It is recommended to install a silencer and a diaphragm check valve near the inlet line of the compressor.

4) Please use the corresponding pipeline according to the interface size of the SL series compressor economizer.

5) In addition to the thermal insulation requirements of the pipeline to the evaporator, pay attention to fixing the pipeline to prevent vibration to prevent the hidden dangers of solder joint leakage caused by vibration.

**7. 5 Condensing pressure regulation**

The suction and exhaust of the compressor should reach a pressure difference of 4bar within 30S after starting. If the pressure difference is too small, the oil supply will be insufficient, and the compressor will fail and stop after starting for a period of time (oil flow and high and low pressure difference protection). At this time, condensing pressure control is required to ensure that after the compressor is turned on, sufficient high and low pressure difference can be established in a short time to ensure the oil supply of the compressor.

The following conditions will cause the high and low pressure difference to be too low：

1) The ambient temperature is low, the condenser is installed outdoors, and it will stop for a long time.；

2) Parallel system, single compressor start；

3) Hot air defrosting, reverse circulation；

4) Low-pressure compressor for dual-machine system；

**7.6 Parallel system operating requirements**

1) When the parallel system is turned on, each compressor is started one after another (two compressors are not allowed to be started at the same time), and the time interval is more than 30S.；

2) After all the compressors are started and the stable operation is completed, pay attention to observe whether the lubricating oil of the external oil separator is clear and full, and ensure that the oil level is in the high-level sight glass.The oil return temperature is controlled between 40~60□；

3) After the compressor is running for a period of time, if the pressure drop before and after the external oil filter is greater than 1.5bar, the external oil filter core needs to be cleaned or replaced.；

4) Multiple compressors in a parallel system can share an external oil component. It is recommended that the oil filter and oil flow switch be configured separately for each compressor.

note：

1) The external oil component of the parallel unit is also installed as a switch to avoid the oil level being too low to affect the oil return of the compressor.；

2) An oil heater is installed on the external oil part of the parallel unit, and the start and stop of

the oil heater is controlled by the oil temperature sensor in the oil part.；

3) The external oil component of the parallel unit is equipped with a refueling port and an oil drain valve to facilitate the replenishment and replacement of lubricating oil.；

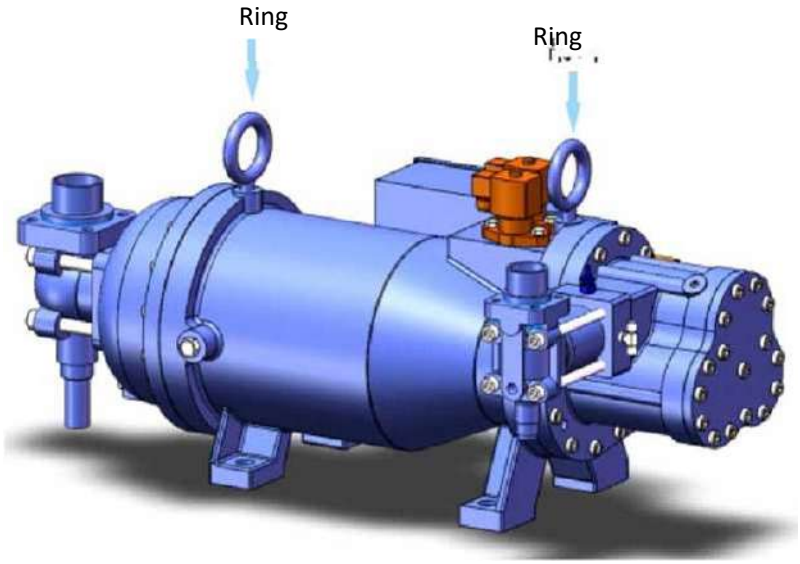
4) The combined lubricating oil temperature is lower than 20□ and cannot be turned on.

## 8. Installation and operation

### 8.1 install

8.1.1 Lifting

Please use a safety steel cable to hook the two ring head bolts above the compressor housing to lift the compressor.




Do not collide with the compressor body during handling or hoisting, especially the components installed on the body, and keep it level. Landing is strictly prohibited.

8.1.2 place

When applied to conventional systems, the compressor must be placed horizontally.

It is recommended to install the compressor with a fixed steel bracket and use a damping pad to reduce the impact of compressor vibration on the system. When the damping pad is installed, the four bolts at the bottom corner should be subjected to uniform force, and the nuts should be tightened to just enough to slightly deform the damping pad. Recommended installation location：

◎Avoid approaching other heat sources to prevent thermal radiation.

◎Close to the electric control cabinet for easy wiring.

