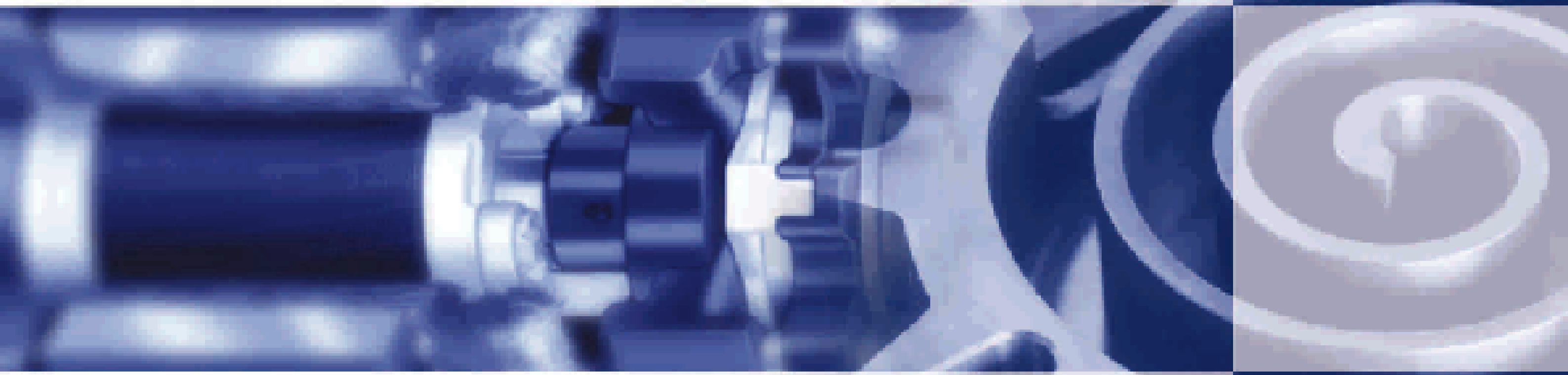
Copeland Scroll™



# Refrigeration Scroll Enhanced Vapour Injection

*ZF13KVE … ZF18KVE*

Application Guidelines

EMERSON™
Climate Technologies

# APPLICATION GUIDELINES: ENHANCED VAPOUR INJECTION (EVI) REFRIGERATION SCROLL COMPRESSORS ZF13KVE-ZF18KVE

## 1 Introduction

This Guideline describes the operating characteristics of the Enhanced Vapour Injection (EVI) refrigeration scroll compressors ZF13KVE to ZF18KVE.

EVI Compressor systems present benefits over standard refrigeration compressors due to the following:

- Capacity Improvement

The capacity is improved by increasing the enthalpy difference in the system rather than increasing mass flow. This is accomplished without increasing displacements.

- Increased COP

The efficiency improves due to the fact that the gain in capacity is greater than the increase in power that the compressor consumes.

- Cost and Energy Advantage

Because a smaller size compressor can be used to achieve the same capacity as a larger conventional model, there is an inherent cost advantage

## 2 Safety Instructions

Only qualified personnel should install and repair COPELAND compressors.

- Refrigerant compressors must be employed only for the use they are made for.
- Only approved refrigerant and refrigerating oils must be used.
- Do not start the compressor until it is charged with refrigerant.
- Correctly used, the compressor and the pressure line piping may reach temperatures that may cause burning if touched.

- Wear safety goggles when working on open systems.
- If the refrigerant needs to be removed from the system, do not disperse it in the environment, use the correct equipment & method of removal.
- For storage, use original packaging and avoid collisions and tilting**.**

- Trained electrical personnel must connect the compressor and its accessories.
- All valid standards for connecting electrical and refrigeration equipment must be observed.
- Limit values for the supply voltage of the unit may not be exceeded.

- It is not allowed to run a test without the compressor being connected to the system and without refrigerant. It is of vital importance that the discharge stop valve has been fully opened before the compressor is started. If the discharge stop valve is closed or partly closed an unacceptable pressure with accordingly high temperatures may develop. When operating with air the so-called diesel effect may occur, i.e. the air sucked in is mixed with oil gas and can explode due to the high temperature and thereby destroy the compressor.

## 3 EVI Theory of Operation

Copeland EVI Scroll compressors are equipped with a vapour injection connection for Economizer Operation. Economizing can be accomplished by utilising a subcooling circuit similar to the circuit shown in Figure 1. This increases the refrigeration capacity and the system efficiency. The benefits provided will increase as the compression ratio increases.

The schematic shows a system configuration for the economizer cycle. A heat exchanger is used to provide additional subcooling to the refrigerant before it enters the evaporator. This subcooling process provides the increased capacity gain measured in the system. During the subcooling process, a certain amount of refrigerant is evaporated. This evaporated refrigerant is injected into the compressor and provides additional cooling at higher compression ratios.

The P-h diagram (Figure 2) shows the theoretical gain in system performance acquired by using the economizer cycle. The extension outside of the vapour dome provides the enthalpy increase, enhancing system performance. Although power increases due to the vapour injection into the compressor, there is still a significant efficiency gain because the capacity gain exceeds the power increase.

