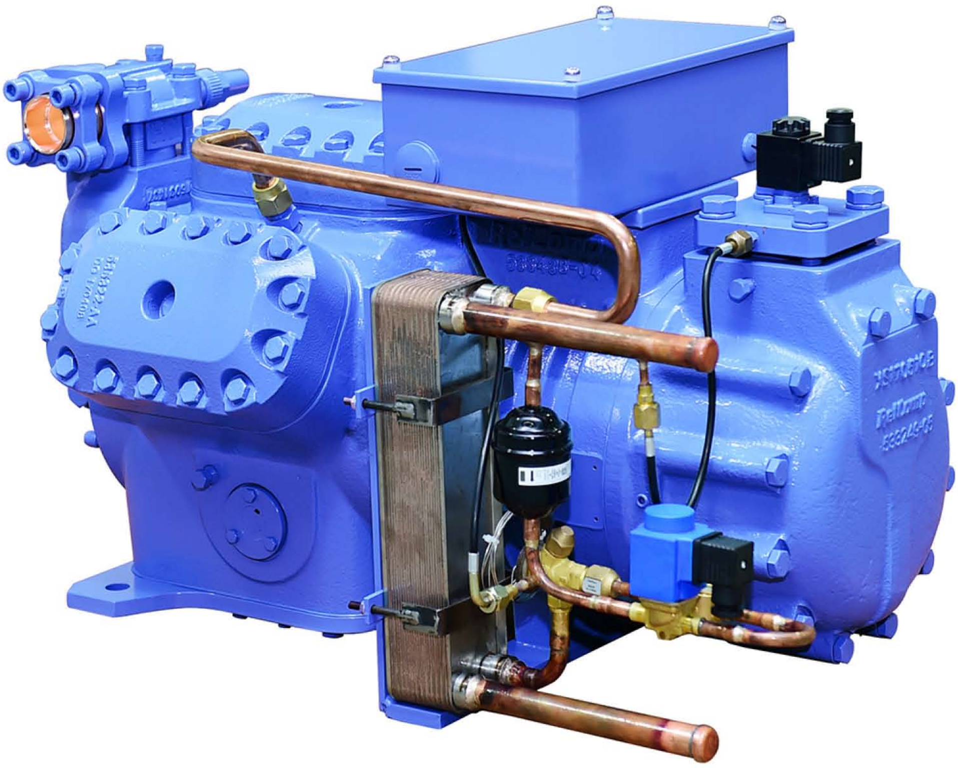
Technical Manual

SBC Series Single Machine Dual-stage Piston Compressor



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1. Overview

1.1. Introduction

There are 6 models of SBC series semi-hermetic dual-stage piston compressors which including four cylinders and six cylinders (see Table 1.1-A).

This series adopts four-pole three-phase motor (1450rpm at 50Hz) and connects directly to the drive shaft.

The compressor has 6 displacements, and the displacement range at 50 Hz is 27.5 to 51.5 m^3/h.

Users can choose the right compressor based on the working conditions and application ranges.

The SBC series compressors are mature in structure and can be used with R22 or HFC chlorine-free refrigerants such as R404A or R507A by selecting different nozzles without changing the main unit.

The SBC series compressors are filled with lubricant while delivery. When the compressor uses R22 refrigerant, please use mineral lubricant; when the compressor uses chlorine-free refrigerant, use synthetic ester lubricant (POE oil). The last letter of the compressor model, if marked with an "E", indicates that the compressor must use POE oil.

Table 1. 1-A SBC Series Compressor Model

	SB4C		SB6C			
	1200	1400	1600	2000	2500	3000
Refrigerant	R22/R404A-R507					
No. of cylinder	4	4	6	6	6	6
Rated motor power [Hp]	12	14	16	20	25	30
Displacement 50Hz low/high [m^3/h]	43/27.5	51.4/32.3	64.7/32.4	75/37.5	86.1/43	102.9/51.5

1.2. Features of SBC series compressor

The dual-stage semi-hermetic piston compressor is highly efficient, durable, compact and low vibration. The final displacement is obtained by two successive compression. The displacement of the first stage compression is the suction of second stage compression, and discharge the gas after two compression. Compared with a single-stage compressor, the compression ratio of each stage of the dual-stage compressor can be smaller, thereby reducing the discharge temperature and improving the efficiency.

Application areas: Freezing, ice making etc..

Compressor features:

1. Reliable valve plate design with impact-resistant spring steel valve plate.
2. The smallest space requirement and compact size design.
3. Small vibration, low noise.
   4-cylinder and 6-cylinder construction with optimized mass balance design for exceptionally quiet operation.
4. High cooling capacity and low energy consumption.
   a. Use high efficiency working valve plate
   b. Design minimum dead space clearance
   c. Use high efficiency and large volume motor
5. High reliable drive components.
   a. The surface of the crankshaft is hardened
   b. Use large-capacity oil pump

  c. Use low friction bearing bush and the aluminum piston
  d. The surface of the piston ring is hard chrome plated
6. The pressure supply lubrication system uses a bi-directional gear pump.
7. The compression efficiency can be further improved by adding a subcooler.
8. Motor
   The standard configuration uses a part winding start motor. It can also be equipped with a Y-Δ start motor according to requirements. The starting current is small and the running consumption is low. According to the electrical properties of different regions, a variety of operating voltages and frequencies are designed to meet various voltage requirements. The motor is made of special materials and can be compatible with various refrigerants such as R22, R404A and R507A. Optimized rotor and stator sections for maximum efficiency and power factor.
9. Motor protection
   The protection module INT69B2 has functions such as motor high temperature protection. Six series PTC thermistors are used to prevent the motor from being burnt out due to high temperature. In addition, the protection module also has the function of system operation information tracking, real-time feedback of the motor and system operation status.
10. Safety valve
   The built-in safety valve is connected to the low pressure side and the intermediate pressure side to ensure that the pressure inside the machine does not exceed the safe value. High standard design requirements, reliable sealing, accurate start, proper open stable displacement and timely return, safe and reliable.
11. Shut-off valve
   Some suction/discharge shut-off valve can be rotated 180° for easy installation, compactness and flexibility.
12. Suction filter
   The built-in high-density suction filter can remove impurities from the refrigerant gas and protects the motor. It is compact and easy to replace.
13. Built-in connection channel
   The SBC series compressors have changed the external pipeline to the internal special gas flow path to avoid leakage caused by poor welding of the connecting pipeline. The SBC series compressors are more compact, simple in appearance and small; The SBC series compressor removes the external connecting pipeline, and save the insulation cotton, which can reduce the system efficiency reduction caused by poor insulation of the connecting pipeline.
14. Automatic liquid injection cooling at the motor side
   The SBC series compressor is built into the special sensor switch in the motor. When the motor temperature reaches the injection temperature, the automatic control solenoid valve is turned on and liquid injection to cool the motor. When the motor temperature returns to a certain temperature, the sensor switch is turned off and stopped injection, so repeating the cycle, so that the motor runs repeatedly in the appropriate temperature range.

1.3. Main components

The main components of the SBC series compressor are shown in Figure 1-1.

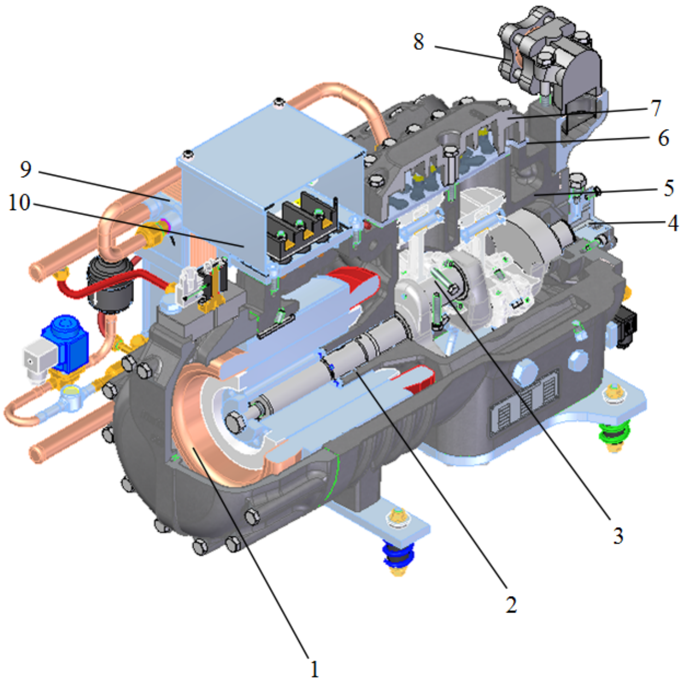


Figure 1-1 Structure diagram of the main components of the SBC series

1. *Motor*
2. *Bearing bushing*
3. *Crankshaft connecting rod piston*
4. *Oil pipeline system*
5. *Body housing*
6. *Valve plate*
7. *Cylinder head*
8. *Suction and discharge system*
9. *Subcooler*
10. *Electrical system*

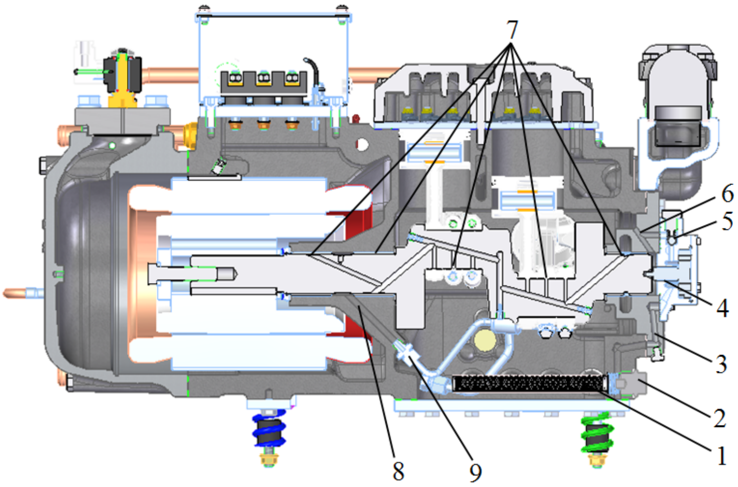
2. Oil pipeline lubrication

2.1. Oil pipeline system

The function of lubricant:

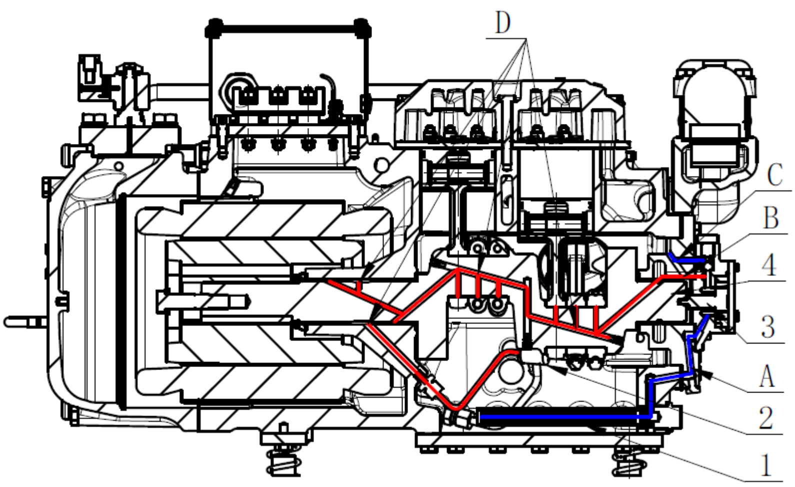
- Lubricating
- Cooling
- Damping
- Cleaning
- Sealing compression chamber

The SBC series semi-hermetic dual-stage piston compressor uses oil pumping for lubrication, as shown in Figure 2-1.



(a) Sectional view of SBC series compressors forced lubrication

1. Oil filter
2. Magnetic plug
3. Oil inlet channel
4. Gear pump
5. Pump with overflow valve
6. Overflow channel
7. Lubrication point
8. Oil return channel
9. Oil return components



(b) Schematic diagram of SBC series forced lubrication

Figure 2-1 SBC series compressor lubrication system

1. Oil filter

2. Oil return pipe components

3. Oil pump

4. Crankshaft

A. Oil pump inlet circuit

B. Oil pump outlet circuit

C. Oil pressure unloading circuit

D. Oil flow channel

The oil circulation lubrication is achieved by the gear oil pump, which is driven by the crankshaft. The oil passes from the crankcase through the oil filter to the gear oil pump, and reaches the gap between the bearing and the crankshaft and the gap between the connecting rod and the crankshaft through the channel inside the crankshaft under high pressure. The optimized geometry design of the parts forms a stable lubricating oil film to achieve the purpose of lubricating the relative moving surface.

2.2. Oil pump

The gear oil pump is connected to the crankshaft through the gear shaft and is directly driven by the motor.Due to the special design of the oil pump, oil can be supplied regardless of whether the crankshaft is rotating clockwise or counterclockwise.

The gear oil pump is installed on the discharge end cover, and the discharge end cover has a connector of an electronic oil pressure difference switch (optional) and an connector of a mechanical oil pressure difference switch MP54 (optional).

The oil pump of the SBC series double stages piston compressor is shown in Figure 2-2.

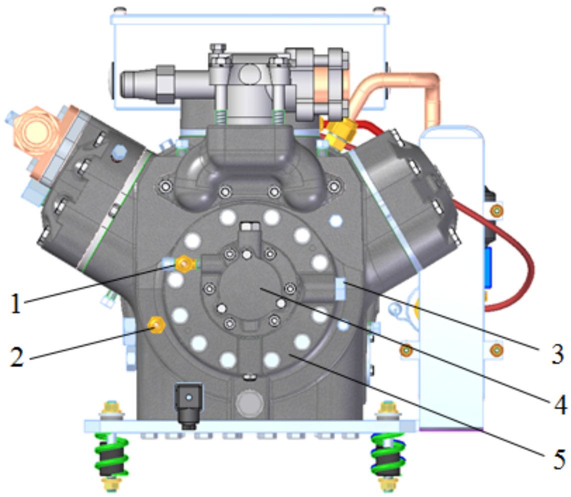


Figure 2-2 Schematic diagram of SBC series compressor oil pump

1. *Oil high pressure side connector 1/4" S.A.E.-FLARE*
2. *Oil low pressure side connector 1/4"S.A.E.-FLARE*
3. *Electronic oil pressure difference connector*
4. *Gear oil pump*
5. *Oil pump base*

The function of the oil safety valve is to bypass the oil to the crankcase tank when the oil pressure exceeds the set safety pressure (the oil safety valve begins to open when the oil pressure difference reaches 2.8 bar, and opens completely when it reaches 4.1 bar).

The position of the oil safety valve is shown in Figure 2-3.

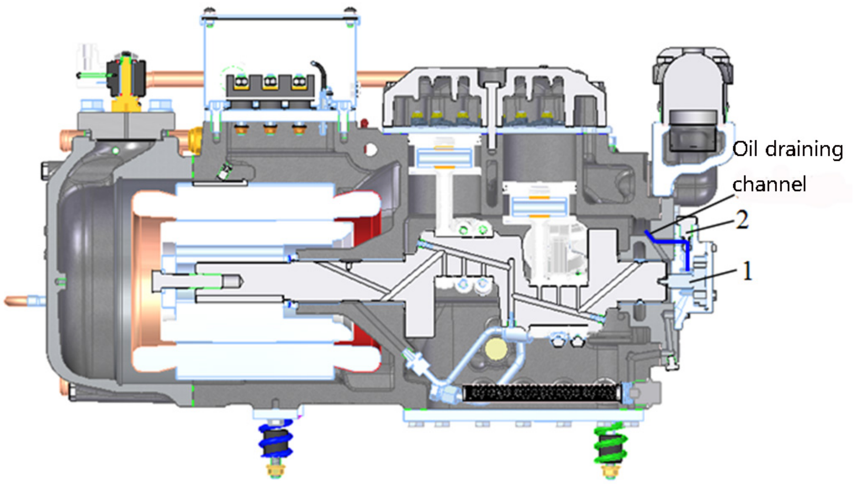


Figure 2-3 SBC series oil safety valveNotes

1. *Gear oil pump*
2. *Oil safety valve*

2.3. Oil pressure

Since the suction end of the crankcase and compressor is directly connected, their pressures are usually equal, and the corresponding oil pump outlet pressure is equal to the sum of crankcase pressure and gear pump pressure.

Usually, the oil pressure difference is an index to detect the oil circuit circulation, which is equal to the oil pump outlet pressure minus the crankcase pressure:

Oil difference = Oil pump outlet pressure - Crankcase pressure

Oil pressure difference is checked through connection No. 1 and No.2, as shown in Figure 2-2.

Normally oil pressure difference relates to compressor size, oil temperature, oil viscosity and the amount of refrigerant in the oil. The proper range is between 2.8 and 4.1 bar (the value can be slightly lower if oil temperature is relatively high).

As shown in Figure 2-4, the oil pressure difference of the compressor is in a critical state during the start-up period. At this time, the compressor has not reached the normal working oil pressure, which is usually related to the following factors:

- Lubrication status of the oil during the last shutdown
- Pressure and temperature during compressor operation
- Compressor downtime

Generally, under the condition of low oil temperature and relatively more refrigerants dissolved in oil, oil pressure difference can hardly reach the safe value, therefore it’s necessary to install oil differential pressure device in oil lubrication (See the Oil line test (page 16)).

It is very dangerous that there is refrigerant dissolved in the oil tank of the crankcase: during the start-up stage of the compressor, the pressure of the crankcase drops rapidly, so that the refrigerant in the oil boils and causes the oil hammer of the compressor. In order to prevent this situation, a crankcase heater must be added to the crankcase (see chapter Crankcase oil heater (page 12)).

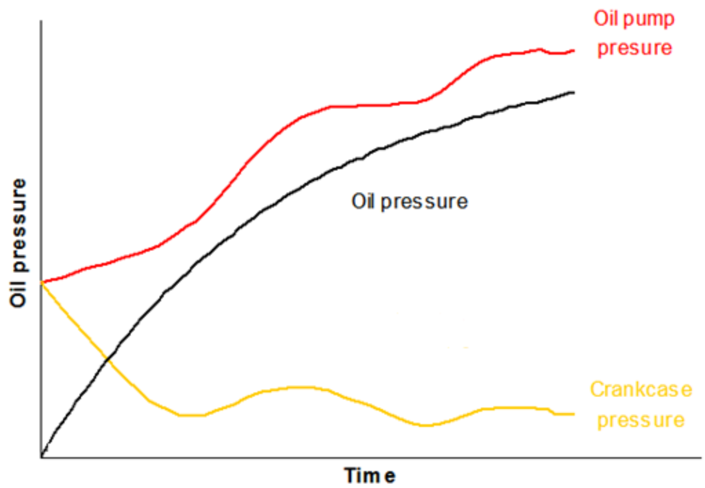


Figure 2-4 Oil pressure difference-time chart during compressor startup

The SBC series dual-stage piston compressor is equipped with a check valve between the suction part and the crankcase, which can prevent the crankcase pressure from decreasing with the rapid decrease of suction part pressure during the start-up stage of the compressor. The operation trend is shown in Figure 2-5.

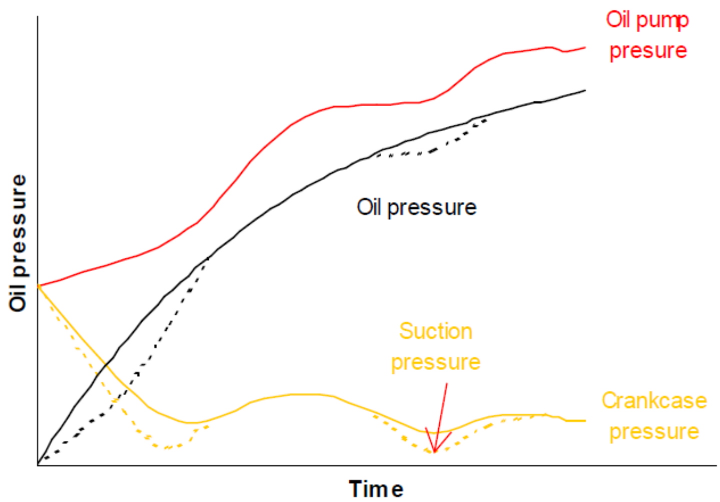


Figure 2-5 The oil pressure difference-time curve between the suction part and the crankcase equipped with check valve

The pressure between the suction part and the crankcase of the SBC series double stages piston compressor is generally equal during the steady operation phase. Therefore, the low pressure of the oil pressure difference used in calculating the oil pressure difference is the pressure of the crankcase, instead of the pressure of the suction.

2.4. Oil filter

The SBC series of dual-stage piston compressors equip with an oil filter, as shown in Figure 2-6. The oil filter is assembled at the bottom of the crankcase for easy replacement.

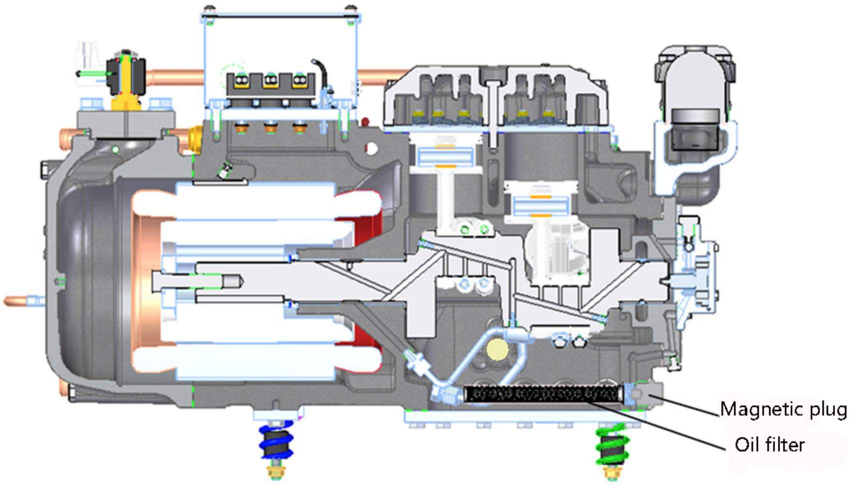


Figure 2-6 SBC series oil filter

The oil filter (code: 518530) of the SBC series dual-stage piston compressor is made of a 100μm stainless steel mesh on the outside and supported by a steel sleeve with hole shaft on the inside. As shown in Figure 2-7.