◎The installation location and direction of the compressor are easy to observe the oil level and daily maintenance.

◎The strength of the installation position is sufficient, and resonance and noise are not easy to occur.

◎Reserve enough service space

8.1.3 Kaifeng pressure relief

When the compressor is connected to the system for piping, the compressor must be 0. After the 5bar of nitrogen is discharged, the next installation work will be carried out.

8.1.4 Installation and piping

The welding part of the pipeline should withstand a pressure test of at least 30 bar, and ensure that the system after welding is clean and dry.

**8. 2 run**

8.2.1 Precautions before operation

Compressor inspection

◎Location of refrigeration oil.

◎Temperature and heating time of refrigeration oil.

◎Is the suction and exhaust valve open?

◎Whether the capillary is twisted or damaged

Electrical system inspection

◎The voltage and frequency of the compressor are correct.

◎Control circuit voltage value.

◎Whether the motor terminal block to ground is above 10MQ.

◎The motor terminal and grounding wire are fixed correctly.

◎ Check whether the setting values of switches, sensors and controllers are correct.

Precautions for vacuuming

◎Use a large diameter nozzle as much as possible to vacuumize.

◎The high and low pressure sides are evacuated at the same time.

◎When vacuuming in winter or low temperature areas, increase the surrounding temperature as much as possible to ensure the vacuuming effect.

◎During vacuuming, the motor insulation must not be measured to avoid serious damage to the motor coil.

**warn：**

**Start vacuuming and do not measure insulation until refrigerant vacuuming is complete.**

**After the new machine is filled with refrigerant, the insulation value should be at least 5MQ or more, otherwise it should be confirmed whether there is a vacuum. Measure the insulation of the motor temperature protection contact with a voltage multimeter below DC9V, do not use a megohmmeter.**

run check

1) Jog the compressor (about 0,5-1 seconds) to determine the normal rotation of the compressor by monitoring the suction and discharge pressure. (The way of determining the normal rotation of the compressor: the suction pressure drops immediately, and the discharge pressure rises at the same time.

2) After starting, check whether the lubricating oil in the sight glass on the external oil circuit is full. If there is any problem, please check the system high and low pressure difference (oil supply pressure difference), whether the filter is blocked (oil pressure difference alarm), whether the external oil return solenoid valve is open, and check whether the oil outlet is blocked.

3) When the compressor is started, the lubricating oil in the oil separator will foam for a short time, but when the compressor works under the rated working conditions, the lubricating oil foam will disappear. Under normal circumstances, the normal oil level in the oil fraction is above the midline of the low-sleeve sight glass. Otherwise, it means that the system is insufficiently refueled or the compressor runs out of oil.

4) The operating conditions of the compressor should be adjusted as follows: the exhaust temperature should be higher than the condensing temperature by more than 30K, and the suction superheat degree should be within 15K.

5) The entire equipment, especially the pipeline must be tested for abnormal vibration.

6) The compressor is running for a long time and needs to be checked daily: the operating data of the machine (such as three-phase voltage, compressor line current, etc.), the oil temperature and oil level of the lubricating oil, all the sensing parts of the compressor, Check the connection of the wires and their tightness, and check the oil sight glass.

7) When the unit is running, special attention should be paid to its auxiliary equipment and the maintenance cycle of the unit.

8) After the compressor is turned off, the oil heater on the external oil separator should be kept on.

**Warning: Too low discharge temperature and too low temperature of lubricating oil in the oil when starting up will cause a large amount of refrigerant to dissolve in lubricating oil, which will not only damage the compressor bearings, but also easily cause the compressor to lose oil.**

## 9. Failure analysis and maintenance

### 9.1 General fault description

| fault condition | reason |
|---|---|
| Motor coil temperature switch action (protection module alarm 1) | 1. The high load causes the suction superheat to be too high |
| | 2. High voltage is too high, the load is too large |
| | 3. Poor motor cooling |
| | 4. Frequent startup |
| | 5. Coil PTC failure |
| | 6. Power phase sequence error or phase loss |
| | 7. The motor coil is bad and the temperature is too high |
| | |