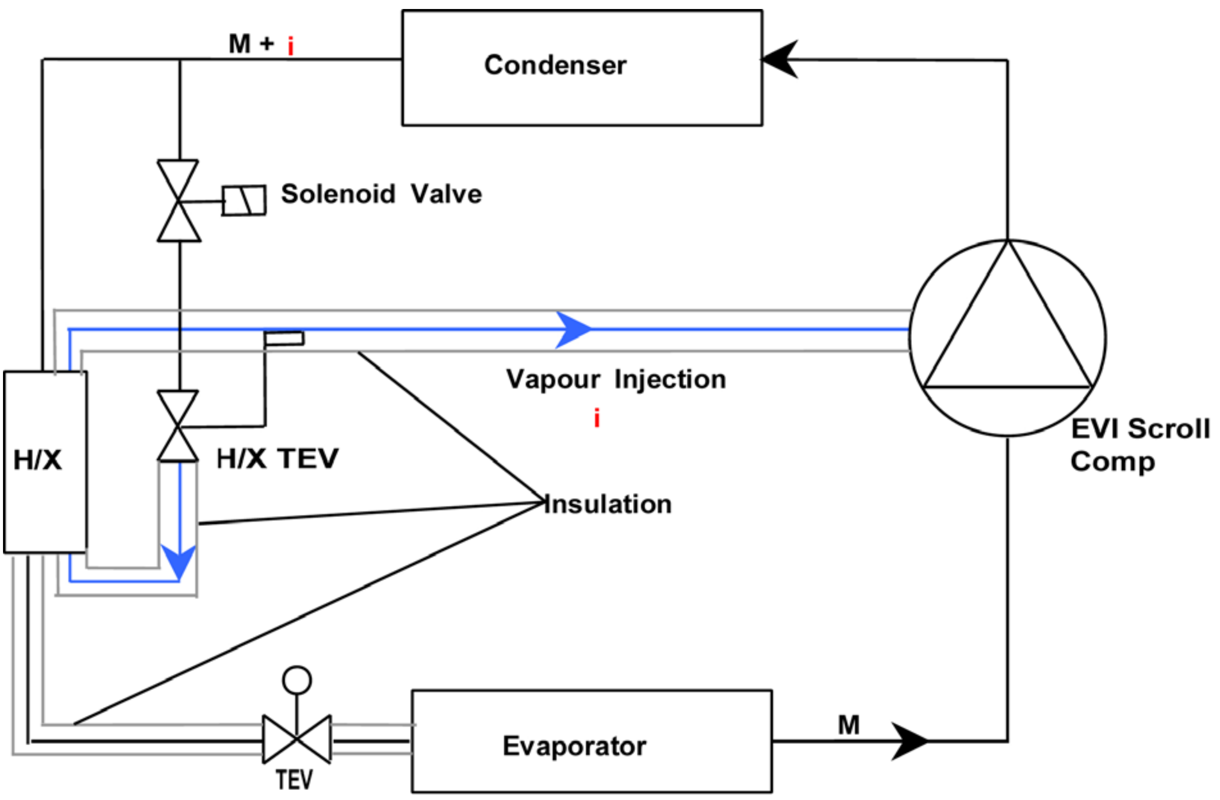



Figure 1. EVI Schematic

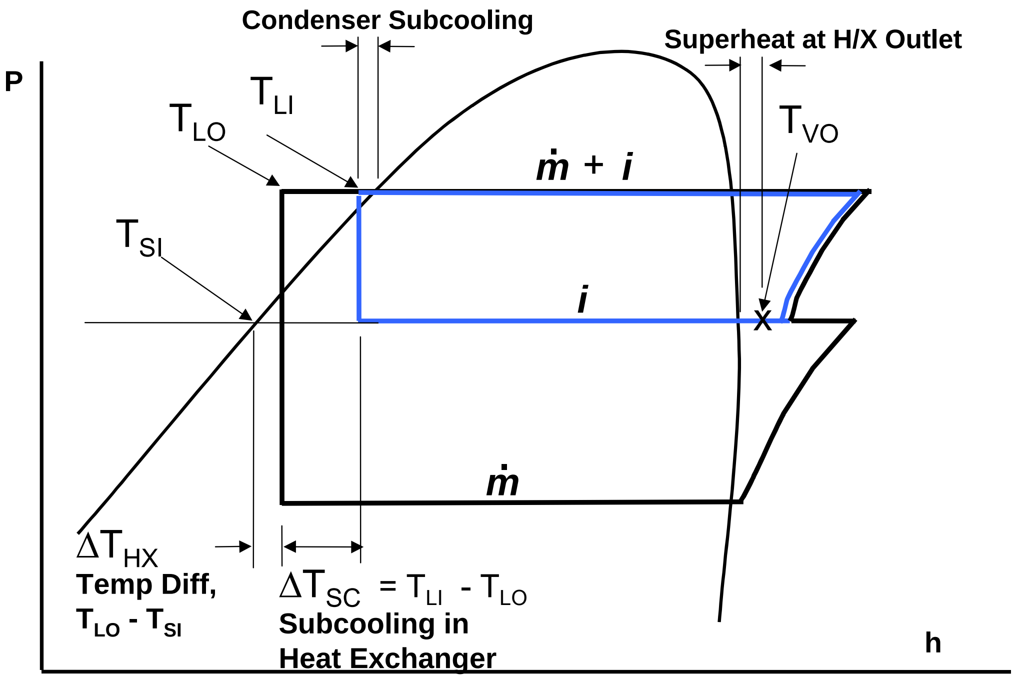



Figure 2. EVI Ph chart

| Definition(s) | Description |
|---|---|
| Tc | Condensing Temperature |
| Tli | Liquid temperature entering H/X |
| Tlo | Subcooled liquid leaving H/X |
| Pi | Intermediate Pressure |
| Tsi | Saturated temperature at intermediate pressure |
| Tvo | Vapour temperature leaving H/X |
| Tvi | Vapour temperature entering H/X |
| Tsc | Liquid subcooling in H/X |
| M | Evaporator Mass Flow |
| I | Vapour Injection Mass Flow |
| $\Delta T_{HX}$ | Liquid temp out H/X-Liquid- Saturated temperature at intermediate pressure |
| $\Delta T_{SC}$ | Liquid temp in to H/X- subcooled liquid temp out H/X |

## 4 Nomenclature

The model numbers of Copeland Scroll compressors have been designed to include a coded nominal capacity at ARI operating conditions in BTU/h at 60 Hz without vapour injection
All refrigeration scroll compressors are charged with Ester oil, which is indicated by the letter “E”.

***Model Designation***

| Z | F | 18K | V | E | - | T F D | - | 5 5 1 |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | | 6 | | 7 |

1 Z = Compressor family: Z = Scroll
2 F = Low Temperature
3 Nominal capacity [BTU/h] @ 60 Hz and ARI low temperature conditions using multipliers "K" for 1000, without vapour injection
4 - Vapour Injection for EVI operation
5 - POE Oil
6 - Motor version
7 - Bill of Material Number

## 5 Qualified Refrigerants

R404A and R507 are approved for use with the EVI compressors.