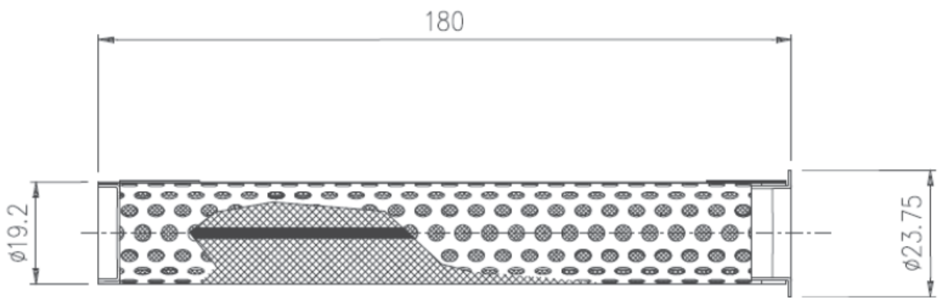


Figure 2-7 SBC series oil filter

The connection of the oil filter is provided with a magnetic plug, which can rely on the magnetic force to attract impurities passing through the metal mesh. If the oil is particularly dirty, the oil filter will stop supplying oil, and the gear oil pump will not provide enough lubricant for the compressor.

WARNING
If the internal cleanliness of the refrigeration system is not enough, the oil filter will be quickly blocked during the start-up stage of the compressor. Please pay attention to the oil pressure difference during the commissioning phase of the compressor unit.

2.5. Crankcase oil heater

The crankcase heater can reduce the dissolution of refrigerant in the lubricant during shutdown.

The crankcase heaters of the SBC series compressors are resistance heaters that are mounted on separate sleeves, as shown in Figure 2-8.

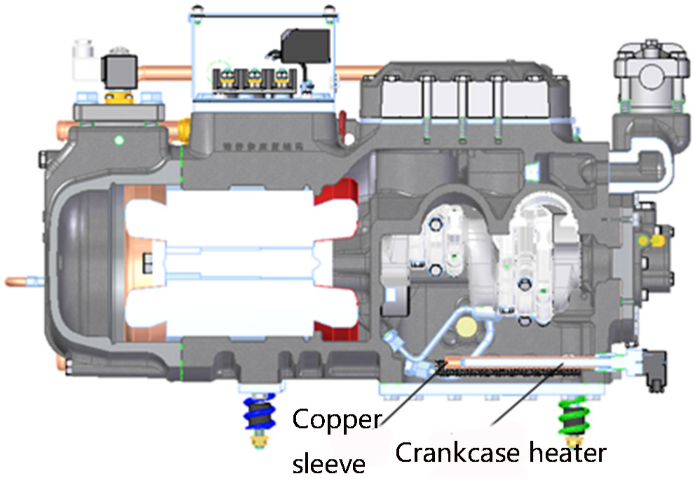


Figure 2-8 SBC series crankcase heater

The crankcase heater is separated from the crankcase by a sleeve and no oil change when replacing the crankcase heater. Pleas check chapter 8 Overall dimension (page 47) for the specific position and size.

Check table 2.2-A for main technical parameters of crankcase heater. Check figure 2-9 for dimension parameters.

Table 2. Table 2-A Electrical parameters of the crankcase heater

Compressor model	Crankcase heater code	Rated power (W)	Power (V)	IP class
SBC series	303894 (583000)	150	230V AC (1)	IP65
	303895 (583010)	150	110V AC	IP65
	303896 (583020)	150	24V DC	IP65

NOTE

(1) Standard voltage

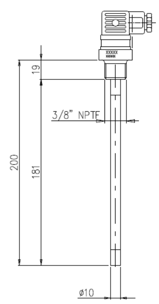


Figure 2-9 Crankcase heater overall dimension

Crankcase heater is applied during compressor shutdown, start the crankcase heater during the following situations:

- Compressor crankcase temperature lower than 10°C
- The temperature difference between temperature and standard evaporating temperature is lower than 10-15K
- Long time shutdown
- Large refrigerant injection

- Refrigerant condensates in the compressor (The oil temperature is highest of the refrigeration system during shutdown phase)

Crankcase heater can not be applied during the following situations:

- The refrigerant injection amount of refrigeration system is relatively small
- The normal running refrigeration system after check
- Compressor pump-down and the room temperature is above 10°C
- System shutdown in short time or the oil temperature of crankcase can't be cooled down.

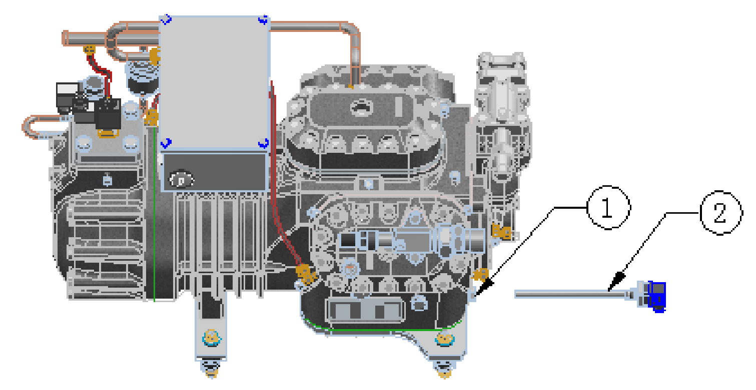
Check the above working conditions that no use crankcase heater for safe working condition.

> **WARNING**
> Start the crankcase heater 24 hours before the first start after compressor long time shutdown.

Check table 3. 2-B for crankcase heater assembly.

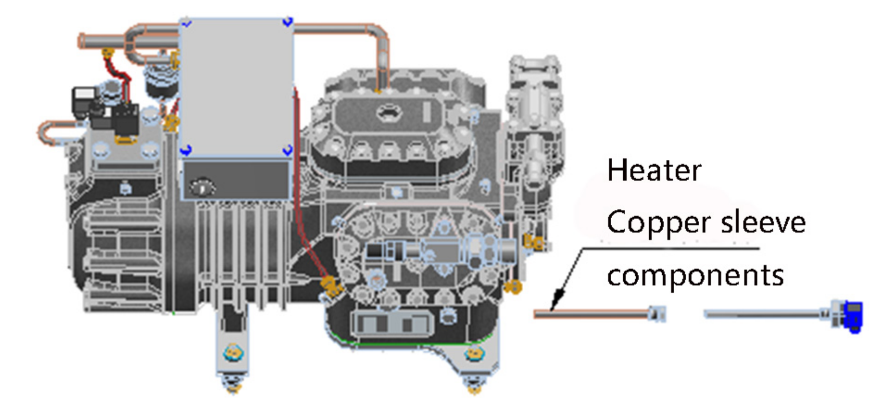
Ensure the lubricant temperature before compressor start should be 30K higher than room temperature or other components in the refrigeration system, check if crankcase heater working normally during refrigeration system maintenance.

Table 3. 2-B Schematic diagram of crankcase heater replacement



Replacement procedures for the crankcase heater:
(a) Loosen the assembly nut 1
(b) Disassemble the crankcase heater 2
(c) Replace and install the crankcase heater
(d) Tighten the assembly nut

Table 4. Table 2-C Replacement diagram of heater copper sleeve



Replacement procedures for the heater copper sleeve:
(a) Cut off the power supply of the crankcase heater
(b) Close the suction and discharge shut-off valves
(c) Discharge the refrigerant and recycle the lubricant
(d) Disassemble and replace the heater copper sleeve assembly
(e) Check if the crankcase heater works properly after powering on

WARNING

Attention! Ground protection of the electrical circuit.

2.6. Oil level

The standard compressor delivery is filled with lubricant, the compressor oil level can be observed by the oil sight glass beside the crankcase oil tank.

Ensure the normal oil level during normal compressor operation, The Min. Oil level and Max. Oil level of compressor is shown in figure 2-10, the oil level of normal working condition can be observed through the oil sight glass.

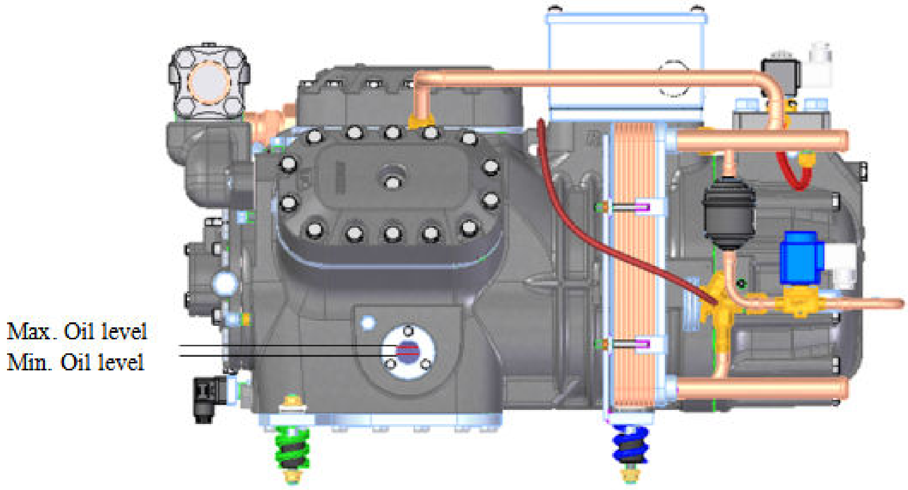


Figure 2-10 Oil Sight glass

Oil sight glass overall dimension drawing is shown as figure 2-11 and fixes at the compressor by three bolts M6x16.

WARNING
Charge the required lubricant for the refrigeration system under compressor initial oil injection if necessary.

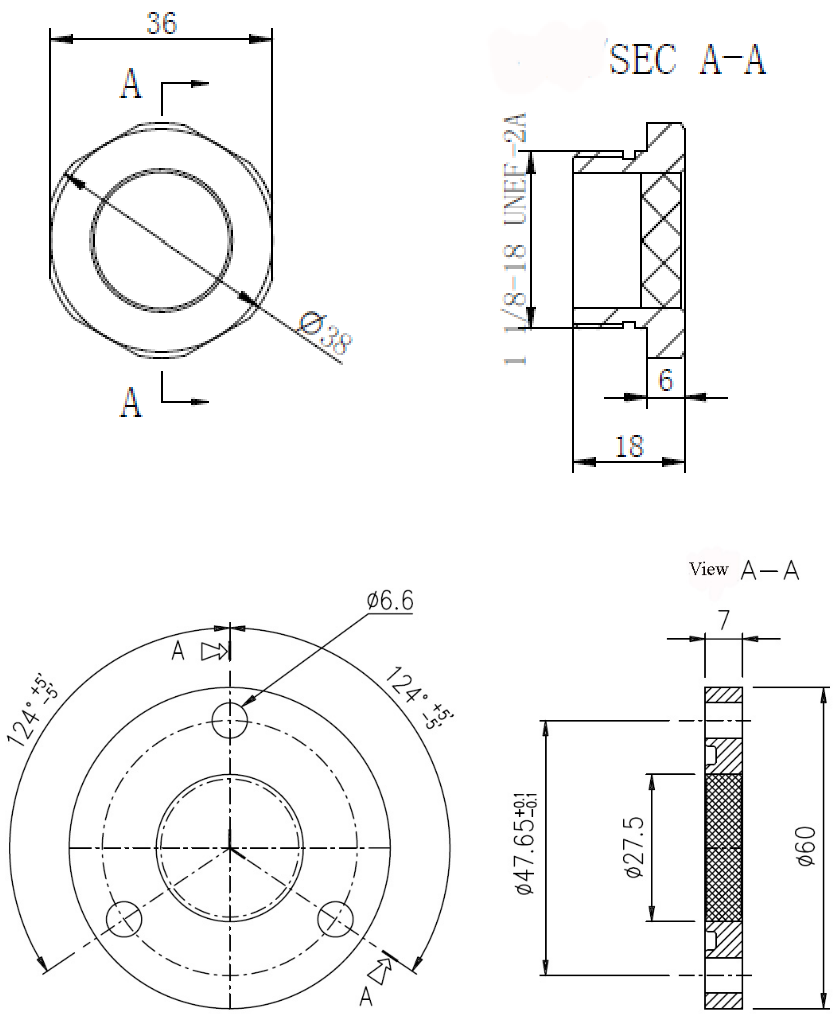


Figure 2-11 Overall dimension drawing of oil sight glass

2.7. Oil line test

Oil differential pressure switch introduction:

SBC series piston compressors need to control the oil pressure difference. You can choose to install the oil pressure difference controller (mechanical or electronic) on the compressor, or you can control the pressure difference through the unit.

When the oil pressure difference of the compressor is too low, the compressor should be shut down. However, in the first 90 seconds of the compressor start-up phase, the oil pressure protection is shielded. After 90 seconds, the pressure difference should be higher than 0.65bar (deviation 0.2bar), otherwise the compressor will be shut down. See Figure 2-12.

In the control of the unit, a manual start or range button is required. In case of the compressor oil pressure difference fault, the compressor fault should be eliminated by the experienced commissioning engineer, and then the compressor should be restarted.

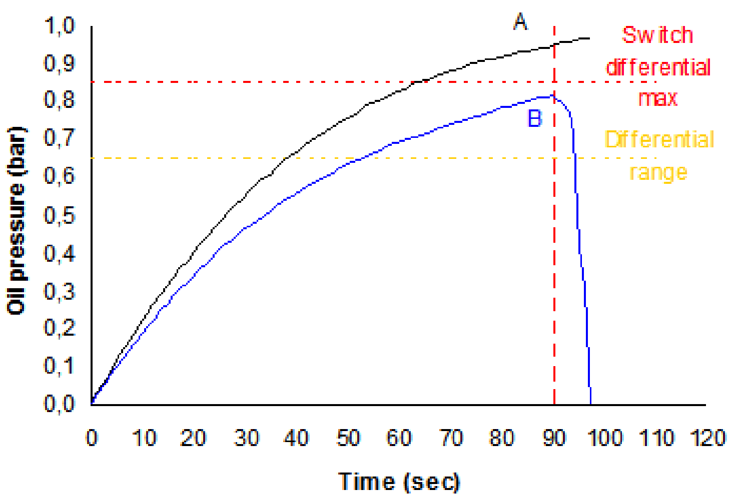


Figure 2-12 Oil pressure difference switch starting phase

The oil pressure differential switch monitors the oil pressure difference (as shown in Figure 2-20) during the stable operation stage (non start stage): if the oil pressure difference of the compressor is less than 0.65 bar and the oil pressure difference of the compressor exceeds 0.65 bar in 90 seconds, the compressor oil pressure difference will not shut down.

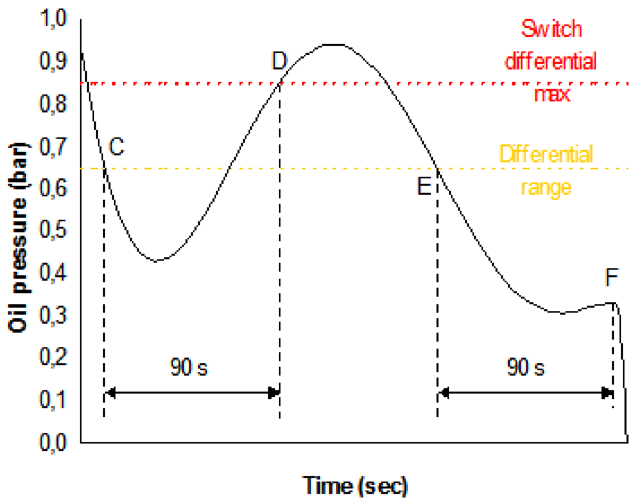


Figure 2-13 Oil pressure difference switch operation phase

2.7.1. Electronic oil pressure difference switch

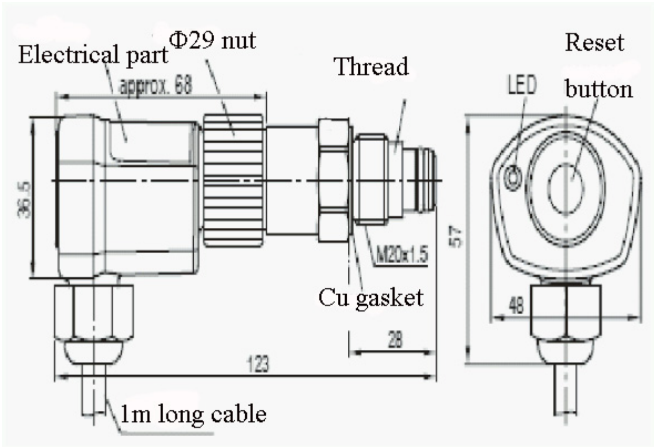
The electronic oil pressure difference switch is used to monitor the oil pressure difference of the lubricant when the compressor is running, so as to ensure that the lubricant has enough flow supply when the compressor is running. The electronic oil pressure difference switch is suitable for SBC series dual-stage piston compressors.

> **WARNING**
> All SBC series dual-stage piston compressors must monitor pressure, ensure the pressure difference.

Electronic oil pressure difference switch can replace the mechanical one, it consists of two parts:

- Pressure probe with thread
- Circuit control module, reset button, signal light, control wiring

Table 5. Electronic oil pressure difference switch parameters

		**Electrical part**	
Figure 2-14 Schematic diagram of electronic oil pressure difference switch		Power	AC 50/60Hz 115-230V -15...+10%
		Activate point voltage (D1)	AC 50/60Hz 115-230V -15...+10%
		Working temperature	-30...+70°C
		Delays: Power connection output delay Activate point D1 connection output delay Fault alarm output delay Output delay of pressure difference protection Output delay when it's reset (power off) Output delay when it's reset (reset button)	3s ±1s 5s ±2s 5s ±2s 90s ±5s About 5s About1s
		Power output	AC 240V 2.5A C300 AC/DC 24V,>20mA
		Mechanical service life	About 100000 times on-off
Mechanical part		IP class (Based on EN60529)	IP54 (Indoor status)
Working temperature	-30...+90 °C	Housing material	PA66/PA6 Reinforced fiber-glass
Pressure difference protection	0.65bar±0.15bar	Connection cable	6xAWG-18 cable, L=1m
Max. working pressure	30 bar	Installation	Connection nut
Housing material	Brass	Weight	About 160g
Connection thread	M20x1.5	Verification basis	EN 61000-6-2 EN 61000-6-3 EN 61000-1
Weight	About 130g	Certification	HL file No.E222056

In operation, with reference to Figure 2-15; during the compressor start-up phase, the closing of the auxiliary relay K1 makes the electronic oil pressure difference switch working. If the oil pressure difference is too low, the red LED flashes, and the delay starts to work, and the electronic oil pressure difference switch output is still closed (red line and orange line). If the oil pressure difference is still lower than the set value after 90 seconds, the electronic oil pressure difference switch output disconnects and the compressor will be shutdown. If the oil pressure difference equals or exceeds the set value within 90 seconds, the electronic oil pressure difference switch output is still closed, the red light is not flashing, and the delay time is reset. When the oil pressure difference fails, please reset after at least 90 seconds. Before resetting, the operator should confirm the oil pressure difference fault and its cause. The microprocessor inside the electronic oil pressure difference switch can also accumulate the time of insufficient oil pressure. The output of the electronic oil pressure difference switch will still be disconnected when the accumulated time reaches the set value.

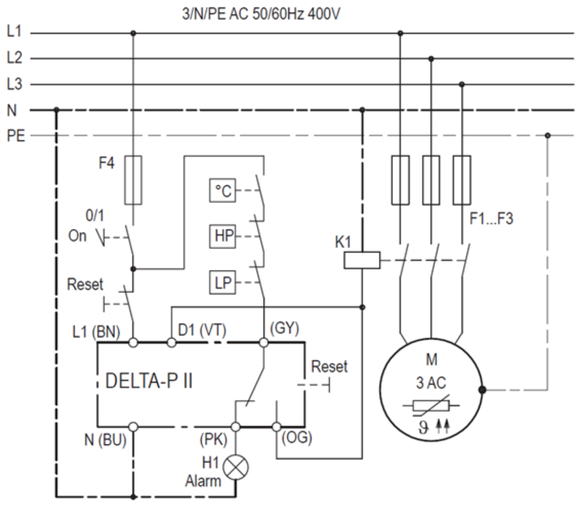


Figure 2-15 Wiring diagram of electronic oil differential pressure switch

No.	Terminal	Color	Function	Notes
1	L1(BN)	Brown	Power live wire	
2	N(BU)	Blue	Power neutral wire	
3	D1(VT)	Purple	Pressure difference protection after power on	
4	(GY)	Grey	Signal public end	
5	(PK)	Pink	GY connects with PK while alarming	Under normal condition, GY and PK disconnects after power on 3 seconds, GY connects with OG
6	(OG)	Orange	GY disconnects with OG while alarming	

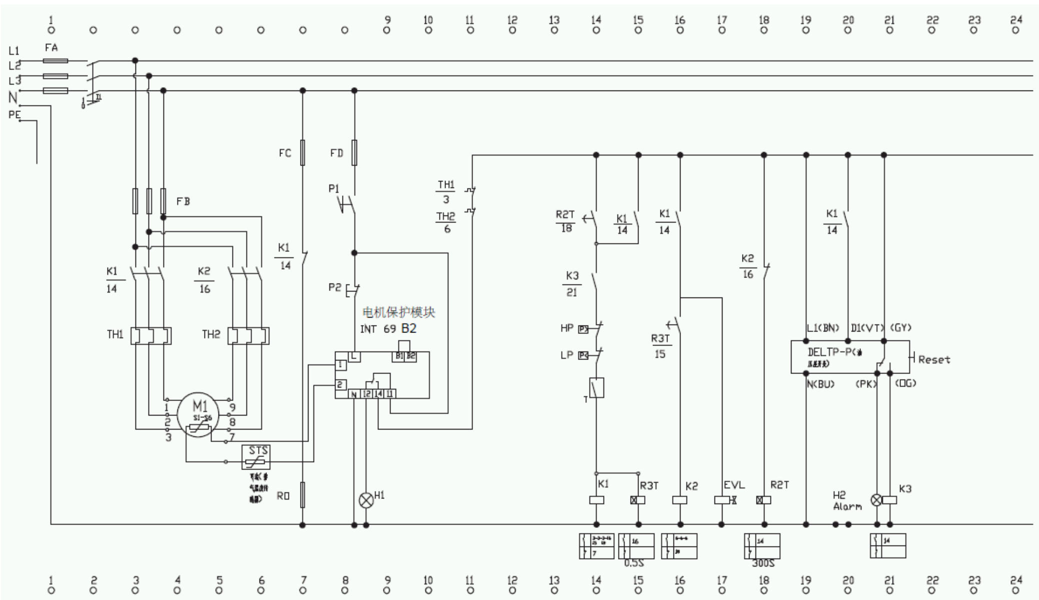


Figure 2-16 Electrical wiring diagram of electronic oil pressure difference switch

FA: Main fuse

I1: Main switch

R2T: Start delay time relay

TH1: First winding thermal relay

FB: Compressor fuse

INT68VS: Compressor protection module

R3T: PW start time replay

TH2: Second winding thermal relay

FC: Crankcase heater fuse

K1: First winding contactor

R0: Oil groove electrical heater

DELTP-P: Electric oil pressure difference switch

FD: Control circuit fuse

K2: Second winding contactor

S1-6: Motor winding PTC components

P1: Control circuit switch

H1: Emergency light of compressor protection module

LP: Low pressure controller

STS: Discharge temperature sensor

P2: Rest button of compressor protection module

HP: High pressure controller

M1: Compressor

T:Thermostat

H2: Emergency light of oil pressure difference

The installation of the electronic pressure difference switch is shown in Figure 2-17.