| | |
|---|---|
| Exhaust air temperature too high (protection module alarm 2) | 1. Suction superheat is too high |
| | 2. High voltage is too high, the load is too large |
| | 3. Oil loss, bearing damage |
| | 4. Motor overheating |
| | 5. The non-condensable gas content in the system is too high |
| Tolerance does not move | 1. The oil temperature is too low, the lubricating oil point is high |
| | 2. capillary blockage |
| | 3. Oil filter clogged |
| | 4. Blockage of the oil tank |
| | 5. Capacitive solenoid valve port blocked |
| | 6. Capacitive solenoid valve coil fault |
| | 7. Worn piston ring |
| | 8. Insufficient lubricating oil |
| | 9. System temperature switch failure |
| Poor motor insulation | 1. Compressor motor wire connector is wet and dew condensation |
| | 2. Defective compressor motor |
| | 3. Bad motor terminal |
| | 4. Poor insulation of electromagnetic contactor |
| | 5. Acidification inside the system, corroding insulation |
| | 6. Long-term high temperature operation of the coil, insulation |
| | 7. Frequent startup, coil deterioration |
| | 8. The water content of the refrigerant is too hig |
| Motor does not start | 1. Voltage is too low |
| | 2. Wrong connection of motor coil |
| | 3. Phase loss, reverse phase rotation |
| | 4. Motor protection switch action |
| | 5. Heavy vehicle start |
| | 6. Exhaust shut-off valve is not open (high pressure switch action) |
| | 7. motor failure |
| Abnormal vibration and noise | 1. a foreign body has entered |
| | 2. Loose screws inside the body cause the internal parts to loosen |
| | 3. Rotors rub against each other or against the casing |
| | 4. compressor oil loss |
| | 5. Bearing damage |
| | 6. AC electromagnetic sound |
| | 7. Resonance between the unit and the water system piping |
| compressor oil loss | 1. Insufficient exhaust superheat, excessive return of liquid refrigerant, resulting in poor oil content |
| | 2. Insufficient design of system flow rate and unreasonable matching |
| | 3. The system is large or the oil is accumulated at the corners, resulting in insufficient refrigeration oil, and it is necessary to supplement the refrigeration oil |

**9.2 maintenance**

9.2.1 lubricating oil

Lubricating oils have extremely high thermal and chemical stability. Oil changes are usually not

required if the system is assembled correctly; however, the acidity of the oil should be checked regularly to prevent damage to the motor and compressor. Therefore, the RFC recommends that the oil be changed after the system has been operated for 2000 hours for the first time. If the system needs to be cleaned, do the following:

1) Install an acid removal filter in the suction line;

2) Change oil and filter

3) Clean the circuit by purging the compressor system from the highest point on the discharge side.

Oil can be discharged through the oil outlet on the side of the oil separator and charged through the oil filling port on the oil separator. When refueling, the oil should be sucked into the oil separator from the oil filling port by vacuuming.

Compressor bearings have a design life of 40,000 hours with good lubrication (clean oil filter, oil pressure in the correct range) and stable load. Any changes to the conditions described above or excessive changes in load will shorten the life of the compressor, sometimes significantly. Bearing replacement must be carried out in a workshop by qualified personnel.

9.2.2 The direction of rotation of the rotor

If the reverse rotation occurs for more than 3 seconds after the compressor is turned off, the check valve located in front of the discharge shut-off valve may be damaged, so the check valve must be replaced. In any case, the reverse rotation must not last more than 5 seconds to prevent compressor damage and unreasonable alarms from the protection module.

| time (hours) | 50-100 | 1000 | 2500 | 5000 | 10000 | 15000 | 30000 | 40000 |
|---|---|---|---|---|---|---|---|---|
| Oil filter | C/S | C/S | C/S | C/S | C/S | CIS | CIS | s |
| lubricating oil | C | C | s | c | c | c | c | s |
| Suction filter | C | C | c | c | c | c | c | c |
| The electromagnetic valve | C | C | c | c | c | c | c | s |
| check valve | C | C | c | c | c | c | c | CIS |
| protection module | C | C | c | c | c | c | c | c |
| Input voltage | C | C | c | c | c | c | c | c |
| motor contact point | C | C | c | c | c | c | c | c |
| Electrical insulation | C | C | c | c | c | c | c | c |
| Leakage at the joint | CIS | CIS | CIS | CIS | CIS | CIS | C/S | CIS |
| vibration noise | C | c | c | c | c | c | c | c |

### 9.3 Maintenance points

1. The electrical insulation of the motor should be checked before the new operation every year.

2. Vibration and noise are mainly checked by humans. If you have any questions, please consult RFC immediately.

3. After each overhaul, the entire compressor must be redone the air tightness test to confirm that there is no leakage in all parts.

4. Bearings must be replaced in the same group, not only some of them.

5. The oil filter must be cleaned regularly to maintain the smooth flow of the oil circuit system, especially after the first installation and commissioning of the system is completed, it must be cleaned up. RFC is supplied with a special oil filter for easy maintenance and replacement.

6. After the new machine runs for a period of time, remove the suction filter for cleaning to ensure the normal operation and service life of the compressor in the future.