## 6 Application Envelope

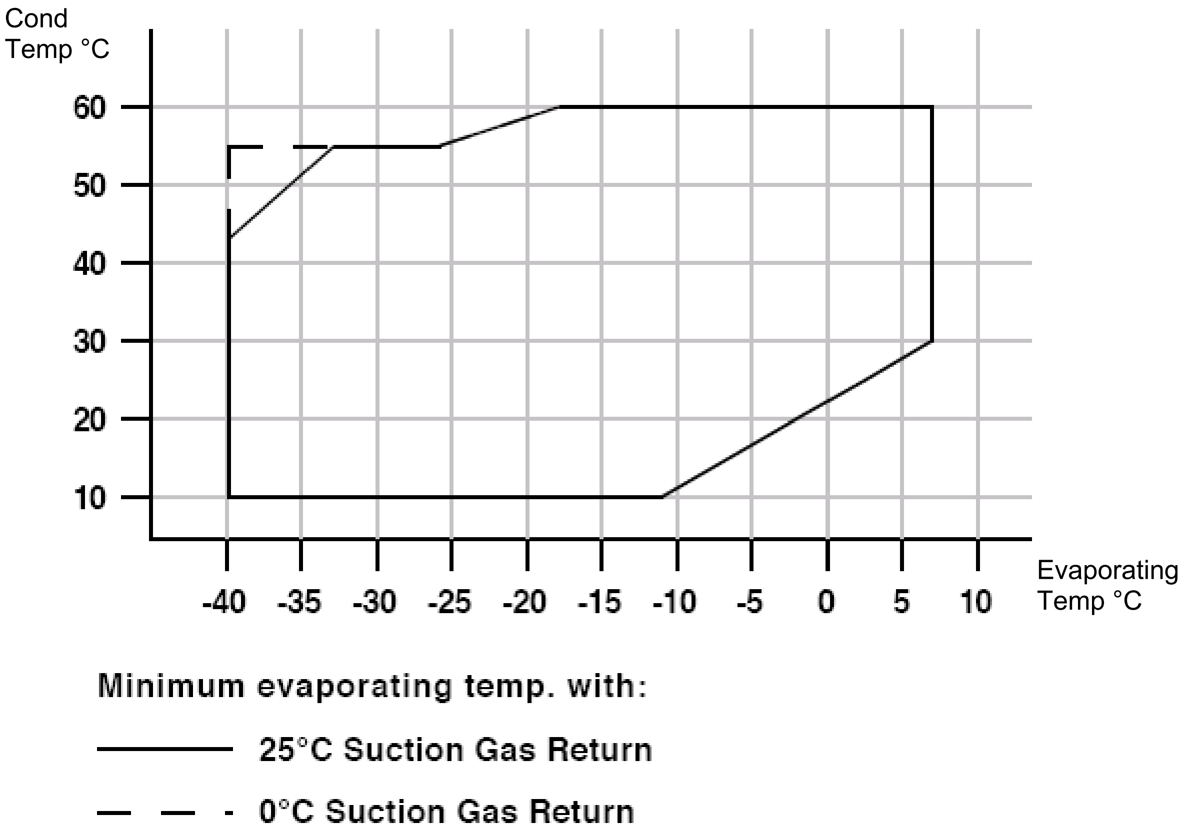



Figure 3. Application envelope of EVI compressors

## 7 System Configuration

### 7.1 Liquid Extraction

Upstream liquid extraction (before the heat exchanger) is recommended as it optimises the heat exchanger performance. The TXV regulates the flow of subcooled refrigerant out of the condenser and into the heat exchanger (Figure 4). Minimum level of condenser natural subcooling has to be guaranteed at the TXV inlet to avoid flash gas, which would cause the valve to hunt.

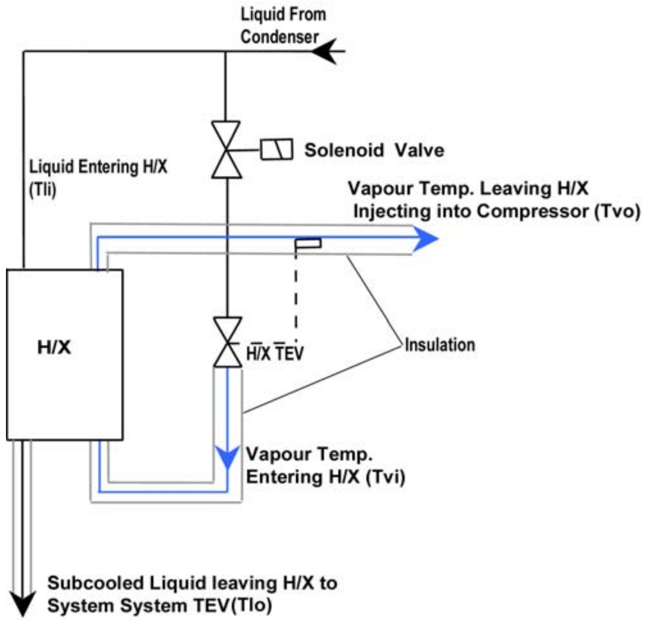



Figure 4. Upstream Extraction

### 7.2 Heat Exchanger Piping Arrangements

Best subcooling effect is assured if counter flow of gas and liquid is provided as shown (see figure 5). In order to guarantee optimum heat transfer, the plate heat exchanger should be mounted vertically and vapour should exit it at the top.

VO = Vapour temperature leaving H/X
VI = Vapour temperature entering H/X
LI = Liquid temperature entering H/X
LO = Subcooled liquid leaving H/X

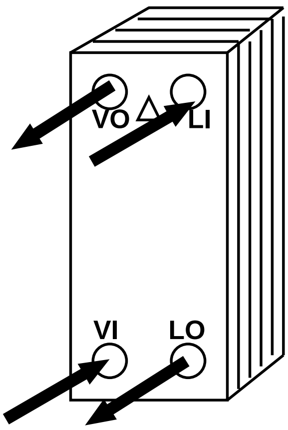



Figure 5 H/X Piping Arrangement

## 8 System Design Guidelines:

The following sections discuss system design guidelines for the EVI product.
Please use Copeland Selection software, where all parameters are given for selecting a single heat exchanger. The Copeland Selection software can be downloaded from www.eCopeland.com.