- For the overall dimensions of the electronic oil pressure difference switch, refer to chapter 8 Overall dimension (page 47).
- After making sure no pressure inside compressor, remove plug and aluminum gasket from compressor gear oil pump base and tightenoil pressure difference switch and copper gasket with 100Nm torque.

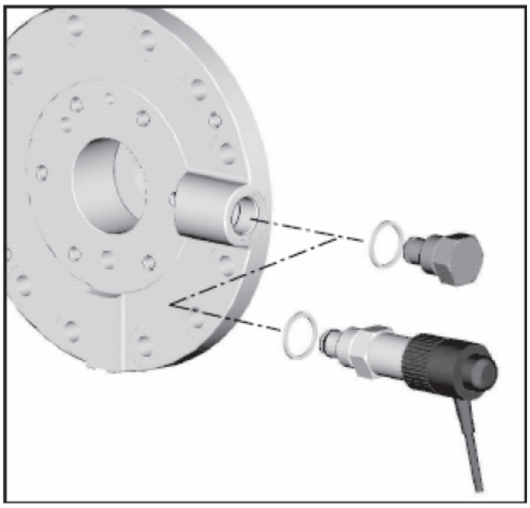


Figure 2-17 Installation diagram of the electronic oil pressure difference switch

2.7.2. Mechanical oil pressure difference switch MP54

Mechanical oil pressure difference switch MP54 for all SBC series piston compressors can be ordered with the compressor, and it can also be assembled in compressor if it is required.

The installation diagram of the mechanical oil pressure difference controller is shown in figure 2-18.

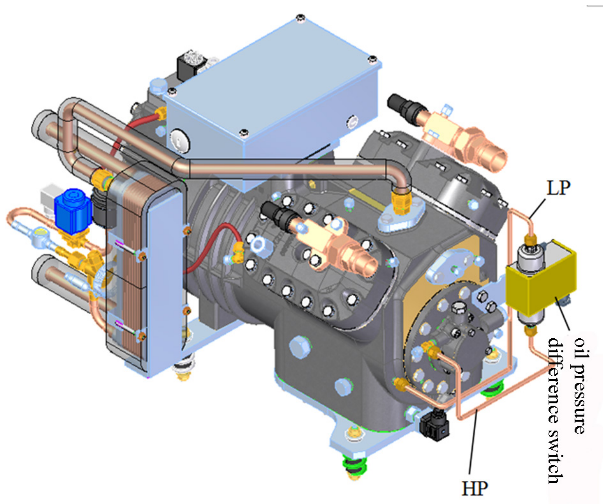


Figure 2-18 Installation diagram of mechanical oil pressure difference switch MP54

Figure 2-19 shows the mechanical oil pressure difference controller MP54 components.

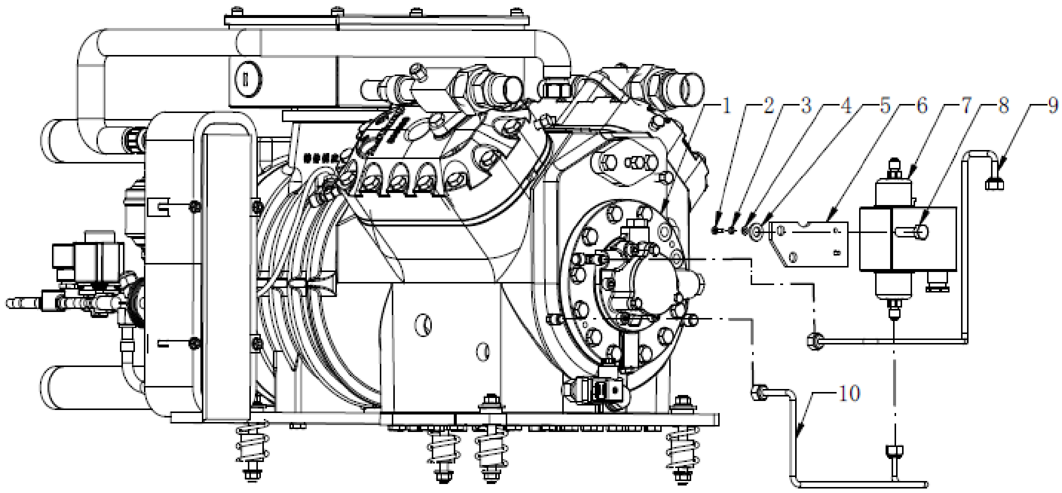


Figure 2-19 Mechanical oil pressure difference controller MP54 components (code: 303191)

Details of mechanical oil pressure difference switch components, as shown in Table 6.

Table 6. Mechanical oil pressure difference switch components (code: 303191)

No.	Code	Description	QTY
1	SBC series	SBC series compressor	1
2	610630	M4x12 bolt	2
3	614463	M4 spring gasket	2
4	614464	Gasket D=4.3	2
5	614170	Gasket D=10.5	2
6	519044	Oil pressure difference switch bracket	1
7	760508	Oil pressure difference switch MP54(60B0168)	1
8	612150	M10x35 bolt	2
9	540682	LP pipe	1
10	540683	HP pipe	1

MP54 and oil pressure difference switch mounting components can be ordered from the after sales department. Oil pressure difference switch and the components of oil pressure difference switch should be assembled before vacuuming and refrigerant charging.

WARNING

After several times compressor shutdown due to low oil pressure, please confirm default reason for low oil pressure, since it greatly damages compressor.

Oil pressure difference switch MP54 parameter shows at Table 7.

Table 7. Oil pressure difference switch MP54 parameter

Power	230V or 115V, AC. or DC.1phase -50/60Hz
Extended time	90s
Pressure difference	0.65 bar
Deviation	0.2 bar
Rated electric parameter	AC: 2A,250V / DC: 0.2A,250V
Electric ingress protection	IP20

Application electric diagram of mechanical oil pressure difference switch MP54 is shown in Figure 2-20.

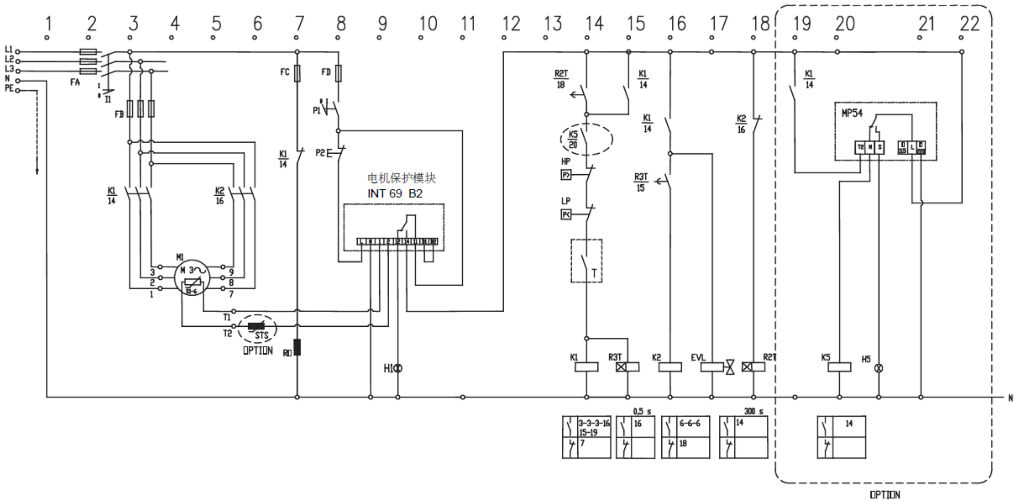


Figure 2-29 Electrical diagram of mechanical oil pressure difference switch MP54 application

T: Thermal protection

FD: Control circuit fuse

K1: Compressor starting contactor

R4: Compressor protective relay

S1-6: Motor temperature sensor

H5: Compressor oil differential pressure alarm light

FA: Main fuse

HP: High pressure switch

K2: Compressor operating contactor

M1: Compressor

P1: Compressor switch

K5: Oil pressure difference relay protector

FB: Compressor fuse

LP: Low pressure switch

R2T: Start time delay relay

I1: Main switch

P2: Compressor protective reset button

MP54: Oil differential pressure switch

FC: Oil heater fuse

H1: Compressor protection light indication

R3T: Sub-coil delay relay

RO: Oil heater

EVL: Compressor liquid injection solenoid valve　　*STS: Discharge temperature sensor*

2.8. Oil return

All SBC series compressors are equipped with a venturi ejection tube to eject the oil on the suction side into the crankcase oil tank., as shown in Figure 2-21 and Figure 2-22.

Generally, the oil flow rate of the gear oil pump is larger than the oil flow rate required by the compressor. During the operation of the compressor, the excess oil except for the oil required by the compressor returns to the crankcase oil sump through the venturi ejector. The oil passes through the venturi ejector (the blue arrow part, above), and the oil on the suction side (the oil level on the suction side is lower than the oil level of the crankcase) can be ejected back to the crankcase oil tank.

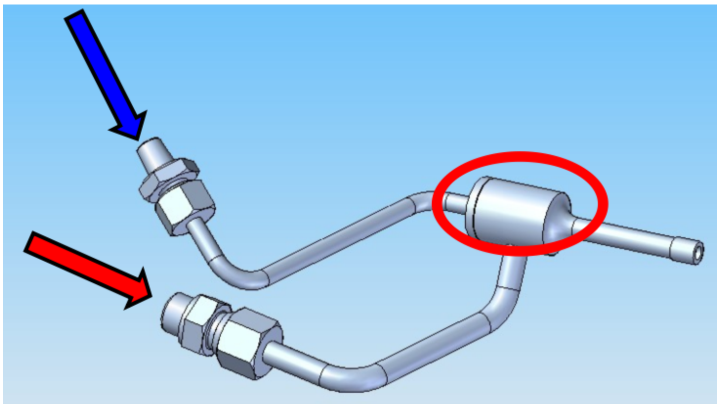


Figure 2-21 Oil return ejector

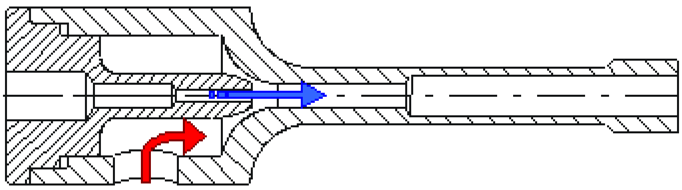


Figure 2-22 Venturi ejector profile view

2.9. Anti-foaming valve

In the previous chapter Oil pressure (page 10), all SBC series compressors are equipped with a check valve between the crankcase and the suction part. The check valve is closed at the moment of compressor start to prevent the lubricant from "foaming" as the pressure in the crankcase of the compressor decreases with the pressure on the suction side. As shown in Figure 2-23.

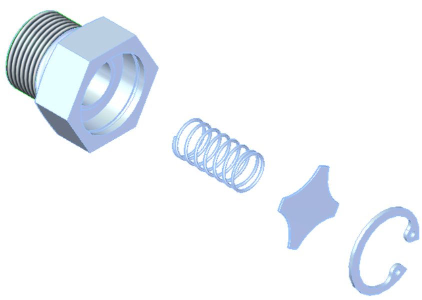


Figure 2-23 Explosion drawing of anti-foaming check valve

2.10. Lubricant

Lubricant should meet the following requirements:

- Enough bearing lubrication;
- The oil viscosity under nominal working condition;
- The intersolubility with refrigerant under low temperature.

> **WARNING**
> Never apply the lubricant not recommended by RefComp; prohibit contacting with humid air for the lubricant has high hygroscopicity.

Following table are the lubricants for different refrigerants of RefComp.

HCFC refrigerant R22

3GES

Code	Chemical property	Viscosity @40°C (mm^2/s)	Viscosity @100°C (mm^2/s)	Flash point(COC °C)	Pour point(°C)	Ignition point(°C)	Specific gravity/ density(g/cm^3)	Total acid value(mgKOH/g)	Water content(ppm)	Floc point(°C)
S008	mineral oil	29.5	4.31	178	-40	-	0.909	0.01	20	-53

According to the oil viscosity required by condensing temperature, two kinds of lubricants can be applied for HFC refrigerants R404A and R507.

HFC refrigerants R404A and R507.

Tc<55°C

3.5GES

Code	Chemical property	Viscosity @40°C (mm^2/s)	Viscosity @100°C (mm^2/s)	Flash point(COC °C)	Pour point(°C)	Ignition point(°C)	Specific gravity/ density(g/cm^3)	Total acid value(mgKOH/g)	Water content(ppm)	Floc point(°C)
S009	polyol ester (POE)	32.3	5.14	230	-35	-	0.956	0.01	35	-

Tc>55°C

4.5GES

5GES

Code	Chemical property	Viscosity @40°C (mm^2/s)	Viscosity @100°C (mm^2/s)	Flash point(COC °C)	Pour point(°C)	Ignition point(°C)	Specific gravity/ density(g/cm^3)	Total acid value(mgKOH/g)	Water content(ppm)	Floc point(°C)
S010	polyol ester (POE)	66.6	8.22	254	-40	-	0.960	0.01	35	-

2.11. Lubricant injection

Part of lubricant will stay at the refrigeration system during normal refrigeration system operation.

Generally, part of lubricant will stay at the refrigeration pipelines, so the oil level of compressor oil sight glass will decrease. Charge 10% more lubricant of lubricant injection amount to the refrigeration system according to the actual situation if required.

The lubricant for the oil separator should be considered if the refrigeration system is equipped with oil separator.

Regularly check the oil level through oil sight glass during initial operation.

At the previous chapter Oil level (page 15), check the compressor oil level when compressor running smoothly, the compressor oi level varies a lot for the mutual dissolution with refrigerant during compressor shutdwon.

Lubricants of HCFC and HFC refrigerants are with strong hygroscopicity, lubricant shall not contact with air for a long time during oil replacement or other situations.

When the refrigeration system operation and oil level are stable, check if the lubricant property changed after 300 hours operation: lubricant color, odour and chemical composition, consider replacing the lubricant if lubricant changes. Check the following items:

- Kinematic viscosity;
- Humidity;
- System PH value;
- Lubricant composition.

Some lubricant properties are shown in table below.

Replace the lubricant, oil filter etc, if the compressor lubricant property changed. Some refrigeration components will damage since there might be some acid inside the lubricant.

Look	Clear and transparent, no muddy	Clear and transparent, no muddy	Clear and transparent, no muddy
Color	L0.5 (ASTM)	L0.5 (ASTM)	L0.5 (ASTM)
Kinematic viscosity (40°C)	29.5 (mm^2/s)	32.3 (mm^2/s)	66.5 (mm^2/s)
Humidity	20 (ppm)	35 (ppm)	35 (ppm)
Acidity	0.01 (mgKOH/g)	0.01 (mgKOH/g)	0.01 (mgKOH/g)

2.12. Oil temperature

The oil temperature shall not exceed 80°C during normal working status, the temperature difference between oil temperature and condensing temperature is round 40K, the discharge temperature shall not exceed 140 °C.

3. Liquid subcooler and liquid injection components

3.1. Expansion valve kit with liquid subcooler

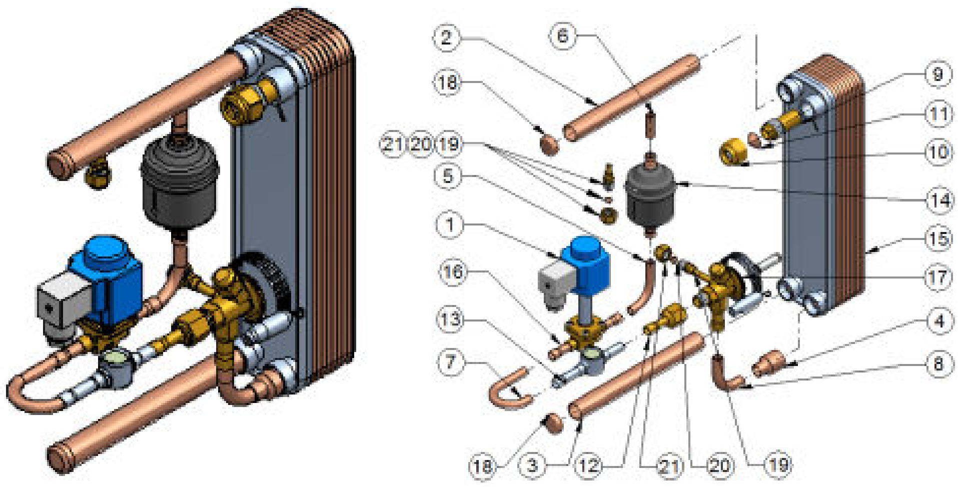


Figure 3-1 Explosion diagram of expansion valve kit with liquid subcooler

1. *Solenoid valve coil*
2. *7/8" copper tube*
3. *7/8" copper tube*
4. *Copper reducer Cu19-13*
5. *3/8" copper tube*
6. *3/8" copper tube*
7. *3/8" copper tube*
8. *1/2" copper tube*
9. *5/8"SAE direct connector*
10. *Nut*
11. *Copper cap*
12. *Welding connector*
13. *Sight glass*
14. *Drying filter*
15. *Pltae heat exchanger*
16. *Solenoid valve*
17. *Thermal expansion valve*
18. *Copper cap Cu22*
19. *PIn valve*
20. *"Copper cap 1/4" "SAE"*
21. *Nut 1/4" SAE*

3.2. Nozzle model

The SB4C series has only one type of nozzle (code 700353) for refrigerants R22, R404A and R507.

There are three types of nozzles for the SB6C series. Choose the appropriate nozzle according to different refrigerants and actual working conditions, as shown in table 8.

Table 8. Expansion valve kit nozzle model of SB6C Series with liquid subcooler

Model	Refrigerant and working condition	Code	Nozzle
SB6C-1600	R404A-R507	700354	nozzle 4
	R22	700353	nozzle 3
	R404A Pe<-60°		
SB6C-2000	R404A-R507	700355	nozzle 5
	R22		
	R404A Pe<-60°	700353	nozzle 3
SB6C-2500	R404A-R507	700355	nozzle 5
	R22		
	R404A Pe<-60°	700353	nozzle 3
SB6C-3000	R404A-R507	700356	nozzle 6
	R22	700355	nozzle 5
	R404A Pe<-60°	700353	nozzle 3

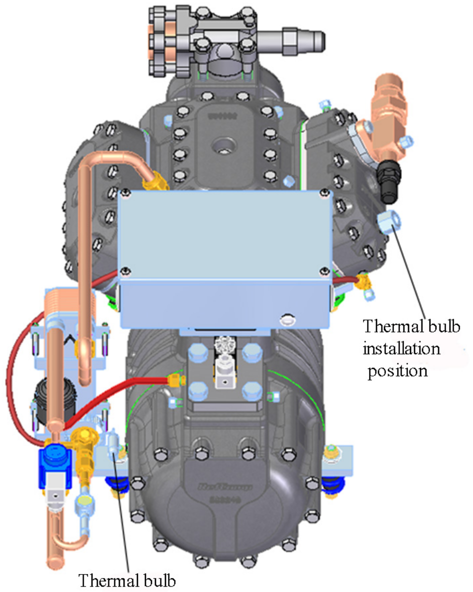


Figure 3-2 Expansion valve kit with liquid subcooler

As shown in Figure 3-2, the expansion valve kit with liquid subcooler has good cooling effect, simple and efficient, and wide application range. The expansion valve kit with liquid subcooler prevails.

3.3. Working principle

The final displacement of dual-stage SBC series piston compressor is obtained by two successive compression. The displacement of the first stage compression arrives the suction of second stage compression through the internal passage, discharge the gas after two compression.

As shown in Figure 3-3, the subcooler has two cooling pipelines. The pipeline 1 controls the cooling motor by connecting the built-in sensor of the motor with the external solenoid valve. The SBC series compressor is built into the special sensor switch in the motor. When the motor temperature reaches the injection temperature, the automatic control solenoid valve is turned on, and starts injecting to cool the motor. When the motor temperature returns to a certain temperature, the sensor switch is turned off and stopped the injection, so repeating the cycle, so that the motor runs repeatedly in the appropriate temperature range. The pipeline 2 is used to reduce the suction temperature of the secondary compression, and the low-temperature refrigerant from the subcooler is mixed with the first-stage compressed gas to reach the suction temperature which reduces the secondary compression, thereby improving the efficiency.