The key parameter in determining the proper heat exchanger size is the Saturated Injection Temperature (Tsi). The Tsi has been determined through extensive testing. This value can vary for each compressor and should be obtained from SELECT.

After determining the Tsi, a 5K condenser natural subcooling, 5 K heat exchanger $\Delta T_{HX}$ and 5 K heat exchanger superheat are targeted. This is done to optimise system performance while maintaining system reliability and functionality at the same time. Once these parameters are known, the heat exchanger capacity (kW) can be determined, which gives the required heat exchanger size. (See Figure 6 below)

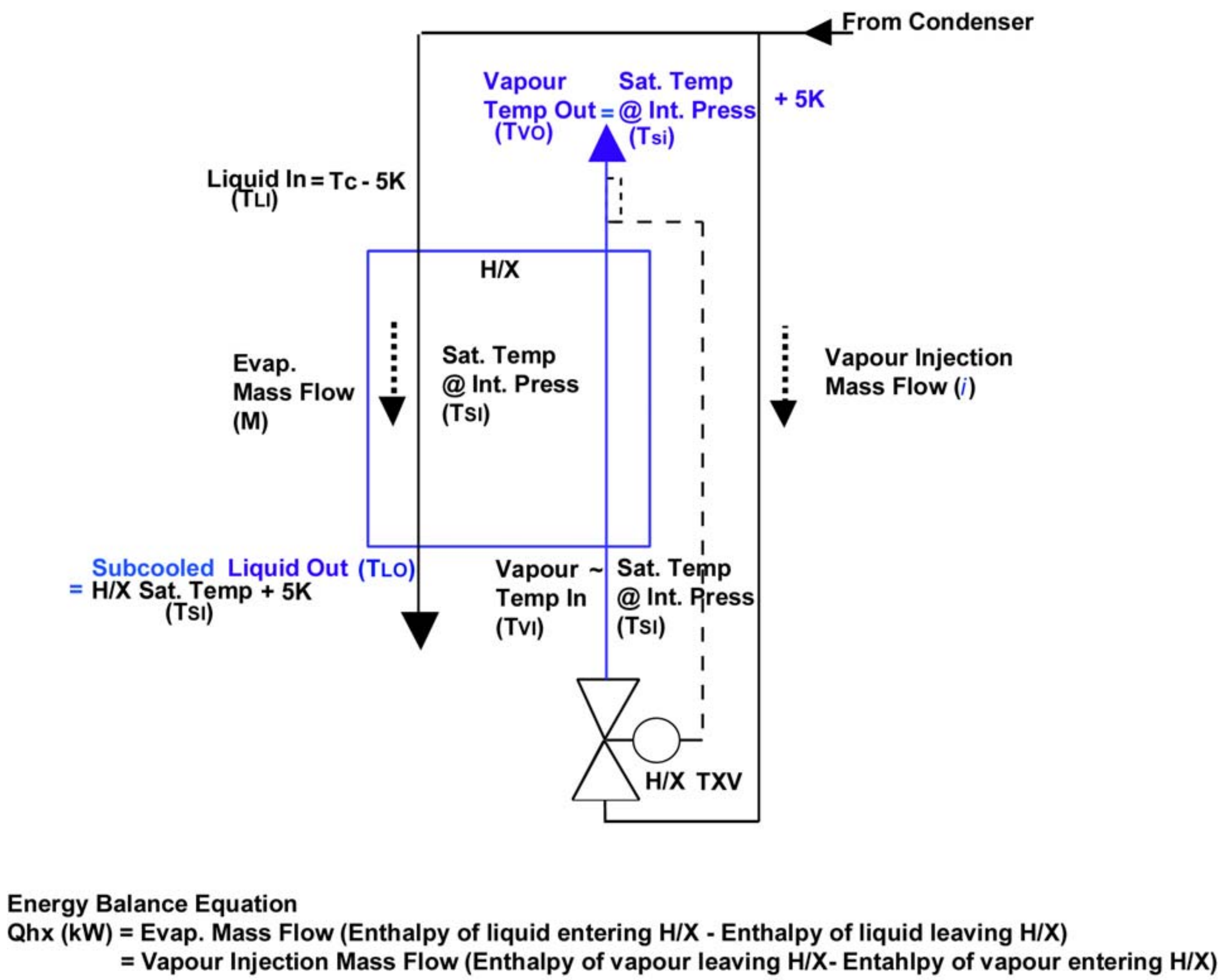
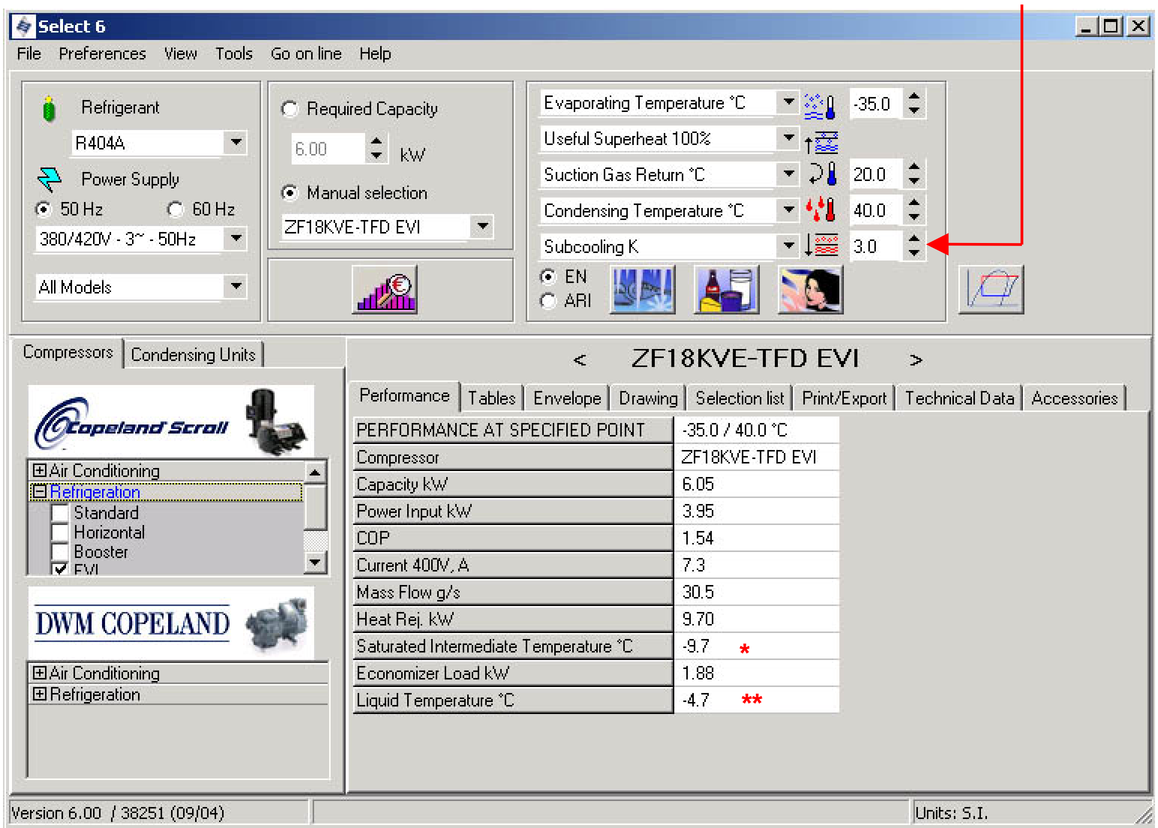



Figure 6. Heat Exchanger Details

## 8.1 Heat Exchanger sizing using Select

Figure 7 is an extract form SELECT which gives details of Economiser/heat exchanger load (kW) saturated intermediate temperature (Tsi) and sub-cooled liquid out of heat exchanger.

3K Natural Subcooling in Condenser




* Tsi temperature

**: Tlo Liquid temperature leaving the HX

Figure 7. Details on EVI performance given by SELECT software.

## 8.2 Exchanger Sizing

Heat exchangers should be sized for nominal operating conditions with adequate design margin to allow for the entire range of system operation.

## 8.3 Liquid and Vapour Injection Line Sizing

The liquid line from the heat exchanger to the evaporator should be insulated and kept as short as possible in order to maximise the subcooling effect.
The vapour injection line from the heat exchanger to the compressor should be 3/8" – 1/2.

## 8.4 Heat Exchanger TXV Sizing

The heat exchanger thermostatic expansion valve should be designed for maximum load while taking into account partial load conditions.

## 8.5 Solenoid valve

A liquid line solenoid valve is required to prevent migration of refrigerant to the compressor when it is switched off.

For multiple compressor application, a solenoid valve in the vapour injection line of each individual compressor is required. Each solenoid valve has to be energised in parallel to the compressor contactor. See "Multiple compressor application" section for more information.

## 8.6 Multiple Compressor Application

Multiple EVI compressors can be used with either a single heat exchanger for each compressor or a common heat exchanger for all compressors.

In case of a common heat exchanger, a solenoid valve should be installed on each individual vapour injection line.

Special care has to be given to the design of the heat exchanger and of the thermostatic expansion valve (TXV) to allow for part load operation. Good refrigerant distribution is required in the common heat exchanger as well as sufficient velocities for oil return, even at part load.
In the case of a large range of capacity modulation (more than 2 compressors in parallel), the use of an Electronic Expansion Valve (EXV) or of two different TXV(s) controlled by individual solenoid valves, may be necessary. For example, one at 100% full load and the second solenoid valve for 30% of full load. (See Figure 8 and Figure 9).

It is necessary to ensure that the solenoid valves, vapour injection lines and header(s) are adequately sized in order to keep pressure drop to a minimum. At the same time, the layout should be such that excessive amounts of oil do not accumulate in the header.

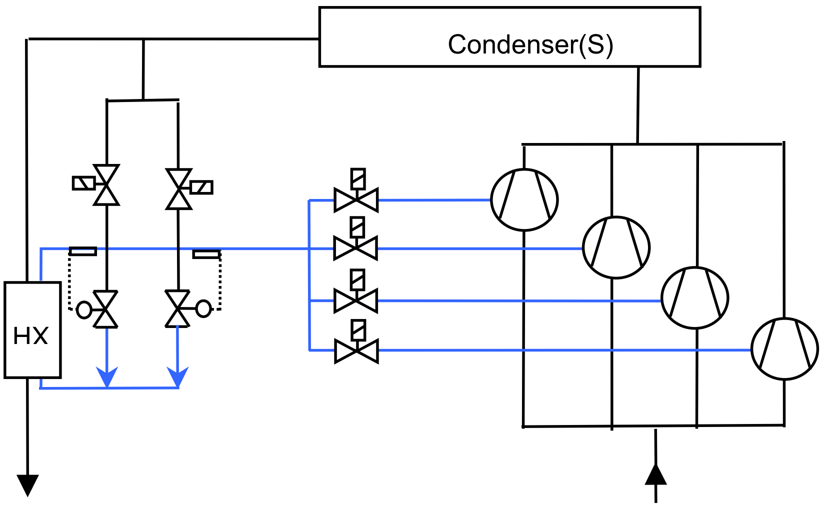



Figure 8. EVI Paralleling with HX Thermostatic valves of different capacity

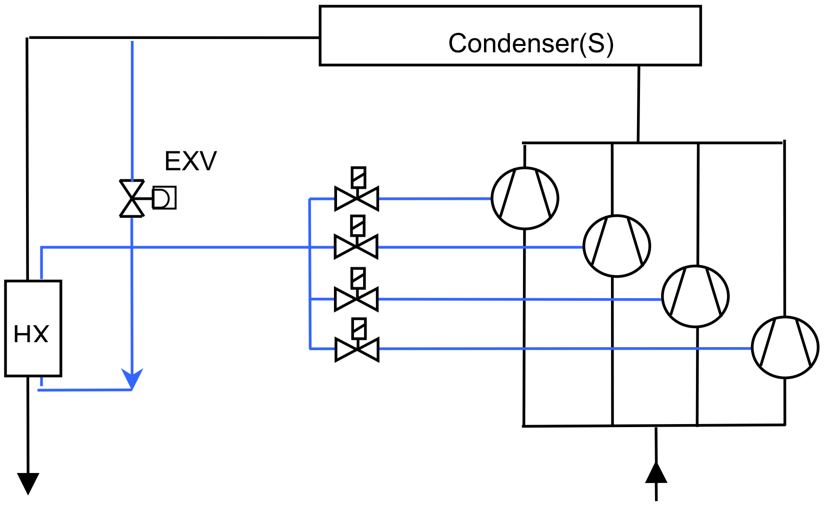



Figure 9. EVI Paralleling with HX Electronic Expansion valve (EXV)