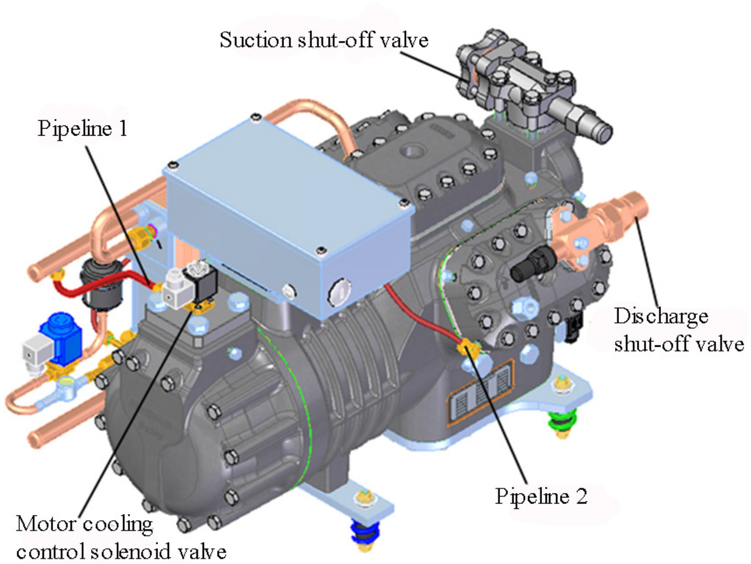
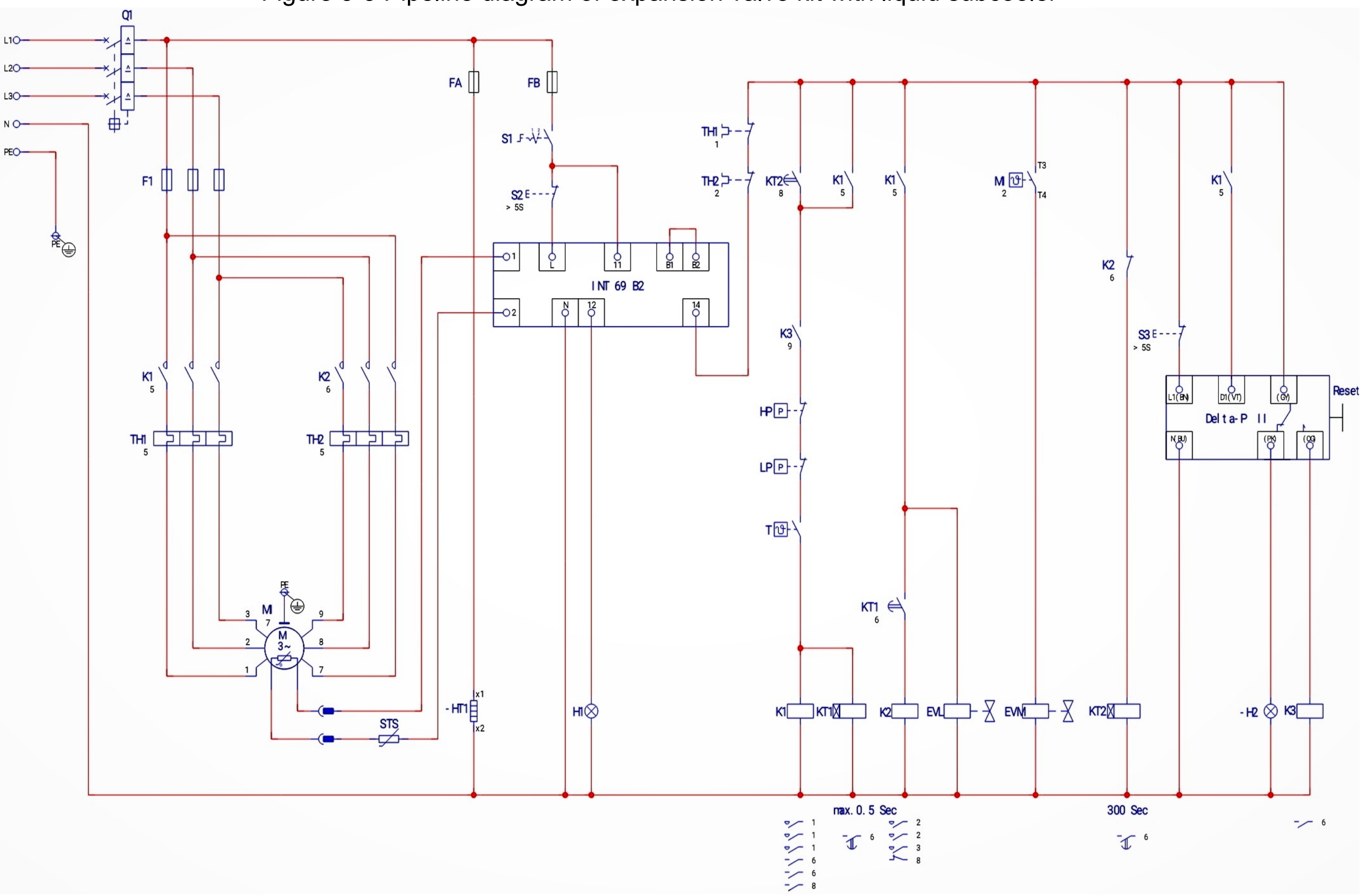


Figure 3-3 Pipeline diagram of expansion valve kit with liquid subcooler



Q1: Main switch

F1: Compressor fuse

FA: Heater fuse

FB: Control circuit fuse

K1: Motor contactor 1

K2: Motor contactor 2

K3: Oil pressure difference controller intermediate relay

TH1: Thermal overload relay 1

TH2 : Thermal overload relay 2

M1: Compressor motor (built-in PTC and motor-side automatic liquid injection sensor)

STS: Discharge temperature sensor

HT1: Electric heater

S1: Control switch

S2: Fault reset switch

S3: Fault reset switch

HP: High voltage switch

LP: Low voltage switch

T: Temperature controller

KT1: Time relay sub-coil

KT2: Time relay running time interval

H1: Overload signal indication

H2: Oil pressure difference alarm

EVL: Liquid supply solenoid valve

EVM: Motor-side automatic liquid injection solenoid valve

T3: Motor end automatic injection sensor contact 3 (at the terminal block)

T4: Motor end automatic injection sensor contact 4 (at the terminal block)

Motor end automatic injection control circuit:

The special sensor switch built in the motor, the contact is connected to the T3 and T4 of the terminal block, and the sensor is connected with the EVM (automatic liquid injection solenoid valve of the motor end) and connected to the 230V power to realize automatic liquid injection control.

4. Components

4.1. Suction filter

The installation positions of the suction filters of the SB4C and SB6C series compressors are shown in Figure 4-1 and Figure 4-2.

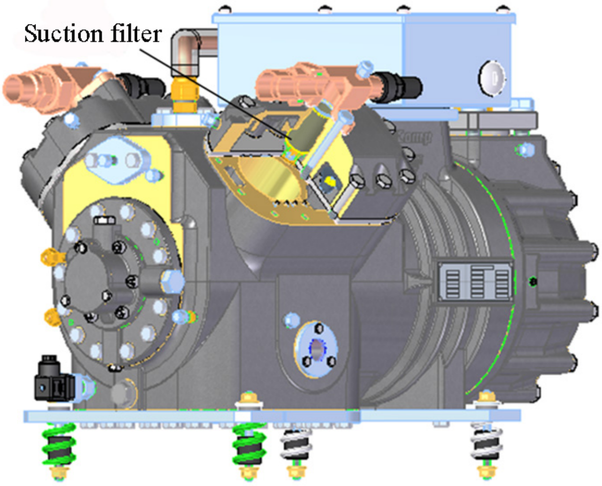


Figure 4-1 Position of the SB4C series suction filter

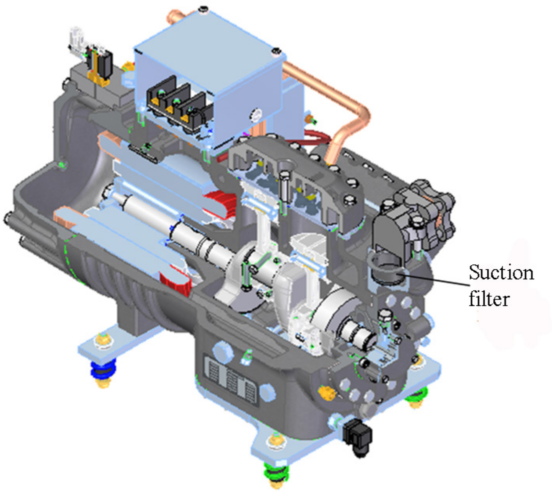
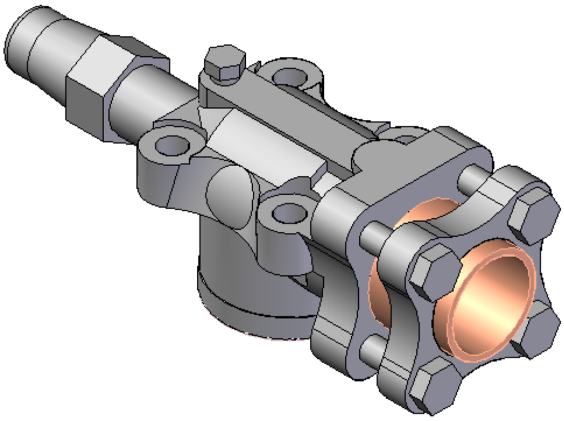


Figure 4-2 Position of the SB6C series suction filter

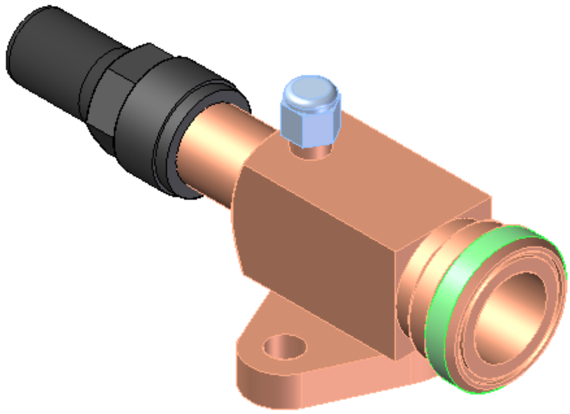
4.2. Stop valve

On the suction side, the suction stop valve of the SB4C series compressor adopts a similar structure as shown in Figure 4-3(b). The SB6C series compressor suction stop valve uses a similar structure as shown in Figure 4-3(a).

On the discharge side, the SB4C and SB6C series compressor discharge stop valves adopt a similar structure as shown in Figure 4-3.



(a) Suction stop valve

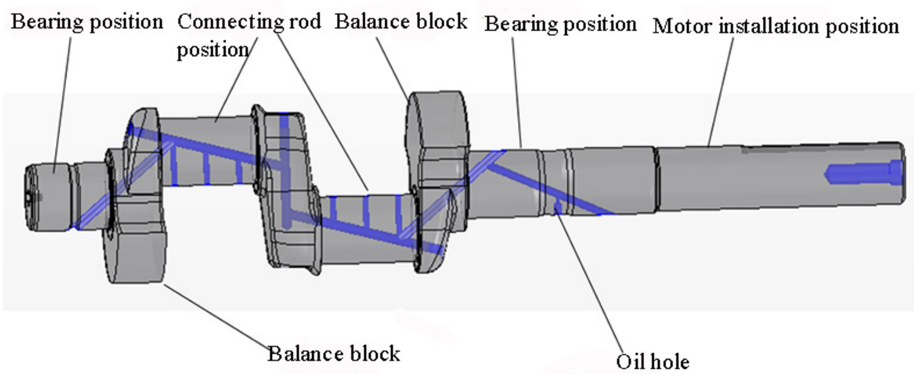


(b) Discharge stop valve

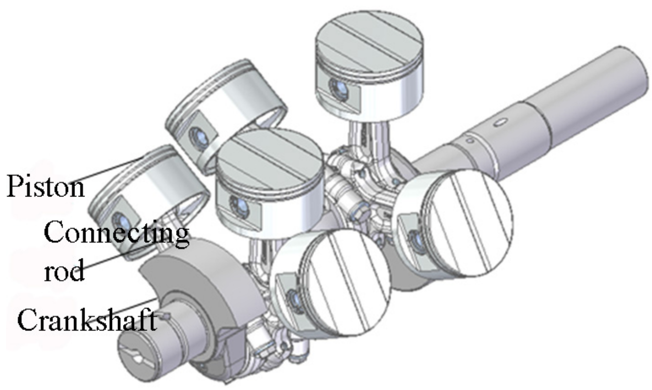
Figure 4-3 Stop valve

4.3. Crankshaft

The SBC series dual-stage piston compressor is designed with a balance block on the crankshaft. The crankshaft balance block is cast together with the crankshaft, as shown in Figure 4-4(a).



(a) Schematic diagram of SBC series crankshaft



(b)Schematic diagram of the mutual position of the crankshaft, connecting rod and piston

Figure 4-4 Schematic diagram of SBC series crankshaft piston connecting rod

4.4. Connecting rod piston

The connecting rods and pistons of the SBC series dual-stage piston compressor are connected by connecting rods, and the small end of the connecting rod has a wear-resistant bushing, which can enhance the service life. Consider the assembly lubrication between connecting rod and piston before use. As shown in Figure 4-5.

> **WARNING**
> Pay attention to the distance between the connecting rods, and the connecting rod and piston should be assembled to the corresponding side, otherwise the connecting rod will be broken.

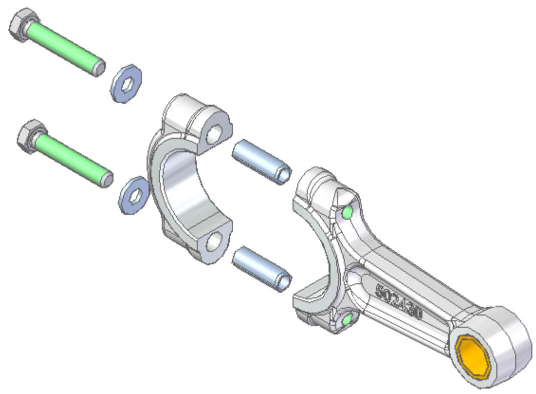


Figure 4-5 Schematic diagram of the SBC series connecting rod components

As shown in Figure 4-6, piston ring 4 has directionality and the surface marked as “TOP” should face up while assembly.

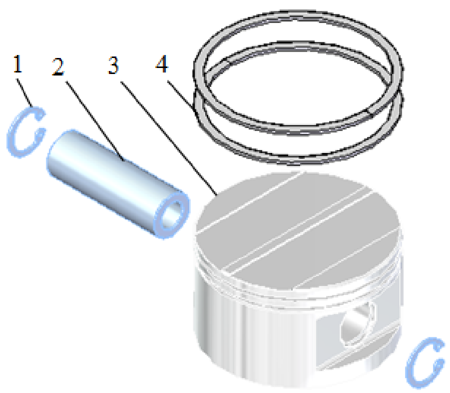


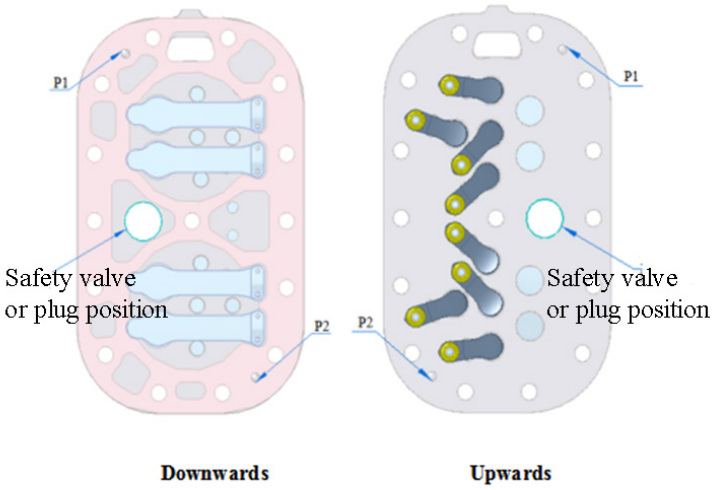
Figure 4-6 Piston

1.	*Retaining ring*	*3.*	*Piston*
2.	*Piston pin*	*4.*	*Piston ring*

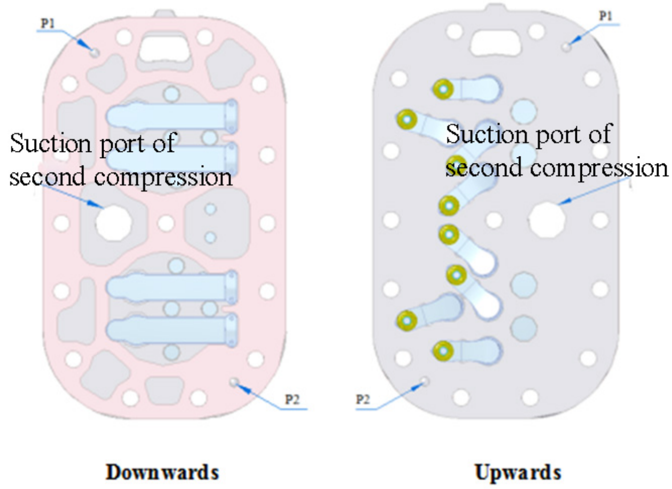
4.5. Valve plate

Figure 4-7 shows the correct assembly schematic diagram of the valve plate.

1. Install the gasket between the compressor housing and the valve plate correctly.
2. Refer to the direction shown in Figure 4-7 for the installation direction of the valve plate.
3. Correctly install the alignment pins at P1 and P2 positionsand the positions of the holes on the compressor housing as shown in the figure.
4. The valve plate is normally maintenance free.



(a) Schematic diagram of the first stage compression valve plate



(b) Schematic diagram of the second stage compression valve plate

Figure 4-7 Schematic diagram of the SB4C series valve plate

> ⚠ **WARNING**
> Ensure that the valve plate and its accessories are properly installed. Please avoid collision between the valve plate and other metal parts when cleaning the valve plate.

4.6. Bushing

Two bushings are fitted between crankshaft and compressor housing, the assembly method as shown in Figure 4-8, oil pump base side bushing as shown in Figure 4-9.

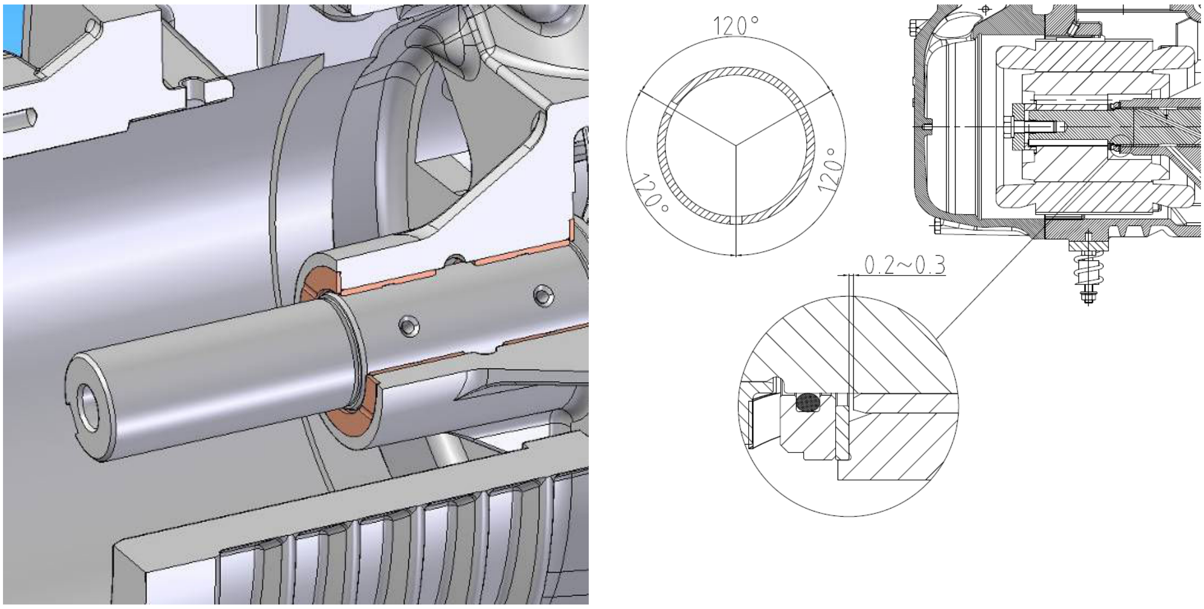


Figure 4-8 Schematic diagram of the motor side bushing

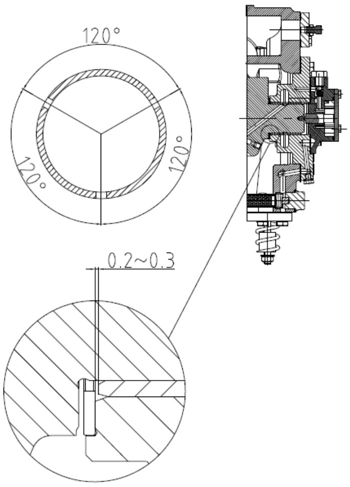


Figure 4-9 Schematic diagram of oil pump base bushing

Precautions of bushing assembly:

- Cutting “Clinch” should be placed at the top
- Respect a placement dimension of 0.2-0.3mm
- Once bushing is assembled, dimension should be Φ=45 (+0.04/+0.08)mm.

> **NOTE**
> When replacing the bushing, the bushing can be replaced when the hole at the bushing is less than Φ50.016mm. If it is larger than Φ50.016mm, please contact RefComp.

5. Electrical devices

5.1. General

The SBC series motors are three-phase four-pole asynchronous motors (50Hz, 1450 rpm or 60 Hz, 1750 rpm).

The standard motors for all models of the SBC series of dual-stage piston compressors are part winding start motors. A star/delta starter motor can also be provided as an optional accessory.