## 9 Lubrication

The oil level should be maintained at midpoint of the sight glass. If an oil regulator is being used the level should be set within the top half of the sight glass
The compressor is supplied with an initial oil charge. The compressor is supplied with an initial charge of polyolester (POE) lubricant. In the field the oil level could be topped up with Mobil EAL Arctic 22 CC. The recharge values can be taken from Copeland Selection Software.
They must be operated with these specific oils only. Under no circumstances are ester oils to be mixed with mineral oil and/or alkyl benzene when used with chlorine-free refrigerants.
Ester oil behaves extremely hygroscopically (see Figure 10), and this influences the chemical stability of the oil.
The number of start/stop cycles should be limited to 10 per hour. A high cycling rate will pump oil into the system and may lead to lubrication failure. Oil leaves the compressor at start up regardless of the low oil carry over of the Scroll. The short running time is insufficient to return the oil to the compressor and possibly results in a lack of lubricant.
It must be considered that the entire system will be coated with oil to some extent. Oil viscosity changes with temperature. System gas velocity changes depending on temperature and load. In low load conditions gas velocity may not be high enough to return oil to the compressor. System piping should be designed to return oil under all operating conditions, including part loads.

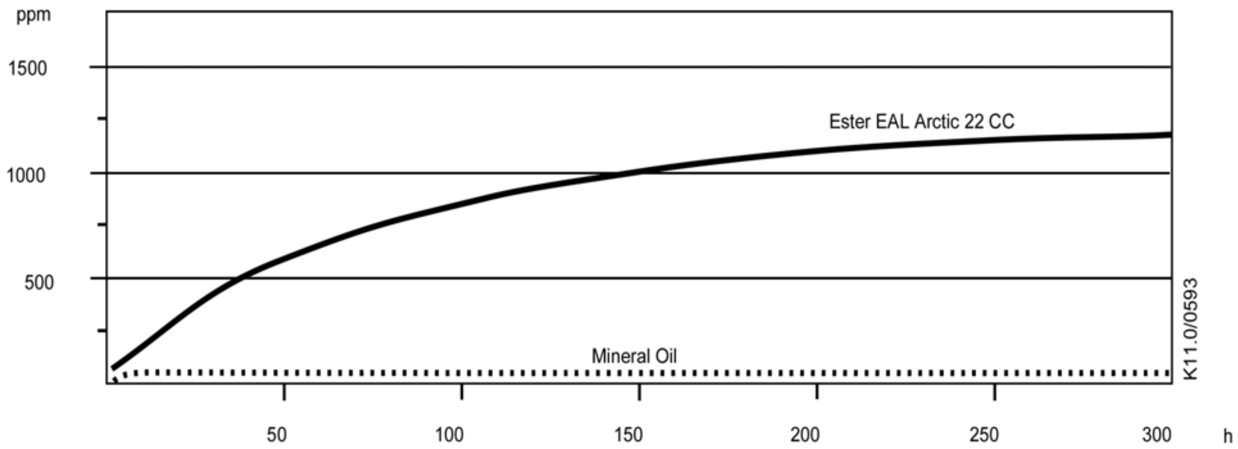



Figure 10 Absorption of moisture in ester oil in comparison to mineral oil (ppm) by weight at 25°C and 50% relative humidity. h = hours

The system should be evacuated down to 0.3 mbar/ 0.22 Torr or lower. If there is uncertainty, as to the moisture content in the system, an oil sample should be taken from various points and tested for moisture. The residual moisture in the installation should be brought below 50 PPM by good evacuation practice (refer to section 32 System Evacuation and Charging Procedure) and the use of a suitable filter drier, with an equilibrium point dryness (EPD) of 50 PPM or less.

Sight glass/moisture indicators currently available can be used with the HFC refrigerants and lubricants; however, the moisture indicator will just show the moisture contents of the refrigerant. The actual moisture level of POE would be higher than the sight glass specifies. This is a result of the high hygroscopicity of the POE oil.

## 10 Refrigerant Migration

Due to the Scroll's inherent ability to handle liquid refrigerant in flooded start and defrost cycle operation, an accumulator may not be required. For single compressor systems with extremely large charges greater than 4,5 kg, an accumulator is recommended. Excessive liquid refrigerant flood back during normal off cycles, defrost cycles, or steady operation can dilute the oil in any compressor causing inadequate lubrication and bearing wear. Proper system design will ensure maximum compressor life.
Due to the high starting torque of three phase Scroll compressors any excessive amounts of refrigerant that have migrated into the shell during standstill periods must be driven out of it prior to start-up. Crankcase heaters are required on outdoor systems where the charge limits exceed the above value. Crankcase heaters should also be used when compressor packs are installed outdoors.

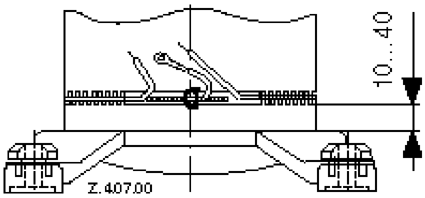
## 11 Pump Down

To control refrigerant migration a pump down system could be used. The discharge check valve with refrigeration scroll compressor is designed for low leak back and will allow the use of a pump down without the addition of an external check valve. If the compressor is stationary for prolonged periods, refrigerant could migrate into the compressor and therefore a crankcase heater must be installed. If constant cold air is drawn over the compressor, this could make the crankcase heater ineffective, and therefore a pump down system is recommended.

## 12 Crankcase Heaters

Equipment for heating the oil in the crankcase is necessary if the system configuration enables large amounts of refrigerant to condense in the compressor and be absorbed by the oil. At the high temperature produced by the heater refrigerant is constantly vaporised and problems in oil supply are reduced. For correct mounting location of such a heater, please see Figure 11.

Figure 11 Crankcase heater location




## 13 Mufflers

Flow through Copeland Scroll compressors is continuous and has relatively low pulsations. External mufflers, previously applied to piston compressors, may not be required for Copeland Scrolls. Because of variability between systems, however, individual system tests should be performed to verify acceptability of sound performance.

## 14 Pressure Controls

Both high and low pressure controls are required and the following working pressures are recommended: for ZF EVI models, the normal minimum setting should be 0.3 bar g (R404A). The maximum is 28 bar g.

## 15 Shut-Off

Since the Copeland Scroll compressor is also an excellent gas expander, the compressor may run backwards for a very brief period at shut-off as the internal pressures equalise, and a typical sound is generated. A check valve in the discharge connection of the compressor prevents the compressor from running backwards for more than a few seconds. Additionally there is a dynamic discharge valve mounted on the fixed Scroll, which effectively eliminates reverse rotation.

## 16 Starting

During the very brief start-up, a short metallic sound is audible, resulting from initial contacting of the spirals and is normal.
Due to the design of the Copeland Scroll, the internal compression components always start unloaded even if system pressures are not balanced. In addition, since internal compressor pressures are always balanced at start-up, low-voltage starting characteristics are excellent for Copeland Scroll compressors. Moreover, if low voltage conditions exist at start up, protector trips could result.

## 17 Deep-Vacuum Operation

Do not run a "refrigeration scroll" compressor in a deep vacuum. Failure to heed this advice can result in arcing of the Fusite pins causing permanent damage to the compressor.

## 18 Discharge Temperature Control

Internal discharge temperatures reached under some extreme operating conditions (such as loss of charge or extremely high compression ratio caused by failure of condenser fan) can cause compressor damage. In order to guarantee positive compressor protection the compressor must be equipped with an external discharge temperature sensor. This thermostat is not insulated and the equivalent set point for an insulated sensor is 120°C maximum. The thermostat should be positioned as shown in Figure 12 below.

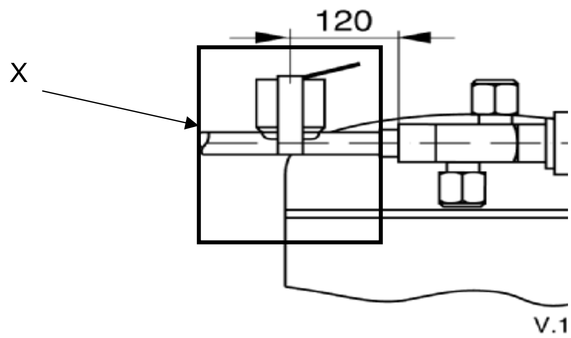



Figure 12 Discharge Line Thermostat

## 19 Discharge Thermistors

An alternative to the discharge line thermostat is to have thermistors with the sensing element located in the head of the compressor. More details are available upon request.

## 20 Standard Motor Protection

Conventional inherent internal line break motor protection is provided with models ZF13-18KVE.

## 21 Electrical Installation

Independently from the internal motor protection, motor protection devices (fuses and circuit breakers) indicated by F6...8 have to be installed before the compressor is shown in figures 13. Selection of the circuit breakers, fuses have to be carried out according to VDE 0635 or DIN 57635 or IEC 269-1 or EN60-269-1.
Motor insulation material class is “B” for models ZF13 KVE ... ZF 18 KVE according to VDE 0530 or DIN 57530.
The recommended wiring diagram is shown in Figure 13.

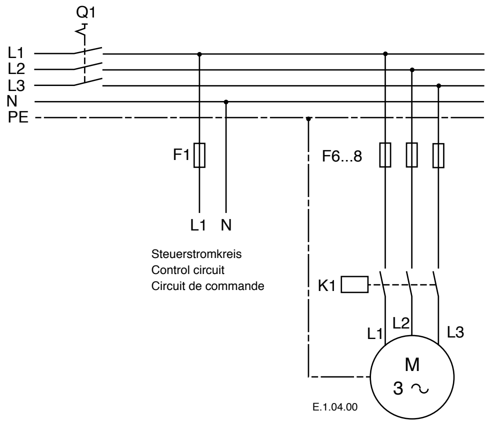



Figure 13. Power Circuit three phase

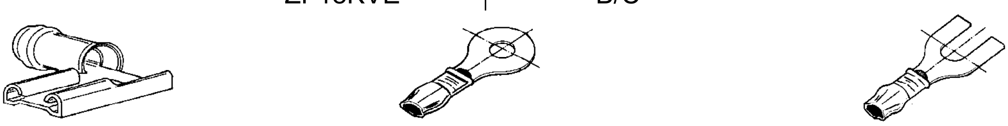
## 22 Three-Phase Models

Scroll compressors, like several other types of compressors, will only compress in one rotational direction. Direction of rotation is not an issue with single-phase compressors since they will always start and run in the proper direction. However, three-phase compressors will rotate in either direction depending upon phasing of the power to L1, L2 and L3. Since there is a 50/50 chance of connecting power in such a way as to cause rotation in the reverse direction, it is important to include notices and instructions in appropriate locations on the equipment to ensure proper rotation direction is achieved when the system is installed and operated. Verification of proper rotation direction is made by observing that suction pressure drops and discharge pressure rises when the compressor is energised. Reverse rotation results in a sound level above that with correct rotation direction, as well as substantially reduced current draw compared to tabulated values and after several minutes of operation the compressor’s internal protector will trip.
All three-phase compressors are wired identically internally. As a result, once the correct phasing is determined for a specific system or installation, connecting properly phased power leads to the same terminals should maintain proper rotation direction.