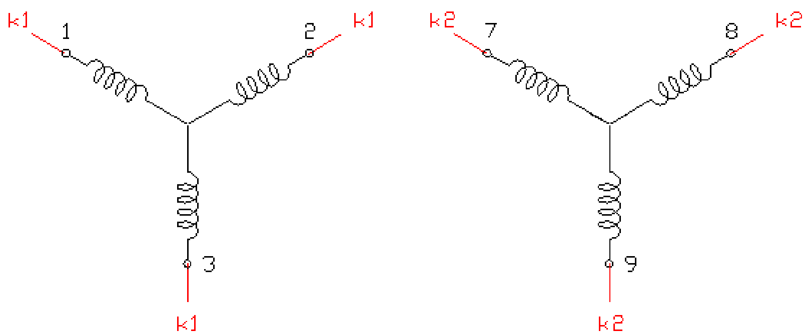
When PW motor is started, one of the coils of the motor is powered when it is started, and both coils of the motor are powered when it is in normal operation.

Figure 5-1 shows the terminal diagram of the part winding motor.

5.1.1. Part-winding start

Schematic diagram of part winding starter motor. As shown in Figure 5-1.

> **WARNING**
> PW coil measurement method: terminals 1, 2, and 3 are connected to each other; and terminals 7, 8, and 9 are insulated. Terminals 7, 8, 9 are connected to each other; and terminals 1, 2, and 3 are insulated.



Motor coil

Figure 5-1 Connection diagram of PW part winding Y-YY

5.1.2. Star-delta start

Schematic diagram of star-delta starting motor. As shown in Figure 5-2.

> **WARNING**
> Star-delta coil measurement method: terminal 1 and terminal 8 are connected and insulated from other terminals; terminal 2 and terminal 9 are connected and insulated from other terminals; terminal 3 and terminal 7 are connected and insulated from other terminals.

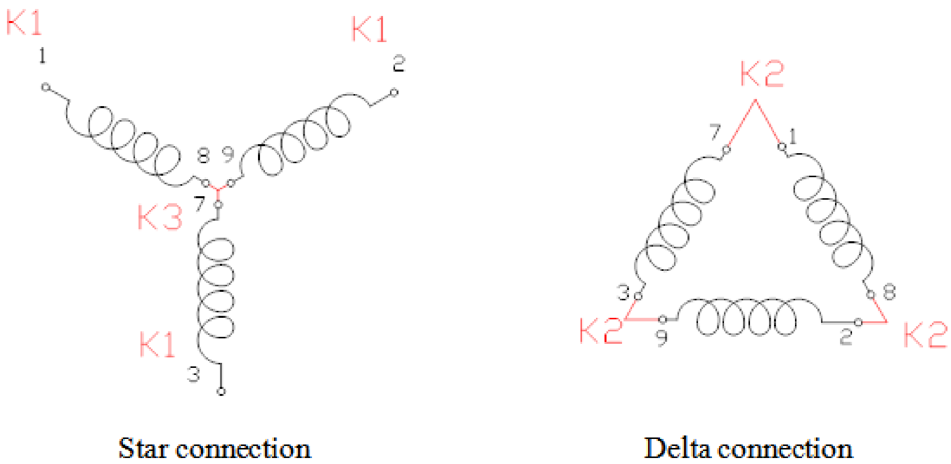


Figure 5-2 Connection diagram of star-delta

Whether it is PW start or star-delta start, the compressor motor needs to have a small starting current LRA and a small starting torque in the shortest time during the start-up phase. In order to achieve the purpose of reducing compressor starting current and starting torque, RefComp recommends that designers use high and low pressure balancing devices on the unit.

PW start and star-delta start electrical schematic diagram as shown in Figure 5-3.

As shown in Figure 5-3, K2 starts after K1 contactor starting in PW starting, generally with a delay of 0.3-0.7 seconds.

In the star-delta connection, the star operation time (K1-K3 closing) should not exceed 1.5s (0.8-1s is recommended). When converted to delta connection (k1-k2 closing), K2 closing should be 35-50ms after K3 opening.

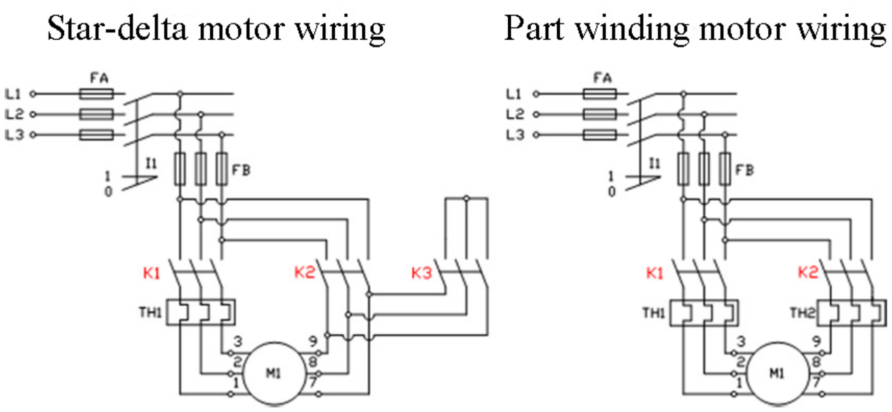


Figure 5-3 (a) Wiring diagram of the star-delta motor and part winding motor

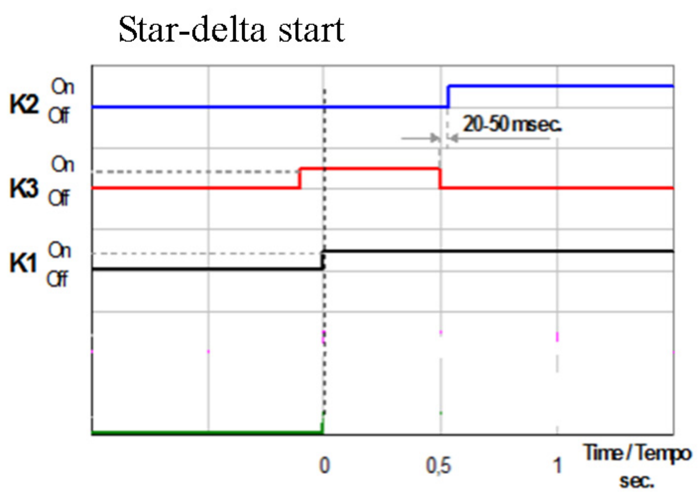


Figure 5-3 (b) Schematic diagram of the star-delta start contactor delay

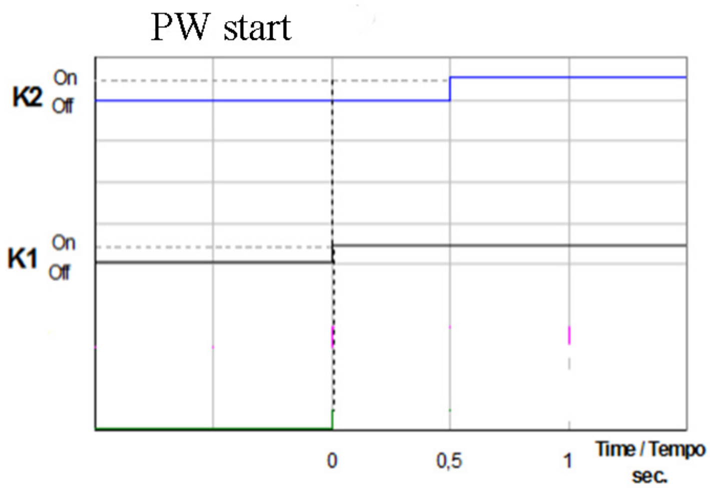


Figure 5-3 (c) Schematic diagram of the part winding start contactor delay

Figure 5-3 Schematic diagram of star-delta wiring and PW wiring and contactor delay

FA, FB: Compressor main circuit fuse

TH1, TH2: Thermal protection

I1: Main air switch

Motor design and test are based on European Norm EN60335-2-34.

M1: Motor

5.1.3. Motor insulation

The ground insulation, measured in factory before the shipping, is higher than 300MΩ (tested with Megger at 1000Vcc).

The moisture and acidity of the compressor will influence the electrical insulation. The insulation degree is also influenced by the motor temperature: higher is the temperature, lower will be the correspondence motor insulation. The Min. insulation resistance is 2MΩ, or the compressor motor operation might be risky. Check the dry filter and replace the lubricant under this situation.

WARNING

Prohibit testing the motor insulation level when the refrigeration system is in a vacuum.

5.2. Motor protection device

5.2.1. Motor thermistor

To protect the motor, 6 PTC thermistors are equipped into the compressor motor of SBC series, the activation temperature is 130°C.

When the temperature is lower than 40°C, the resistance value of the thermistor chain should not exceed 1800Ω. If the temperature of one thermistor exceeds a critical value, the resistance value of the resistor will increase exponentially. The compressor motor power is cut off by the protection module. The resistance value of the resistance chain can be measured according to the resistance terminals T1 and T2 in the electrical cabinet.

WARNING

When testing the resistance value of the resistance chain, the voltage used should not exceed 3V.

5.2.2. Motor protection module (INT69B2)

The SBC series piston compressor adopts INT69B2 protection module to protect the motor of the compressor. The module can also be connected with oil temperature sensor and discharge temperature sensor to protect the oil circuit and discharge temperature.

INT69 B2 protection module electrical parameter is shown in Table 9.

Table 9. INT69 B2 protection module electrical parameter

		Mechanical life	Approx. 1 million switching cycles
		IP class (based on EN60529)	IP00
		Housing	PA66 glass-fibre-reinforced
		Mounting	Screw mounted or snapped onto 35mm standard rail according to EN 60715
		Test loop	
		-Type	PTC (Based on DIN44081/082)
		-No. of sensor	1-9 (In series)
Supply voltage	AC 50~60Hz 115~230V ±10% 3VA	-R25	<1800Ω
Working temperature	-30~+70 °C	Reset of lock-out	Power off>5s
Output capacity	MAX. AC 240V 2.5A C 300MIN. AC/DC>24, >20mA	Weight	Approx. 170g

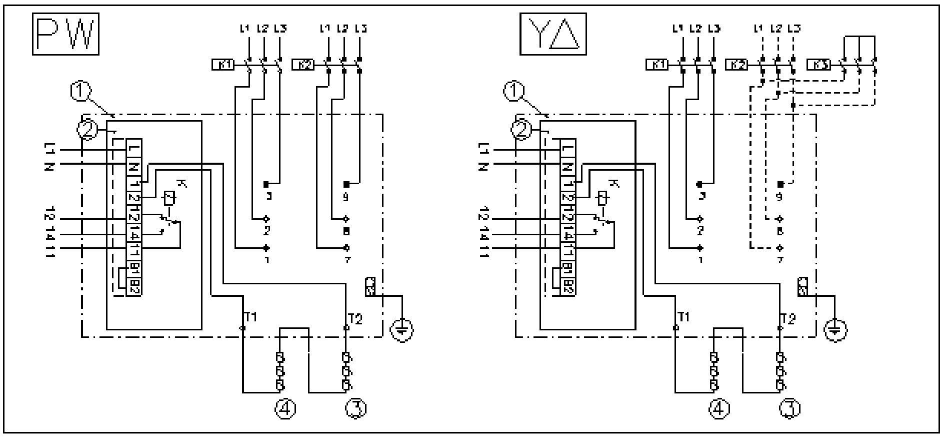


Figure 5-4 INT69 B2 electrical wiring diagram (PW wiring and star-delta wiring)

1	Terminal board	L1/L2	Single phase power supply
2	INT69 B2	11/14	Control circuit
3,4	Motor thermistor PTC	1/2	Thermistor connecting wire (orange)
L1,L2	Three-phase power	12	Alarm
K	Relay	b1	Automatic lock connection
PW	K1 PW (PW 50%) the first contactor K2 PW (PW 50%) the second contactor	Y/Δ	Star operation contactor of K1 and K3 (Y) Delta operation contactor K1 and K2 (△)

In order to protect the protection module, it is necessary to install 4A open circuit fuse on the control circuit.

After any alarm, check the module and control circuit carefully: disconnect K1 or K2, when the control circuit is powered on, the module should be in the alarm state.

When the thermal protection of the motor occurs, it should be reset manually to ensure that the compressor can be started only after the motor fault is confirmed and eliminated.

WARNING

Shutdown and reset the INT69 B2 after motor cooling from motor overheating.Prohibit power supply of terminal 1-2, B1-B2, T1-T2.

Cut off motor power supply if the resistance of thermistor resistance chain of INT69 B2 exceed 4.5KΩ, and reset when the resistance less than 2.75KΩ. The default set of compressor protection module INT69 B2 from RefCmop is **B1-B2** connection, the alarm reset of the protection module is automatically lock-out, automatically reset the module while take out the two terminal connection, RefComp recommends to keep the factory default.

Compressor should start after 30 minutes of motor overheat protection, it provides enough time to cool compressor motor, or the compressor motor might burn.

Generally, protection module will install at the compressor terminal box or the control cabinet, but the thermistor cables should be twisted and keep far away from power supply cable to prevent the false alarm and interference.

5.3. Power supply

- Standard motor 400V-3-50Hz-PW/460V-3-60Hz-PW (motor with different power supply need to be ordered)

- Allowable voltage variation range: Rated voltage±10%;
- Allowable voltage unbalance of L1-L2-L3:2%;
- The Max. voltage drop of compressor start-up phase:10% of rated voltage;
- Allowable frequency variation range:2% of rated frequency;
- Allowable current unbalance: 5-12%

Calculate as follows:

Current of the first contactor:

$$I1 - I2 - I3 \tag{1}$$

Current of the second contactor:

$$I7 - I8 - I9 \tag{2}$$

Current of each power supply phase:

$$IR = I1 + I7 \tag{3}$$

$$IS = I2 + I8 \tag{4}$$

$$IT = I3 + I9 \tag{5}$$

Unbalance of the three R-S-T currents:

$$I_M = \frac{I_R + I_S + I_T}{3} \tag{6}$$

$$SB_3^{\%} = \frac{MAX|(I_R, I_S, I_T) - I_M|}{I_M} \cdot 100 \tag{7}$$

$$SB_3^{\%} < 5\% \tag{8}$$

Six unbalance currents 1-2-3-7-8-9:

$$I_M = \frac{I_1 + I_2 + I_3 + I_7 + I_8 + I_9}{6} \tag{9}$$

$$SB_6^{\%} = \frac{MAX|(I_1, I_2, I_3, I_7, I_8, I_9) - I_M|}{I_M} \cdot 100 \tag{10}$$

$$SB_6^{\%} < 12\% \tag{11}$$

NOTE
Motor direction has no influence for lubricant supply due to the special design of oil pump.

Power supply of compressor accessories

The standard power supply for other compressor accessories (crankcase heater, solenoid valve, etc.) is 230V, 50/60Hz;Following power supply are also available.

- 110V 50/60Hz;
- 24V AC 50/60Hz.

5.4. Motor accessories

Refer to the compressor FLA for the selection of compressor power supply cable, fuse etc.. Normally, each coil contactor of motor with PW start should at least be 65% of FLA, for star-delta start, the contactor should at least be 75% of FLA.

5.5. Motor data

Check chapter 6 Model and technical data (page 43).

5.6. Terminal box

IP54 is the electrical standard of compressor terminal box. Note: as shown in Figure 5-5, screw A should be screwed with Teflon gasket, otherwise electrical level can't be guaranteed.

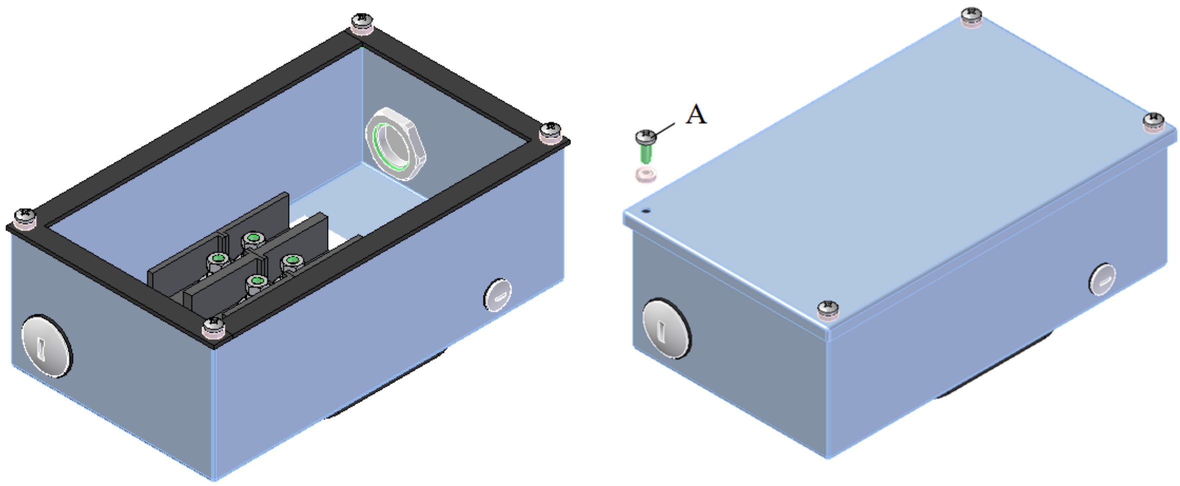


Figure 5-5 Schematic diagram of terminal box

5.7. Terminal board

There are six terminals of motor coil at the terminal board, terminals are insulated with ceramics, rubber cover is outside the ceramics to prevent short circuit caused by the condensing water. Check if the rubber cover damage and the tightness of terminal cable during maintenance.

Check the three-phase electricity connection method of compressor:

- Terminal 1-7 connects with phase A
- Terminal 2-8 connects with phase B
- Terminal 3-9 connects with phase C

Compressor motor can be direct-on-line (DOL) as shown in Figure 5-6. The corresponding terminals 1-7,2-8,3-9 can be connected using the DOL.

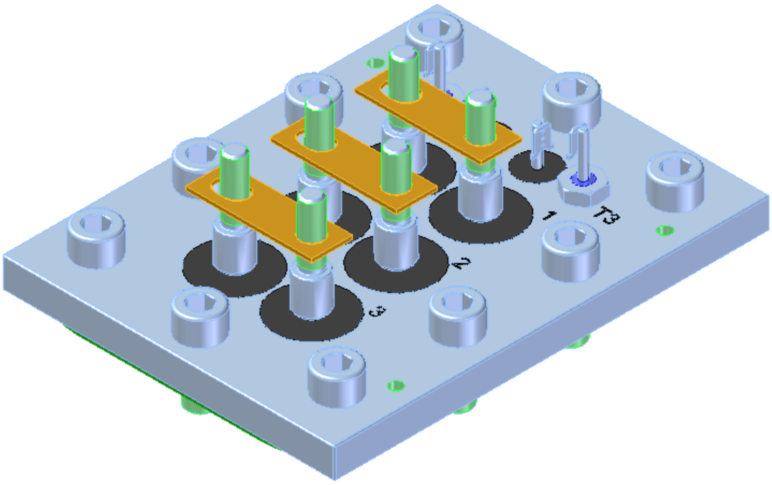
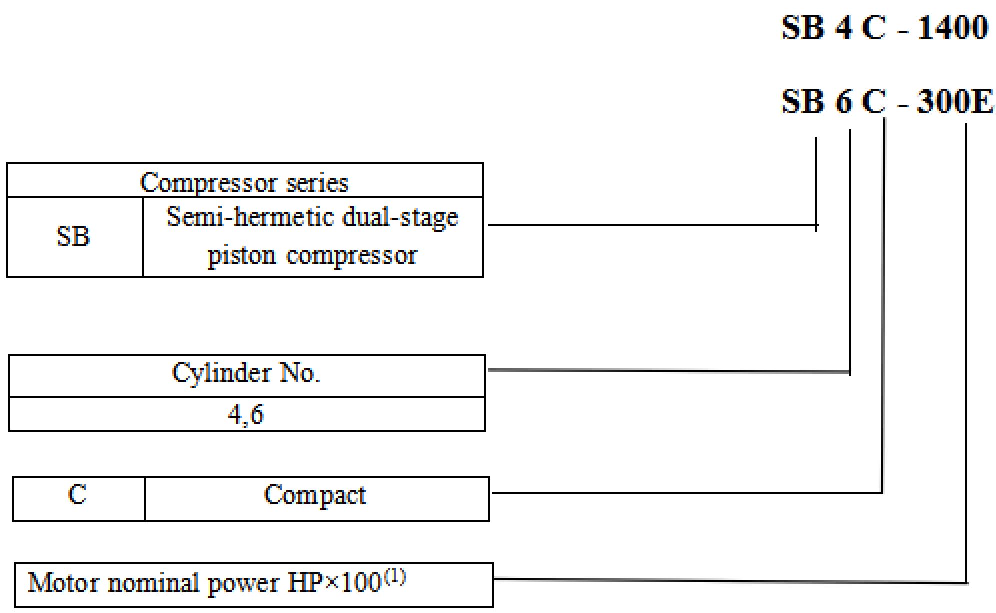


Figure 5-6 DOL connection diagram

6. Model and technical data

6.1. SBC series compressor model



NOTE
(1) “E” stands for compressor that uses POE oil.

For example: SB4C-1400

- SB: represents a semi-hermetic dual-stage piston compressor
- 4: represents 4 cylinders
- C: represents a compact type, used to distinguish from SB series
- 1400 (140E): represents a nominal motor power is 14HP
- The model ending with the letter E indicates a compressor that requires POE oil.

6.2. SBC series compressor technical data

Model: SBC		SB4C-1200	SB4C-1400	SB6C-1600	SB6C-2000	SB6C-2500	SB6C-3000
		SB4C-120E	SB4C-140E	SB6C-160E	SB6C-200E	SB6C-250E	SB6C-300E
Rated power	Hp/kw	12/8.8	14/10.3	16/11.8	20/14.7	25/18.4	30/22.1
Displacement (50Hz, low pressure / high pressure)	m^3/hr	43/27.6	51.5/32.3	64.7/32.4	75/37.5	86.1/43	102.9/51.5
No. of cylinder		4	4	6	6	6	6
Weight	Kg	202	206	215	225	235	242
Lubricant charge amount	dm^3	3.7	3.7	4.2	4.2	4.2	4.2
Crankcase heater	230V-150W-50/60Hz						
ID of discharge pipe Φ	mm	28	28	35	35	35	35
	inches	1 " 1/8	1 " 1/8	1 " 3/8	1 " 3/8	1 " 3/8	1 " 3/8
ID of suction pipe Φ	mm	35	35	42	42	42	42
	inches	1 " 3/8	1 " 3/8	1 " 5/8	1 " 5/8	1 " 5/8	1 " 5/8

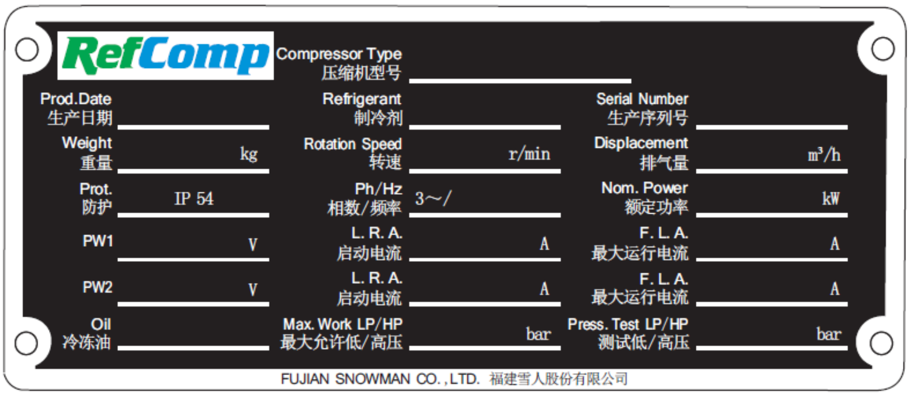
Standard motor (part winding)	400/3/50Hz(1)						
Starting current LRA	A	74/123	88/146	88/146	102/170	123/201	150/243
Maximum power consumption	KW	15	20	22	26	29	33
FLA	A	27	34	39	46	50	55

NOTE

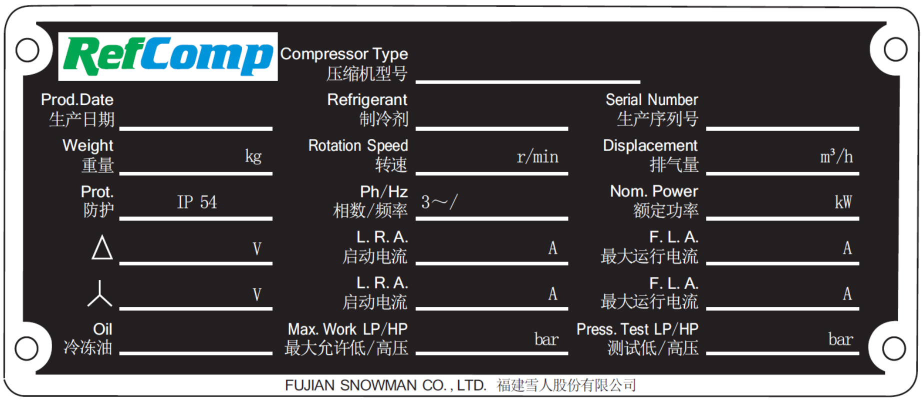
(1): current ±10%

6.3. Nameplate

Compressor nameplate is shown in figure 6-1.



(a) Part winding PW



(b) Star-delta Y-△

Figure 6-1 Nameplate parameter of PW and Y-△ start compressor

7. Scope of supply

7.1. Accessories of SBC series compressor can be supplied as required

7.1.1. Standard accessories

- Part-winding starting motor (400V/3/50Hz-460V/3/60Hz)
- Crankcase heater
- Discharge stop valve
- Suction stop valve
- Spring shock pad
- Direct-on-line (DOL)
- Motor protection module INT69B2 (230V/1/50-60Hz)
- Charging the oil
- Safety valve
- Oil sight glass
- Oil filter
- PTC thermistor
- IP54 electrical box
- Nitrogen protection

7.1.2. Optional accessories

- Special voltage motor
- Star-delta start motor (400V/3/50Hz-460V/3/60Hz)
- Special packing
- Oil pressure difference switch
- Discharge temperature probe components
- Expansion valve kit without liquid subcooler
- Expansion valve kit with liquid subcooler (recommended)
- LCM liquid subcooler
- LCM injection module

The standard electrical system of the compressor electronic parts (electronic protection module, crankcase heater) are 230V AC 50/60Hz. For special electrical parts, please consult RefComp.

7.2. Accessories can be packed separately while compressor delivery

- Crankcase heater
- Electronic oil pressure difference switch (control system)
- Mechanical oil pressure difference switch
- Expansion valve kit without liquid subcooler
- Expansion valve kit with liquid subcooler
- LCM liquid subcooler
- LCM injection module

WARNING
Generally, compressor is charged with protection Nitrogen of 1-2bar/15-30PSI while delivery, ensure release the Nitrogen while disassemble compressor parts, ensure both high pressure and low pressure are under normal pressure.

8. Overall dimension and packing

8.1. Overall dimension

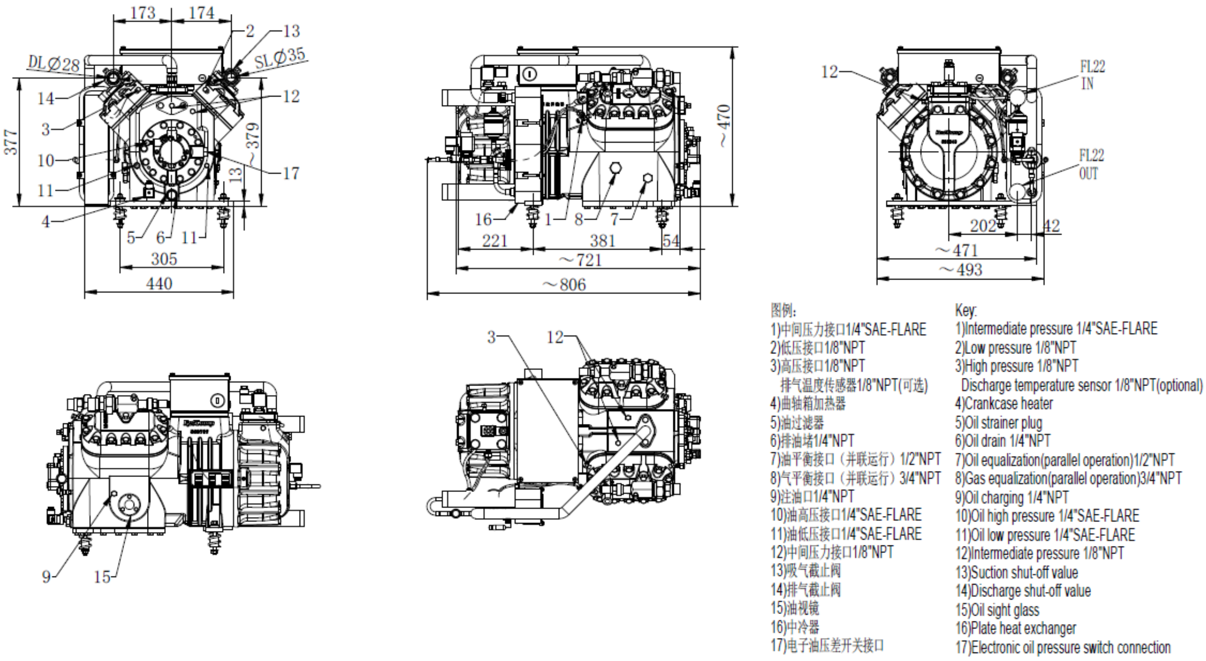


Figure 8-1 Overall dimensions of model SB4C-1200/1400

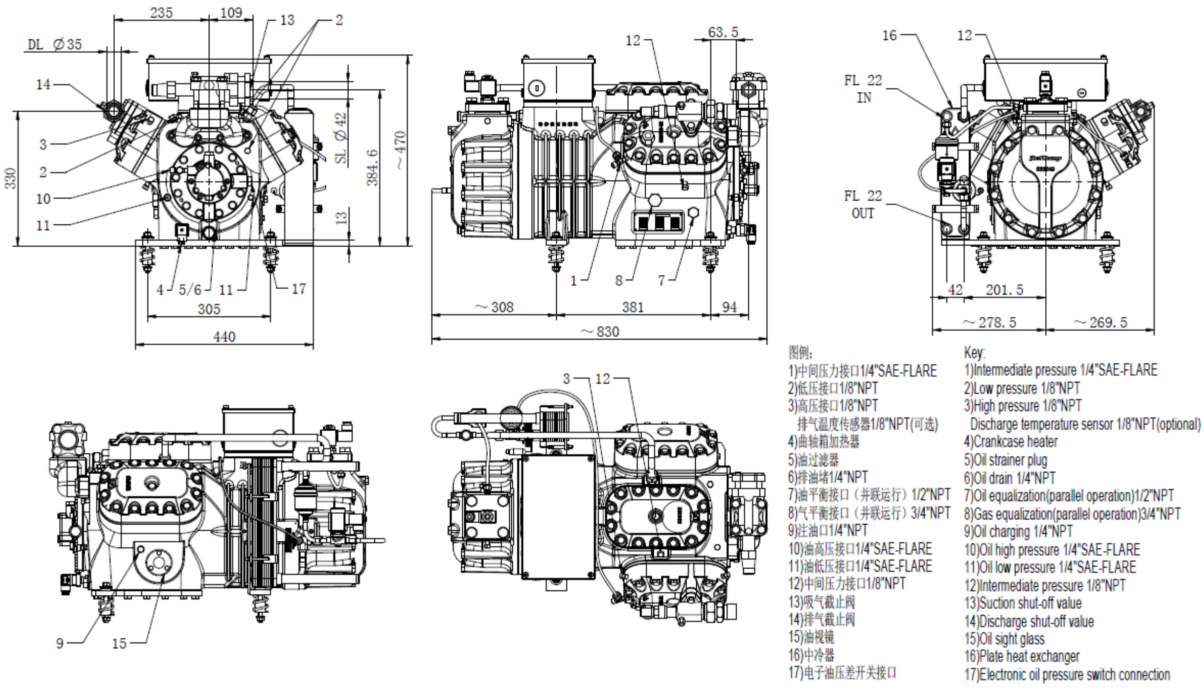
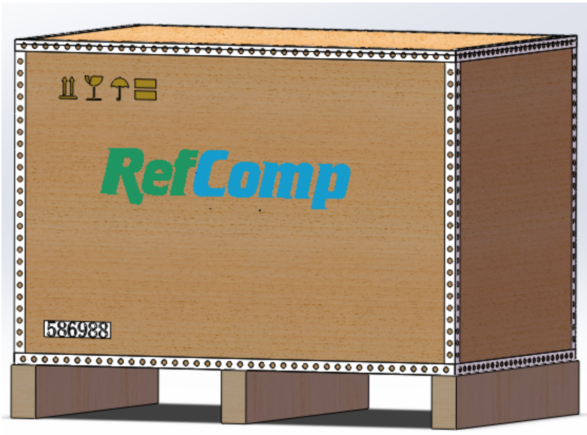


Figure 8-2 Overall dimensions of model SB6C-1600～3000

8.2. Packing

As shown in Figure 8-3, wooden pallet, plywood boards, wooden reinforcing rids and cover plate are applied for SBC series compressors to strengthen the packing strength.

Fix the compressor body to the wooden pallet by 4 screws. Package dimensions: length × width × height = 920 × 676 × 738. The package is shown in Figure 8-4 when the subcooler is not installed on the SBC series compressor.



(a) 3D model of the packing box

(b)Pallet structure of packing box

Figure 8-3 SBC series compressor standard packing box

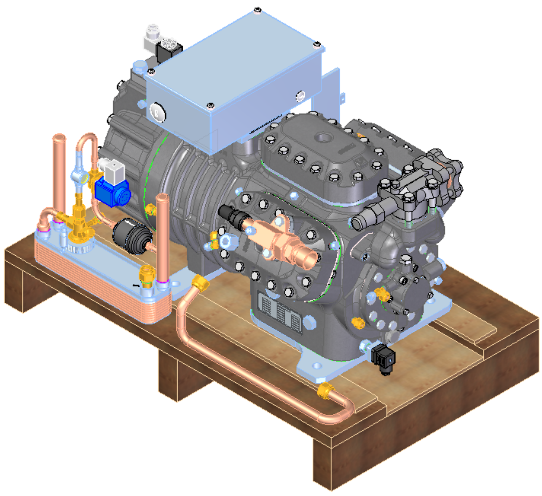


Figure 8-4 Schematic diagram of SBC series compressor packing

WARNING

The compressor moving or lifting must be operated by forklift and the operator should be trained. Following table is the transportation weight (with standard configuration) of SBC series models. Check chapter 7 Scope of supply (page 45) for specific configurations.

Model	Weight (Kg)
SB4C-1200	236
SB4C-1400	240
SB6C-1600	249
SB6C-2000	259
SB6C-2500	269
SB6C-3000	276

8.3. Inspection tests

Please check if packing and compressor has obvious damages while receive compressor. Please contact with RefComp or local dealers if confirm severe damage.

Some parts, especially those need to installed at the compressor at site, will packed separately (such as additional fan), check chapter 7 Scope of supply (page 45).

8.4. Storage notices

Carefully control the stacked layer: Accidents might happen if exceed the Max. Layers (Check figure 8-13).

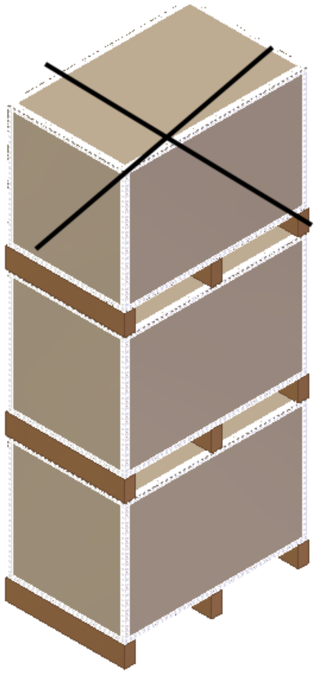


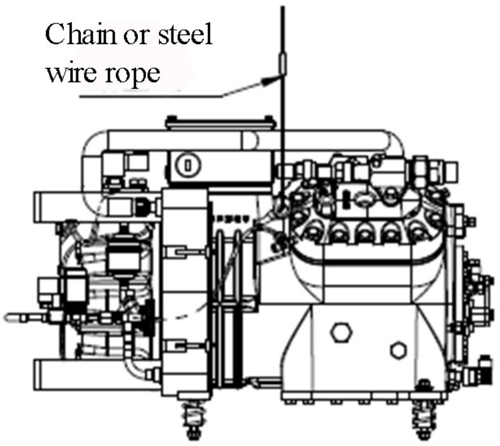
Figure 8-5 Two layers are the Max. layer

The storage environment should not have big variations in temperature and humidity, the storage time should not exceed one year, consider storing at cold place.

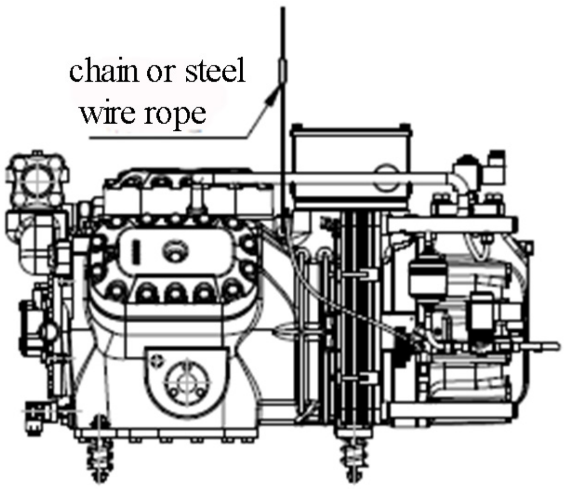
- Humid environment or direct sunshine will damage packing material, especially when many compressors stack together, it's more dangerous.
- Compressor mechanical part or plastic parts will damage if the temperature has severe periodically variations, which will increase the start risk of next start.

8.5. Handling and hoisting

Professional equipment should applied to ensure the safe operation as the compressor is heavy, recommend using the lifting device as shown in Figure 8-6.



(a) Lifting position of SB4C



(b) Lifting position of SB6C

Figure 8-6 Lifting instruction

8.6. Compressor transportation

Generally, there are two kinds of compressor transportation method: Individual compressor packing; or compressor installed at the refrigeration system with shock pad at feet.

8.6.1. Individual compressor packing

Protect compressor from impact and vibration while transporting such packing, or the compressor might fall from pallet. Packing box and compressor might all damage if transport at the bad roads.

8.6.2. Compressor installed at the refrigeration system with shock pad

Shock pad will minimize the vibration and stress to system structure and refrigeration pipelines, especially when compressor starts and shuts down.Compressor can directly installed at the system structure if the vibration-proof measures are not required. Check the inlet and outlet pipelines and ensure no big stress during compressor operation.

Compressor installed at the refrigeration system and transport with shock pad, the long vibration transfer might cause pipelines breaking and refrigerant leaking. Please fix the compressor system to prevent this. (Spring shock pad is for all SBC series, shock pad CKD is packed in a special Nylon bag)

8.7. Spring shock pad

To facilitate identification and assembly, different shock pads have a corresponding specific color representation (which is related to the rigidity of the spring). Table 10 corresponding colors and codes of two different assembly positions of different shock pads.

Table 10. Spring shock pads component code and corresponding rigidity color of SBC series compressor

Compressor model	Position A Rigidity/Color	Component	Position B Rigidity/Color	Component
SB4C-1200/1400,SB6C-1600	green	303131	grey	303130
SB6C-2000/2500/3000	green	303131	blue	303132

NOTE

Two pads for each component

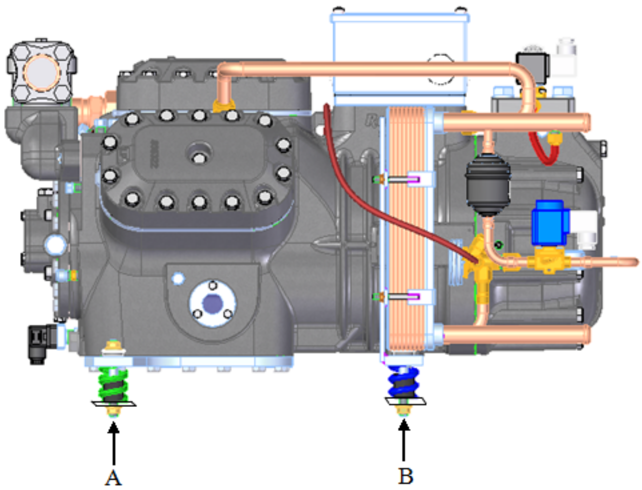


Figure 8-7 Assembly position of spring shock pad of the SBC series compressor

If the compressor has been installed on the unit, the self-tightening nut (1) must be tightened until the compressor base (3) touches the spring guide (4) to reduce the possibility of compressor displacement.

When the refrigeration unit is installed in place, the self-tightening nut on the compressor must be removed or loosened to leave enough clearance between the nut and the shocking pad.

Figures 8-8 shows different shapes of spring shock pad during compressor normal operation and compressor transportation.

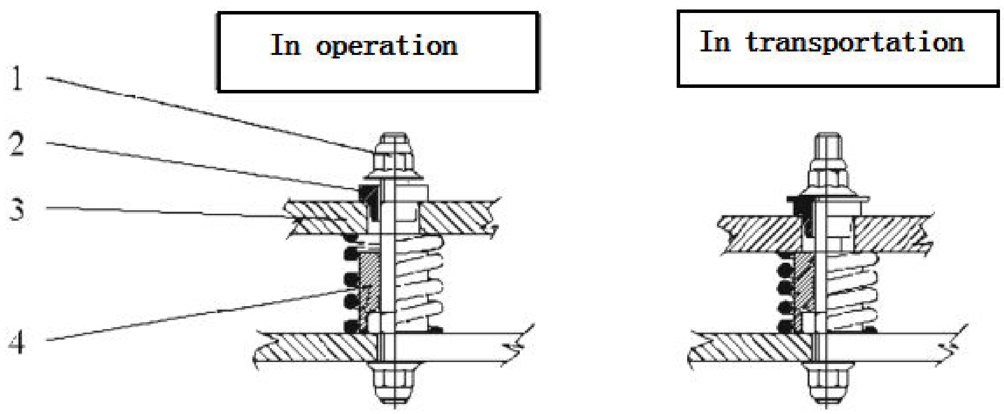


Figure 8-8 The different shapes of spring pad during operation and shipment of the compressor

1.	*Self-locking nut*	*3.*	*Compressor base*
2.	*Shock washer*	*4.*	*Spring guide*

9. Performance parameter

WARNING

- Use ReComp selection software to calculate compressor performance under different working conditions (Check the RefComp website for the most updated release).
  The working condition parameter for calculation should be the same with the pressure tested at the compressor suction port and discharge port (check chapter Overall dimension and packing (page 47)).
  For multi-component refrigerants blends characterized by "glide" phase change (R404A, R507), temperatures are intended as readings in dew point.
  The suction superheat is referred to dew point.

9.1. The performance parameter of refrigerant R22

SB4C-1200										
Tc	20		30		40		50		55	
Te	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa
-50	5.9	4.2	5.5	4.7	-	-	-	-	-	-
-45	7.7	4.8	7.4	5.4	7.2	6	-	-	-	-
-40	9.9	5.5	9.6	6.2	9.3	6.9	-	-	-	-
-35	12.5	6.1	12.2	6.9	11.8	7.8	11.5	8.7	-	-
-30	15.5	6.7	15	7.7	14.6	8.7	14.2	9.7	14.1	10.2
-25	18.8	7.3	18.1	8.4	17.6	9.6	17.2	10.7	17	11.3
-20	22.6	7.9	21.6	9.2	20.9	10.5	20.5	11.7	20.3	12.4

SB4C-1400										
Tc	20		30		40		50		55	
Te	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa
-50	7	5	6.6	5.6	-	-	-	-	-	-
-45	9.1	5.8	8.8	6.5	8.5	7.2	-	-	-	-
-40	11.7	6.5	11.4	7.4	11.1	8.2	-	-	-	-
-35	18.4	7.9	17.8	9.1	17.3	10.3	16.9	11.5	16.7	12.1
-30	14.8	7.2	14.4	8.3	14	9.3	13.7	10.3	-	-
-25	22.3	8.7	21.5	10.0	20.9	11.4	20.4	12.7	20.2	13.4
-20	26.8	9.4	25.7	10.9	24.8	12.4	24.3	13.9	24.1	14.7

SB6C-1600										
Tc	20		30		40		50		55	
Te	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa
-50	8.6	6.2	8.1	6.9	-	-	-	-	-	-
-45	11.3	7.1	10.9	8	10.5	8.8	-	-	-	-
-40	14.5	8.0	14.1	9.1	13.7	10.1	-	-	-	-
-35	18.3	8.9	17.8	10.2	17.3	11.4	16.8	12.7	-	-
-30	22.6	9.8	21.9	11.3	21.3	12.7	20.8	14.2	20.6	14.9
-25	27.5	10.7	26.5	12.4	25.8	14.0	25.2	15.7	24.9	16.5
-20	33.0	11.6	31.6	13.4	30.9	15.3	29.9	17.2	29.7	18.1

SB6C-2000										
Tc	20		30		40		50		55	
Te	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa
-50	10	7.2	9.4	8	-	-	-	-	-	-
-45	13.1	8.2	12.6	9.2	12.1	10.3	-	-	-	-
-40	16.8	9.3	16.3	10.5	15.9	11.8	-	-	-	-
-35	21.2	10.3	20.6	11.8	20.1	13.3	19.5	14.7	-	-
-30	26.2	11.3	25.4	13.1	24.7	14.7	24.1	16.4	23.8	17.3
-25	31.9	12.4	30.8	14.3	29.9	16.2	29.2	18.2	28.9	19.1
-20	38.3	13.4	36.7	15.6	35.6	17.8	34.7	19.9	34.4	21.0

SB6C-2500										
Tc	20		30		40		50		55	
Te	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa
-50	11.5	8.2	10.8	9.1	-	-	-	-	-	-
-45	15.0	9.4	14.5	10.6	13.9	11.8	-	-	-	-
-40	19.3	10.6	18.7	12.1	18.2	13.5	-	-	-	-
-35	24.3	11.8	23.7	13.5	23	15.2	22.4	16.9	-	-
-30	30.1	13.0	29.2	15	28.4	16.9	27.7	18.8	27.4	19.8
-25	36.6	14.2	35.3	16.4	34.3	18.6	33.5	20.8	33.2	21.9
-20	43.9	15.4	42.1	17.9	40.7	20.4	39.8	22.9	39.5	24.1

SB6C-3000										
Tc	20		30		40		50		55	
Te	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa
-50	13.7	9.9	12.9	10.9	-	-	-	-	-	-
-45	17.9	11.3	17.3	12.7	16.6	14.1	-	-	-	-
-40	23.0	12.7	22.4	14.4	21.8	26.1	-	-	-	-
-35	29.1	14.1	28.3	16.2	27.5	18.2	26.8	20.2	-	-
-30	36.0	15.6	34.9	17.9	33.9	20.2	33.1	22.5	32.7	21.7
-25	43.8	17.0	42.2	19.7	41.0	22.3	40.0	24.9	39.7	26.2
-20	52.5	18.5	50.3	21.4	48.7	24.4	47.6	27.3	47.3	28.8

9.2. The performance parameter of refrigerant R404A-R507A

SB4C-120E										
Tc	20		30		40		50		55	
Te	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa
-70	2.5	3	2.3	3.2	-	-	-	-	-	-
-65	3.5	3.5	3.2	3.9	3	4.2	-	-	-	-
-60	4.7	4.0	4.4	4.5	4.1	5	-	-	-	-
-55	6.2	4.6	5.7	5.2	5.3	5.7	5.0	6.8	-	-
-50	7.8	5.2	7.3	5.9	6.8	6.6	6.4	7.2	6.1	7.6
-45	9.7	5.9	9.1	6.6	8.6	7.4	8.0	8.2	7.7	8.6
-40	11.7	6.5	11.2	7.4	10.5	8.3	9.8	9.2	9.5	9.6
-35	14.0	7.2	13.4	8.2	12.8	9.1	12.0	10.2	11.5	10.7
-30	16.5	8.0	15.9	9.0	15.2	10.1	14.3	11.2	13.8	10.8

SB4C-140E										
Tc	20		30		40		50		55	
Te	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa
-70	2.9	3.5	2.8	3.8	-	-	-	-	-	-
-65	4.2	4.1	3.8	4.6	3.6	5	-	-	-	-
-60	5.6	4.8	5.2	5.3	4.8	5.9	-	-	-	-
-55	7.3	5.5	6.8	6.1	6.3	6.8	5.9	7.5	-	-
-50	9.3	6.2	8.7	7.0	8.1	7.8	7.5	8.6	7.3	9
-45	11.5	7.0	10.8	7.9	10.2	8.8	9.5	9.7	9.1	10.2
-40	13.9	7.8	13.2	8.8	12.5	9.8	11.7	10.9	11.3	11.4
-35	16.6	8.6	15.9	9.7	15.1	10.9	14.2	12.1	13.7	12.7
-30	19.5	9.4	18.9	10.7	18.1	12.0	17.0	13.3	16.3	14.0

SB6C-160E										
Tc	20		30		40		50		55	
Te	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa
-70	3.6	4.3	3.4	4.7	-	-	-	-	-	-
-65	5.1	5.1	4.7	5.6	4.4	6.2	-	-	-	-
-60	6.9	5.9	6.4	6.6	5.9	7.3	-	-	-	-
-55	9.0	6.7	8.4	7.6	7.8	8.4	7.3	9.2	-	-
-50	11.4	7.6	10.7	8.6	10.0	9.6	9.3	10.6	9	11.1
-45	14.1	8.6	13.3	9.7	12.5	10.8	11.7	12.0	11.3	12.6
-40	17.1	9.6	16.3	10.8	15.4	12.1	14.4	13.4	13.9	14.1
-35	20.5	10.6	19.6	12.0	18.7	13.4	17.5	14.9	16.8	15.6
-30	24.1	11.6	23.3	13.2	22.3	14.7	20.9	16.4	20.1	17.2

SB6C-200E										
Tc	20		30		40		50		55	
Te	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa
-70	4.2	5	4	5.5	-	-	-	-	-	-
-65	5.9	5.9	5.5	6.5	5.2	7.1	-	-	-	-
-60	8.0	6.8	7.4	7.6	6.9	8.4	-	-	-	-
-55	10.5	7.8	9.7	8.8	9.0	9.7	8.4	10.7	-	-
-50	13.2	8.9	12.4	10.0	11.6	11.1	10.8	12.3	10.4	12.9
-45	16.4	9.9	15.5	11.2	14.5	12.5	13.5	13.9	13.0	14.6
-40	19.9	11.1	18.9	12.5	17.9	14.0	16.7	15.5	16.1	16.3
-35	23.7	12.3	22.8	13.9	21.6	15.5	20.3	17.2	19.5	18.1
-30	27.9	13.5	27.0	15.3	25.8	17.1	24.2	19.0	23.3	20.0

SB6C-250E										
Tc	20		30		40		50		55	
Te	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa
-70	4.8	5.8	4.6	6.3	-	-	-	-	-	-
-65	6.8	6.8	6.3	7.5	5.9	8.2	-	-	-	-
-60	9.2	7.8	8.5	8.8	7.9	9.7	-	-	-	-
-55	12.0	9.0	11.1	10.1	10.4	11.2	9.7	12.3	-	-
-50	15.2	10.2	14.2	11.4	13.3	12.8	12.4	14.1	11.9	14.8
-45	18.8	11.4	17.7	12.9	16.7	14.4	15.5	15.9	15.0	16.7
-40	22.8	12.7	14.4	20.5	20.5	16.1	19.2	17.8	18.5	18.7
-35	27.2	14.1	26.1	15.9	24.8	17.8	23.3	19.8	22.4	10.8
-30	32.0	15.5	31.0	17.5	29.6	19.6	27.8	21.8	26.8	22.9

SB6C-300E										
Tc	20		30		40		50		55	
Te	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa	Pf	Pa
-70	5.8	6.9	5.5	7.5	-	-	-	-	-	-
-65	8.2	8.1	7.5	9	7.1	9.8	-	-	-	-
-60	11.0	9.4	10.2	10.5	9.5	11.6	-	-	-	-
-55	14.3	10.7	13.3	12.0	12.4	13.4	11.6	14.7	-	-
-50	18.2	12.2	17.0	13.7	15.9	15.3	14.8	16.8	14.3	17.6
-45	22.5	13.6	21.2	15.4	19.9	17.2	18.6	19.0	17.9	20.0
-40	27.3	15.2	26.0	17.2	24.5	19.2	22.9	21.3	22.1	22.4
-35	32.6	16.8	31.3	19.0	29.7	21.3	27.8	23.3	26.8	24.9
-30	38.3	18.5	37.1	20.9	35.4	23.4	33.3	26.1	32.0	27.4

10. Application range

General

The evaporating temperature of SBC series compressor normal working is -70°C~-20°C. Application range will be influenced by following factors:

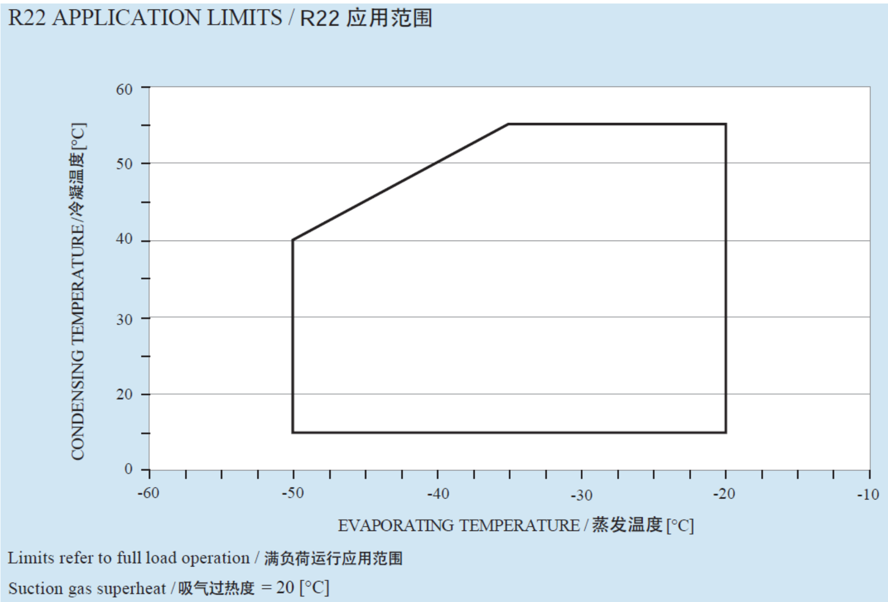
- Refrigerant type
- Suction temperature
- Cooling method
- Power supply

Following diagrams show the application range of SBC series compressors, which contains the following information:

- Refrigerant and working temperature
- Suction temepratture
- Cooling capacity

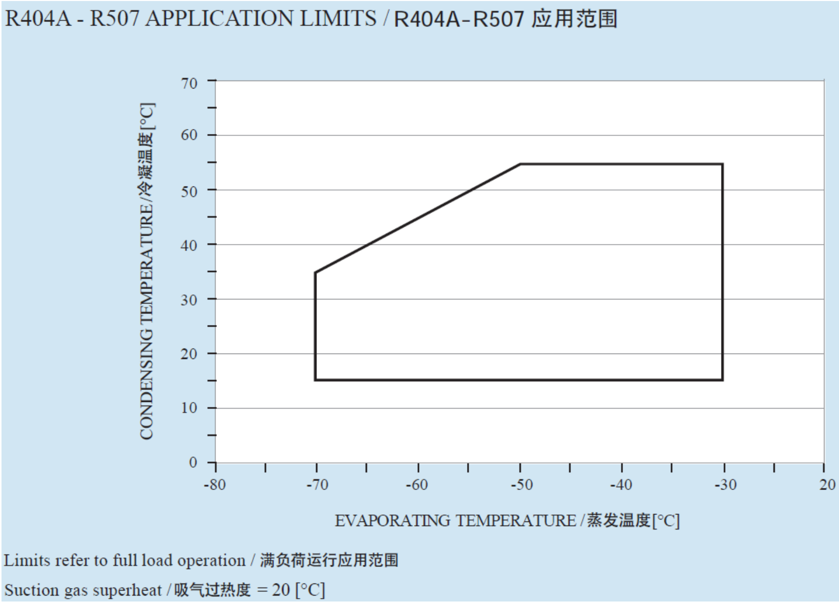
10.1. Application range of refrigerant R22

The application range refers to compressor running at full load with power supply frequency of 50Hz.



10.2. Application range of refrigerant R404A-R507A

The application range refers to compressor running at full load with power supply frequency of 50Hz.



Application range at partial load

Power variation

Using multiple compressors in parallel compounding offers the opportunity to better adapt the cooling capacity to the requirements of the system, saving energy as well as reducing wear on the compressors. However, as in all installations where the cooling capacity is reduced, it must be grant that the return oil is also effective when operating at partial load.

The maximum reduction in cooling capacity is therefore limited by the compressor oil return and motor cooling.

The minimum gas velocity must be respected in both the vertical and in horizontal sections, thermostatic expansion valves must ensure proper heating of suction gas to enable a smooth operation of the compressor.

11. Operation instructions

Use of compressor

For the RefComp piston compressors, only use the refrigerants approved by RefComp, prohibit air or any other gases compression.

Prohibit starting the compressor while the suction and discharge stop valve are not fully open. Do not start up the compressor if the terminal box cover is not properly installed and fixed.

Prohibit any operations for suction and discharge valves or open terminal box while compressor running.

Only nitrogen or carbon dioxide gas is allowed for air-tight test in the refrigeration circulation system, oxygen or acetylene is prohibited.

Prohibit starting the compressor without connecting to refrigeration circulation system.

Attention! Compressor surface temperature may exceed 100°C or under 0°C during starting.

11.1. Installation

Compressor must be installed horizontally. To reduce the vibration from compressor to the unit while install the compressor, the vibration-absorption components are required.

The pipes for connection must be completely cleaned and dry, rusted, phosphated surface or waste pipes are not allowed for connection.

The working ambient temperature and storage temperature of the compressor should be maintained between -20°C and + 50 °C, the relative humidity should not higher than 90% and the clean environment of dust-proof and water-proof; Compressor installation site should avoid fume, heat radiation, moisture and other adverse environmental effects;Compressor installation site should avoid seawater, wind, rain, sun and other direct invasion places, take preventive measures if necessary. If the compressor is operated under extreme conditions (such as extremely low ambient temperature or harsh environment), please take reasonable measures after contacting with RefComp.

Pump-down

If the evaporator or suction pipe of the compressor may be a little hot during the compressor shutdown, then a pump-down cycle is recommended. Please confirm that there is no repeating start-ups, as the maximum start of pump-down cycle is two times per hour.

Heat pump system

WARNING

Reverse circulation or thermal defrosting systems require appropriate precautions to ensure that compressors are not affected by either of the following conditions:

- The liquid refrigerant flows back to the compressor
- Too much oil is taken out of the compressor, which makes the oil level of the compressor decrease too much

To protect the compressor from liquid hammer, it is recommended to install a gas-liquid separator on the suction side.A pressure regulating valve is installed after the compressor to limit excessive pressure reduction when the heat pump circulates.When the compressor starts for 20 seconds, the compressor should enter the specified application range and ensure that the compressor protection is in effect.

11.2. Pressure

Air-tight test and working pressure value as follow:

	Air-tight test	Working pressure
HP	≥30bar	30bar
LP	≥19bar	19bar

The Max. balance pressure of compressor starting is 13 bar.

To prevent motor overload, the working pressure must be within the application range to prevent motor overloading, (Check chapter 10 Application range (page 54), consider various refrigerants). M.O.P. (Max. operating pressure) expansion valve or pressure regulating valve is recommended if necessary.

This may occur sometimes, such as starting after the compressor defrosting, overloading when the goods in the storage house is hot, freezing tunnels, or the start-up phase when hot water is defrosting.

11.3. Temperature

Discharge tempeature: Max.: 140°C;

Min.: Above condensation saturation temperature 30K.

Suction temeperature: Max. :Refer to chapter 10 Application range (page 54);

Min.:For R22, R404A and R507,the Min. superheat is 8K.

The Max. suction superheat is 30K. For oil temperature, please check chapter 2 Oil pipeline lubrication (page 8).

11.4. Running time

Number of start-up:	No more than 6 times per hour
The minimum interval between two starts:	10 minutes
Minimum running time:	3 minutes

11.5. Test

Sealing /vacuuming/ lubricant charge testing

> **WARNING**
> The RefComp compressor is protected by nitrogen (0.5-1bar above atmospheric pressure) to prevent air from entering the compressor.

Follow the instructions below for lubricant injection:

a. Please use dry N_2 for testing the air-tightness refrigeration circulation system, the compressor must be excluded if air is used for circulation system.

b. Vacuum the gas in the entire refrigeration circulation system, including the gas that is isolated in the compressor by the suction and discharge valves of the compressor;

c. Connect the oil separator to the corresponding oil return inlet of the compressor; (Check chapter 8 Overall dimension and packing (page 47) for sizes of connectors);

d. Control the amount of lubricant in the range of the horizontal position as shown in Figure 11-1;

e. Close or tighten the lubricant connection plug.

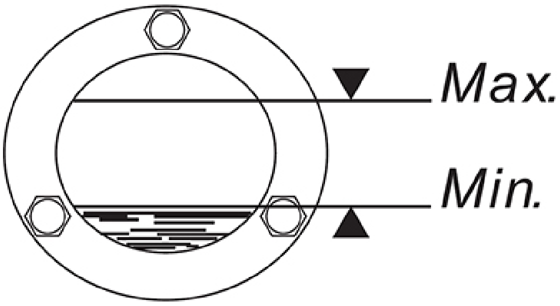


Figure 11-1 Oil level range

The compressor has passed the relevant pressure tests, so the user does not need to do the relevant pressure tests. If the user need to test by himself, please not exceed the design pressure value on the nameplate (Please refer to chapter 6.3 Nameplate (page 44)).

WARNING

- Prohibit operating the compressor if a pressure value higher than indicated on the compressor nameplate.
- Prohibit starting the compressor under vacuum condition.

Refrigerant charge

Flush the liquid refrigerant into the condenser or directly into the refrigerant receiver, complete the refrigerant injection during compressor operation. If charge the liquid refrigerant (R407C), the discharge temperature is at least 30K higher than the condensing temperature to avoid liquid backflow, and control the injection speed a little bit to avoid liquid hammer. Insufficient refrigerant charge will result in low suction pressure or excessive degree of superheat. Please use RefComp selection software to calculate the correct discharge temperature value for reference.

11.6. The start-up of compressor

The compressor start-up procedures are as follow:

a.Release the N_2 inside the compressor, connect the compressor with refrigeration circuit to ensure there is no air inside the suction and discharge stop valve. Compressor internal (such as lubricant) and air shall not contact more than 30 minutes;

b. Refer to the wiring diagram in chapter 5 Electrical devices (page 35) for electrical connection;

c. Perform the following preliminary inspections:

- Correctly set the start time timer;
- Confirm the oil level;
- Check if the settings and functions of safety and protection equipment are normal;
- Check if the high-pressure and low-pressure pressure protection switches are normal;
- Confirm that there is no leakage in the system.

d. The crankcase heater must be turned on 24 hours before the compressor is turned on, and the oil temperature must be at least 15°C above the ambient temperature;

e. Charge Min. refrigerant into the condenser;

f. Open the suction and discharge shut-off valves and starts the compressor;

g. Complete the refrigerant injection of the whole system;

h. Restart the compressor and open the suction stop valve slowly;

i: Ensure the discharge temperature is at least 30K higher than condensing temperature (Check RefComp selection software for the accurate value);

j. Check if the pressure switch is working properly;

k. Check the working parameters.

Shock pad

The shock pad is used to reduce the vibration of the compressor. Spring shock pad is for SBC series.

The minimum height of the spring shock pad ("A" in the following figure) is 30mm. However, when the compressor and pipeline are in operation, there is a certain weight. This height should be more than 30mm to ensure effective shock absorption.

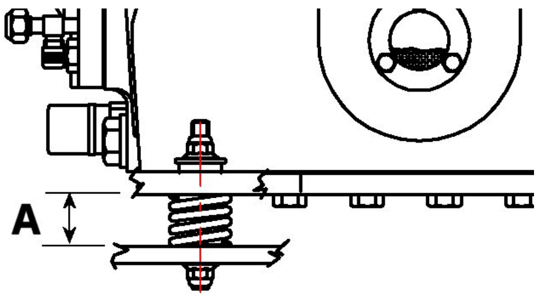


Figure 11-2 Spring shock pad

11.7. Trouble-shooting

Failures	Possible causes	Solutions
1. Compressor can’t start	a. The start switch is not open;	a. Open the start switch;
	b. Fuse burning;	b. Check the circuit to confirm if there is short circuit or proper grounding, and check if the motor is overloaded. Replace the fuse after confirming the cause;
	c. Superheat protection;	c. Check item (12);
	d. Contactor failure;	d. Repair or replace;
	e. Expansion valve not open;	e. Repair or replace;
	f. The motor is faulty;	f. Check the connection or insulation of the terminals (check chapter 5.3), check if there is any burnt insulation material;
	g. The terminals are loose;	g. Check all electrical connections and tighten the contact parts
	h. Compressor safety protection;	h. Confirm and eliminate any safety protection action, restart the motor;
	i. The temperature set of the thermostat is too high.	i. If necessary, lower the setting temperature of the thermostat and set a temperature 15 °C higher than the outdoor temperature.
2. Compressor noise is too loud	a. Unreasonable pipeline supports design;	a. Change, reduce or increase the fixed points of pipeline;
	b. Insufficient buffer gap;	b. Maintenance and replacement of unmatched accessories;

Failures	Possible causes	Solutions
	c.Compressor leaking;	c. Select the proper expansion valve and control the openness;
	d. The motor stator is not fixed properly;	d. Adjust the fixing points and bolts;
	e. Sound insulation, improper vibration.	e. Check the fixing condition of compressor feet (check chapter 11.6).
3. Compressor discharge pressure is too high	a. The discharge valve is partially closed;	a. Open the discharge valve;
	b. The refrigerant charge is too large;	b. Discharge excess refrigerant;
	c. The capillary problem;	c. Clean the garbage at the nozzle of the capillaries;
	d. The refrigerant circuit is mixed with non-condensable gas;	d. Discharge the non-condensable gas;
	e. The capillaries are too small or malfunctioning.	e. Adjust the condensing flow or adjust the throttle.
4. Compressor discharge pressure is insufficient	a. The condensing temperature is set incorrectly;	a. Check the electrical control settings of condenser
	b. The suction valve is partially closed;	b. Fully open the suction valve;
	c. Insufficient refrigerant;	c. Leak detection and fill the refrigerant;
	d. The suction pressure is unreasonable;	d. Refer to item (6);
	e. No compressor upload;	e. Check CR or SU components, refer to item (8);
	f. Too big condenser;	f. Review the system design parameters;
	g. Sealing ring or discharge valve failure.	g. Repair compressor.
5. Compressor suction pressure is too high	a. The compressor load is too large;	a. Decrease compressor load, or increase refrigeration system capacity;
	b. Too much liquid refrigerant;	b. Check the ball valve, adjust the superheat, and check the size of the expansion valve;
	c. No compressor upload;	c. Check CR or SU components, refer to item (8);
	d. Unreasonable compressor selection;	d. Review the design parameters;
	e. The evaporator is not large enough.	e. Review the design parameters.
6. Compressor suction pressure is insufficient	a. Refrigerant leakage;	a. Leak detection and fill refrigerant;
	b. The evaporator is dirty or ice-block;	b. Clean the evaporator or defrost;
	c. The dry filter on the liquid circuit is blocked;	c. Replace the filter cartridge;
	d. The suction circuit filter or compressor suction filter is blocked;	d. Clean the filter;
	e. Expansion valve failure;	e. Check or reset the expansion valve to a suitable superheat degree, repair or replace the expansion valve;
	f. The condensing temperature is too low;	f. Check the condensing temperature control equipment;
	g. Compressor internal blow-by;	g. Refer to item (7);
	h. The water pump or evaporator fan is not working.	h. Check and start.
7. Compressor not working at partial load	a. Capacity regulation components failure;	a. Replace;
	b. Capacity regulation components internal blocked.	b. Replace.
8. Compressor can't load	a. Capacity regulation components failure	a. Replace.

Failures	Possible causes	Solutions
9. Compressor load or unloading is too fast	a. Excessive expansion valve causes excessive suction pressure	a. Change a proper expansion valve.
10. Compressor lubricant pressure is low	a. No Lubricant;	a. Refer to item (11);
	b. Too much liquid refrigerant inside the compressor;	b. Install crankcase heater; set expansion valve to increase superheat; check the check valve of liquid circuit;
	c. Pressure drop between pipeline and pressure probe;	c. Check and the oil pressure probe should close to the filter;
	d. Oil pressure probe internal blocked;	d. Clean the oil line accessories and components;
	e. Incorrect oil pump sealing ring assembly	e. Check the oil pump sealing ring to ensure proper sealing ring assembly;
	f. Oil pressure gauge failure;	f. Check or replace, ensure the right reading;
	g. Oil pump transmission valve failure;	g. Repair or replace;
	h. Oil pump reverse rotation;	h. Reverse connection two-phase power supply;
	i. Oil pressure switch failure;	i. Repair or replace the oil pressure switch;
	j. Oil pressure switch failure;	j. Repair or replace the oil pressure switch;
	k. Oil pump shaft key damage;	k. Replace the damage part;
	l. Compressor bearing damage;	l. Repair the compressor;
	m. Partial failure of CR components;	m. Replace the damage part.
11. Compressor lack of lubricant	a. Lubricant stays at the system pipelines or evaporator;	a. Confirm the refrigerant flow speed;
	b. Oil leakage of CR components;	b. Replace the damage parts of the CR components;
	c. Too slow flow rate at the suction pipeline;	c. Check the suction pipeline size;
	d. Leakage at the piston scraper ring.	d. Repair the compressor.
12. The current is too large and the contactor is in open circuit	a. Condensing temperature too high;	a. Refer to item (3);
	b. Open circuit caused by fuse single phase operation;	b. Find out the cause of the open circuit of the contactor, and then repair or replace the fuse;
	c. The voltage is too low at full load;	c. Check the voltage and confirm if the voltage drop of the supply voltage in each phase is too large;
	d. Loose contact of power supply cable;	d. Check and tighten the terminal;
	e. Contactor failure;	e. Repair or replace the contactor;
	f. The overload contactor is faulty;	f. Refer to the compressor nameplate and select an appropriate contactor;
	g. The contactor temperature is too high due to overload current;	g. Strengthened the ventilation of the electrical cabinet of the relay;
	h. The power supply cable is damaged or the wire hits the ground;	h. Repair or rewire;
	i. The voltage of each phase is unstable, leading to lack of phase or single-phase operation;	i. Check the power supply voltage, and it is not allowed to start until the fault is resolved;
	j. The motor wiring mode (star-delta or part-winding method) is wrong;	j. Repair/ replace contactor or timer;
	k. The wire hits the ground, causing trip protection;	k. Repairing or rewiring the motor;
	l. The compressor parts are stuck.	l. Repair the compressor.
13. Compressor starts and stops frequently	a. The temperature values set by the thermostat are too close to each other;	a. Check the temperature setting of the evaporator and regulate it properly.Caution! Avoid ice blockage;

Failures	Possible causes	Solutions
	b. The solenoid valve fails;	b. Replace solenoid valve;
	c. Too much refrigerant injection;	c. Release excess refrigerant;
	d. Lack of refrigerant;	d. Check the system for leakage, repair and fill refrigerant;
	e. The relevant control valves of the refrigerant flow in the evaporator and condenser fails.	e. Check the temperature setting of the control valve. Clean, repair or replace the control valve if necessary.

11.8. Safety guidelines

WARNING
Operator must wear reasonable protective equipment (safety shoes, overalls, gloves, goggles and mask).

WARNING
Be careful while operating the electrical equipment, and only certified electrician can perform the operation.

WARNING
All maintenance operation must be performed with standstill compressor without power supply.

WARNING
The maintenance, inspection and regulation should be performed only by qualified personnel with reasonable personal protective equipment(safety footwear, overalls, gloves, glasses and mask).

WARNING
The repair and maintenance of all mechanical parts must be operated under power off.

WARNING
The machine and the work area must be secured against access by outsiders!

WARNING
Prohibit operating with power on.

WARNING

If operations of circuit breakers(motor circuit breakers, circuit breakers or others) occur repeatedly, it is essential to be warned and call a qualified electrician.

In cases of burns fuses and circuit breakers work is always suggested to identify and eliminate the cause that caused the trouble, since the replacement or repair indiscriminate, in most cases does not solve the problem.

WARNING

Prohibit cleaning electrical equipment using compressed air:danger of damage to electrical components.

WARNING

The cleaning and troubleshooting must be done with compressor powers off and standstill.

WARNING

The reset switch should be performed only by a qualified electrician, with appropriate personal protective equipment, tools and proper auxiliary equipment.

WARNING

Restore operations of tripped breaker must be with standstill compressor and power off.

WARNING

If the circuit breaker in the circuit continues to act, it must be paid attention and ask the maintenance engineer to solve it.

Operation	Protective clothing	Safety shoes	Gloves	Goggles	Hearing protector	Mask	Helmet
Transportation	★	★	★	△	◆	△	◆
Handling	★	★	★	△	◆	△	◆
Unpacking	★	★	★	△	◆	△	△
Assembly	★	★	★	△	◆	△	△
General use	★	★	★	△	◆	△	△
Commissioning	★	★	★	△	◆	△	△
Cleanness	★	★	★	★	◆	△	△
Maintenance	★	★	★	△	◆	△	△
Disassembly	★	★	★	★	◆	△	◆
Scrap	★	★	★	△	◆	△	◆

★	Necessary
◆	Operate according to the actual situation
△	Unnecessary

12. Design and application of parallel compounding

12.1. Unit character

Parallel compounding has following advantages:

- Increase refrigeration capacity comparing to single compressor;
- High efficiency in capacity regulation;
- Start the compressor unit by unit to decrease inrush transient current;
- System can keep running even one compressor failures;
- Simple and economic circulation system.

12.2. Design and installation

In a system of compressors in parallel compounding, the amount of oil which each compressor drags in the circuits must be balanced by the amount of oil coming back to ensure proper lubrication.

0.01 bar pressure difference in crankcase will cause 10cm difference of level height. Therefore, it's essential to keep the pressure balance of crankcase of each compressor in parallel compounding.

There are two main systems to connect in parallel for Refcomp piston compressor: the system of equalizing oil and gas (for compressors of the same size) or the system with oil level regulators(for more than two compressors and when compressors are of different sizes).

12.3. Oil and gas equalization system

This system is suitable to connect in parallel, maximum two compressors of the same size.

Through the creation of two pipes of equalization for the oil and gas, it's possible to keep the pressure of the crankcase to the same value, thus providing the balance of the amount of oil returning to each compressor.

12.4. Oil level regulating system

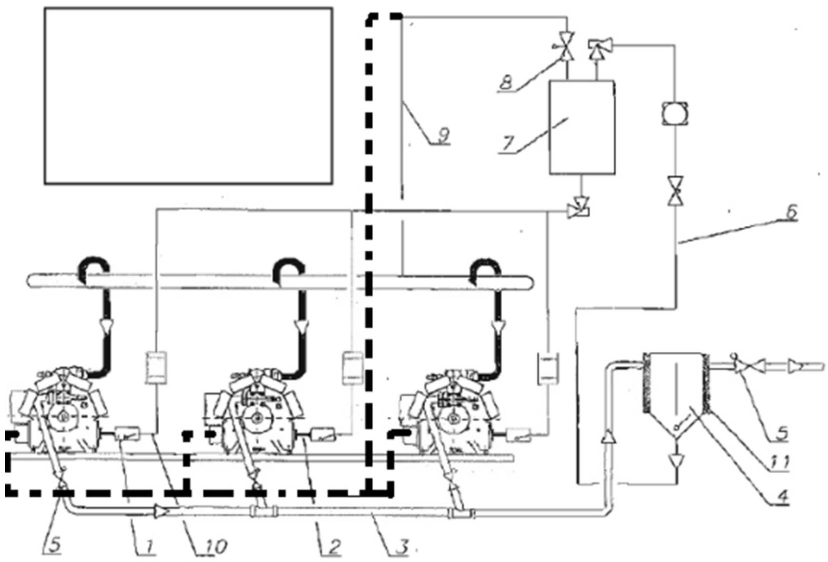


Figure12-1 Parallel compounding with oil level regulators and single oil separator

1.	*Oil level balancer*	*3.*	*Discharge pipeline*	*5.*	*Stop check valve*
2.	*Adapter*	*4.*	*Oil separator*	*6.*	*Oil pipeline*

7.	*Oil tank*	*9.*	*Oil balance tube*	*11.*	*Strainer*
8.	*Oil pressure differential check valve*	*10.*	*Oil pipeline*		

As shown in figure 12-1. this system is suitable for parallel compounding of two or more compressors even of different sizes and also shown an high reliability. The working principle is the following:

Oil drawn from the compressors is separated from the refrigerant in an oil separator, and from there piped in a tank maintained at an intermediate pressure between the suction and discharge pressures. From the oil tank is led to compressor crankcases through the oil level balancer, positioned in place of the oil sight glass which introduces a certain amount of oil each time when the preset level is lowered.

Notes:

- It's suggested to use oil balancer which allow to regulate the level in a certain range (from 1/2 to 1/4 of the oil sight glass);
- It' suggested each oil balancer is provided with balanced connection, which prevent risk of make a siphon of oil inside the crankcase during the shut-off procedure or to full the balancer with oil;
- The oil pressure has to be maintained to a value between suction and discharge ones to grant a safety return of oil.

12.4.1. Suction pipeline

The suction pipes have to be designed so that a standstill compressor can not be flooded with oil or liquid refrigerant; it's suggested to connect each suction pipes to the suction manifold trough an elbow. The diameter of manifold has to be choosen so that the refrigerant gas speed is lower that 4 m/s (horizontal section) or 7m/s (vertical section) when the system is full load.

12.4.2. Gas-liquid separator

It's suggested to use a gas-liquid separator for each suction pipes.

12.4.3. Suction filter

It's strongly recommended to use a suction filter. The cartridge can be removed once the circuit has been cleaned from impurities. The filter casing can be used for the installation of antiacid cartridges in the case of acid burn of the electric motor.

12.4.4. Discharge pipeline

The discharge manifold should have a section at least equal to the sum of individual sections of the discharge lines, which must be descended from the discharge shut-off valve to the manifold. If it is used an oil separator for each compressor, it's necessary to install a check valve between each oil separators and discharge manifold, in order to prevent the refrigerant accumulation in the oil separators of the standstill compressors.

12.4.5. Oil separator

The oil separator is always necessary to low temperature systems and flooded evaporators. The selection has to be made considering the maximum evaporating temperature. After the oil separating, it's necessary to use a check valve to avoid the condensed refrigerant flowing back to the oil separator. The minimum section of connecting manifold should have a section at least equal to the section of discharge shut-off valve. When the outside temperature is low, the oil separator is insulated to prevent condensation of the refrigerant in the oil separator.

12.4.6. Condenser

Because of the wide range of capacity resulting from the parallel compounding, it is necessary to equip with a regulation valve of the condensing pressure.

12.4.7. Evaporator

To protect the compressor from liquid hammer in the starting phase, the suction line at the evaporator outlet should be ascending. The pump-down is recommended.

12.5. Starting and maintenance

At the time of starting the unit, the following precautions should be observed:

- Check the safety devices, with special attention to devices concerning the oil;
- Loading the liquid receiver with an initial base charge;
- Start a compressor for a time and accurately control the pressure and oil level in all operating conditions, taking full charge of refrigerant;
- Check the temperature of the oil separator and oil return. The oil return should operate at intervals. The continuous flow of a warm mixture of oil and gas indicates a malfunction, which may be due to oil overcharging, or to a too small separator or failure of the oil regulator.

13. Maintenance

13.1. Information of maintenance

For motors, in addition to confirming insulation and current condition, you also need to:

- Control the environment and temperature of the cable from the contactor to the motor terminal;
- Check if the cable is tightly fixed to the terminal.

13.2. Lubricant of refrigeration system

If the operating conditions of the system are correct, the entire refrigeration system and lubricant will not be contaminated. When the lubricant circulation and the motor insulation are in a very good condition, then the compressor can work for a long time and stay reliable.

The system working status is depend on the following aspects:

- Reasonable suction superheat degree
- Work within application range
- Reasonable refrigerant charge of the system
- The compressor running smoothly (the compressor does not start and stop for a short time, the oil return is normal, and the compressor does not start up frequently). In the actual operation, any leakage and wrong flow of the refrigerant must be avoided, and at the same time, prohibit compressor oil shortage

In the refrigeration cycle, most of the hazardous pollutants are:

- Air
- Water
- Rust (such as Fe_2O_3, Fe_3O_4)
- Verdigris (such as Cu_2O, CuO)
- Solid particles, metal dust or dust

The following substances should also be prevented from entering the refrigeration system:

- Antifreeze
- Welding material
- Chlorinated solvent
- Lost debris
- Nitrogen or other non-condensable gases

Oil contamination, corrosion, copper sediment and ice blockage are more serious pollution, so we need to prevent them from damaging the compressor.

13.2.1. Oil contamination

Main causes

Oil contamination is generated from composition that are easily decomposed in the lubricant. Oil contamination is caused by acidification from exposure to air at high temperature. Acidification will lead to the decomposition of refrigerant, further increasing the oil contamination. When acidic substances are produced, they react with metal elements to produce insoluble metal salts in refrigerant and lubricant. Crystalline salts of mineral acid is easily adhere to surfaces and more corrosive in wet environments.

How to avoid oil contamination

The oil contamination is avoided by keeping the machine clean and dry, preventing air entering refrigeration system and using high quality lubricant recommended by RefComp.

13.2.2. Corrosion

Main causes

Compressor corrosion in a relatively clean environment is caused by the high operating temperature. However, even if the temperature is well controlled, the pollutants in the environment will cause severe corrosion to the compressor, even more severe than in high temperature operation without pollutants. High humidity air can cause rust. If there is acidification in the system, ferric oxide (Fe_2O_3) will be generated, which will further cause the iron salts and water.

Unclean welding materials can also lead to the formation of metal salts.

When used as antifreeze, methanol may react with aluminum and cause corrosion.

Improper welding methods will lead to various sludge (pickling agent, welding slag etc.) entering the system, and due to the influence of high temperature, copper oxide and iron oxide will form on the internal surface of the compressor.

How to avoid corrosion

To keep the system in a satisfactory cleanliness, various contaminants must be prevented from entering the system.

Use the refrigerant from qualified supplier, refrigerant must be kept in original container, packaged directly by manufacturer, and use lubricant specified by Fujian Snowman.

Avoid too high discharge temperature during operation. If you have any questions, please contact the manufacture.

13.2.3. Copper sediment

Main causes

The copper sediment is occurred when the pollutants (Such as water, air etc.) dissolve copper in the lubricant under high temperature, sediment occurs when the dissolved copper of the lubricant meets the high temperature metal parts. Copper sediment is often occurred around crankshaft and valves for these parts normally have high temperature.

How to avoid copper sediment

The copper sediment is occurred when the pollutants (Such as water, air etc.) dissolve copper in the lubricant under high temperature, sediment occurs when the dissolved copper of the lubricant meets the high temperature metal parts. Copper sediment is often occurred around crankshaft and valves for these parts normally have high temperature.

Avoid machine running under high temperature, or the lubricant and refrigerant will go bad, and more acidic compounds that corrode the copper will form. The recommended Max. temperature is 120°C. 30°C higher than peak temperature is acceptable under some circumstances, don't running under high temperature for safety reason.

Use the recommended lubricants and ensure their viscosity meets the requirements. Avoid welding, chlorinated compounds and other pollution factors, directly or indirectly cause the formation of copper-containing salts. When using R22, avoid oil filter containing paper or fiber material. For pipes selection, it is recommended to use clean copper pipes and prevent metal oxidation during welding or brazing.

13.2.4. Ice blockage

Main causes

If the water content of the refrigerant exceeds the maximum allowable value, it will cause ice blockage of the expansion valve or the suction filter, which will eventually affect the refrigerant circulation.

If the expansion valve is blocked, the continue alternation between the formation and melting of ice will cause strong fluctuations in the evaporating pressure.

If the suction filter is blocked, a high pressure difference will be generated in the filter area, which may blow out the filter, and there is a risk of burning the motor.

How to avoid ice blockage

Follow the installation instructions completely to prevent moisture from entering the refrigeration system. Use refrigerant from qualified supplier, and the refrigerant must be stored in the original container and repacked by the manufacturer. Only use the lubricant oil specified by RefComp. Avoid using opened lubricant. Install a dry filter on the liquid circuit.

13.3. Maintenance suggestion

It is recommended to use the operation recorder to record date, time, capacity level, suction pressure, suction temperature, discharge pressure, discharge temperature, oil pressure, oil temperature, voltage, current (overall current of compressor), oil level, oil acidity, electrical insulation (compressor is in a shutdown status).

For the frequency of detection, please refer to the table below:

No.	Checklist	Weekly	Monthly	Every two months	Annually
1	Read and record the refrigerant pressure	√			
2	Read and record the value of oil pressure,Calculate the oil pressure difference	√			
3	Read and record the motor supply voltage	√			
4	Read and record the supply current	√			
5	Check the compressor oil level	√			
6	Check the refrigerant charge by the flash of the freezing oil	√			
7	Check if the superheat degree is properly		√		
8	Check all safety protection device		√		
9	Check all contactors and electrical plugs		√		
10	Check the humidity indicator of refrigerant		√		
11	Check whether the solenoid valve work normally		√		
12	Check the lubricant status inside the compressor			√	
13	Check the condition of the capillaries (including the unit and the heat exchanger)				√

Note: Item with **bold fonts** (item 5 and item 6) means requiring replacement or supplement.

Comparing the running data, especially the discharge temperature, you may find some hidden failures or problems that will occur in the future from the date variation.

Some hidden failures are reflected from cleanliness and color changes. For example, oil strains on some parts tends to adhere to dust. If you don’t clean for a long time, it will seriously affect the compressor operation. Sometimes they can be judged from the color changes of the parts: such as some parts work in high temperature for long time, the color will change.

Note:

The installation, operation and maintenance of compressors and refrigeration systems only can be carried out by qualified professionals.

13.4. Management procedures of lubricant

You can buy small barrels of lubricants only when you are in a hurry. Confirm the type and the viscosity of the lubricant match the application. Do not pour lubricant from one bucket into another, as this will contact the air and absorb moisture. Air is the main pollution source. The lubricant is generally stored in a sealed container, and the exposure time to the air should not exceed the time required to inject from the container into the compressor crankcase.Lubricants should be odorless. It is a better inspection method to smell the lubricant, because if the lubricant has a pungent odor, then there must be something wrong with the lubricant. Although the color change of the oil is not easy to judge, by comparing with new lubricant, if it appears blue, green, brown or black, then the oil must be changed. After filling new oil to the compressor, it is necessary to carefully track the quality changes (Observe the viscosity, acidity, humidity, etc.) of the newly added oil.Only professional chemical laboratories can test lubricant authoritatively. The oil level should be checked daily to ensure that the normal oil return. If there is oil shortage, add some lubricant appropriately until it reaches the appropriate oil level (the reason for the oil leakage must be analyzed clearly before taking corresponding measures).

Note: Content is subject to change without prior notice.