## 23 Cable Connectors

The table lists recommended types of cable connectors to be used for the various electric terminals of the compressors. “A” and “B” must fit 1/4" or 6.3 mm tab sizes. “C” are to be selected for #10 studs or diameters of 5mm respectively.

| Model | TFD |
|---|---|
| ZF13KVE | B/C |
| ZF18KVE | B/C |



A Flag Receptacle B Ring Tongue C Spade

Figure 14 Cable Connectors

## 24 Current Sensing Relay for use with Economiser Operation

As mentioned earlier, power to the injection solenoid must be dropped if the internal motor protector trips and the danger of flooding the compressor arises. For models ZF13KVE.... ZF18KVE a current sensing relay, e.g. the KRIWAN INT 215, Type K35 can be supplied. For wiring information see Figures 15 and 16.
The relay must be installed in a way that it senses the same phase as the control circuit is hooked up to. "L1" in figures 15, 16 and 17 serves only as an example. It has to be wired in a way that marking "L" faces the compressor and "K" the contactor.

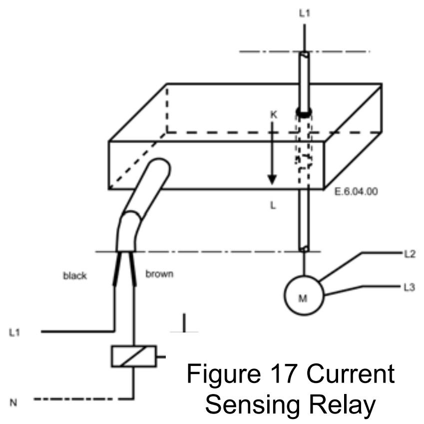


Figure 17 Current Sensing Relay

| Kriwan INT 215K 35 | |
|---|---|
| Ambient Temperature | -20….. +60°C |
| Switching Capacity | AC 50/60Hz 115/230 V Max, 0.5A, Cos φ=0.4 12….40VA |
| Holding Current | $L_{min}$ 0.05A |
| Protection Class | IP 67 |

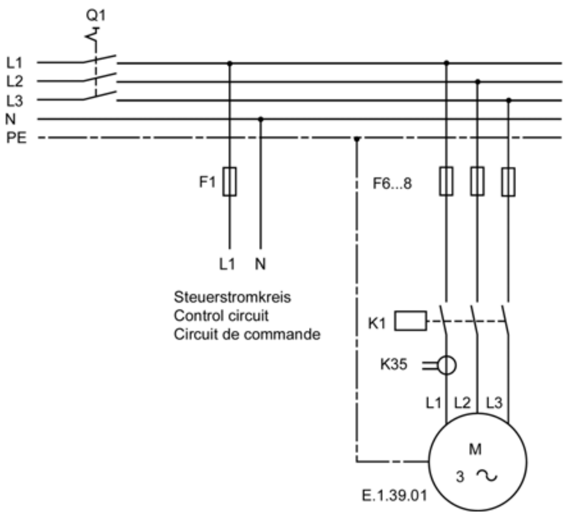


Figure 16 Recommended Circuits

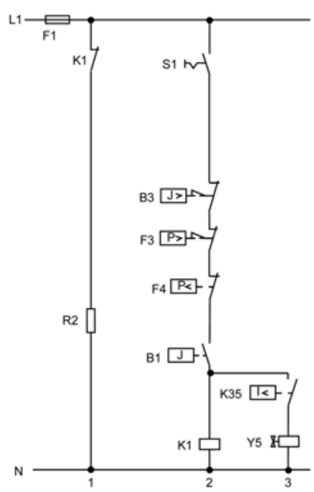


Figure 15 Electrical Schematic

Recommended Circuits

| | |
|---|---|
| B1 | Room thermostat |
| F1 | Control circuit Fuse |
| B3 | Discharge gas thermostat |
| F3 | High pressure switch |
| F4 | Low pressure switch |
| F6…8 | Fuses |
| K1 | Contactor |
| K35 | Current sensing relay |
| Q1 | Main switch |
| R2 | Crankcase heater |
| S1 | Auxiliary switch |
| Y5 | Solenoid valve for Vapour injection |

## 25 High Potential Testing

Copeland subjects all scroll compressors to a high voltage test after final assembly.
Since high voltage tests lead to premature ageing of the winding insulation we do not recommend additional tests of that nature. They may also be carried out with new machines only.
If it has to be done for any reason disconnect all electronic devices (e.g. motor protection module, fan speed control, etc.) prior to testing. The test voltage of 1000 V plus twice the nominal voltage is applied for 1 - 4 seconds between motor winding (each one of the phases) and the compressor shell: The maximum leak current limit is approximately 10 mA. Repeated tests have to be performed at lower voltages.

**Caution:** Do not carry out high voltage or insulation tests if the compressor housing is under vacuum. Copeland Scroll compressors are configured with the motor down and the pumping components at the top of the shell. As a result, the motor can be immersed in refrigerant to a greater extent than hermetic reciprocating compressors when liquid refrigerant is present in the shell. In this respect, the scroll is more like semi-hermetics (which have horizontal motors partially submerged in oil and refrigerant). When Copeland Scroll compressors are high potential tested with liquid refrigerant in the shell they can show higher levels of leakage current than compressors with the motor on top because of the higher electrical conductivity of liquid refrigerant than refrigerant vapour and oil. However, this phenomenon can occur with any compressor when the motor is immersed in refrigerant. The levels of current leakage do not present any safety issue. To lower the current leakage reading the system should be operated for a brief period of time to redistribute the refrigerant to a more normal configuration and the system high potential tested again.

## 26 Compressor Functional Check

No scroll compressor should be started with the suction service valve closed to check how low the compressor will pull suction pressure. This type of test may actually damage a refrigeration Scroll compressor; rather, the following diagnostic procedure should be used to evaluate whether the Scroll compressor is functioning properly.

Proper voltage to the unit should be verified.

- Normal motor winding continuity and short to ground checks will determine if the inherent overload motor protector has opened or if an internal short to ground has developed. If the protector has opened, the compressor must cool sufficiently to reset.
- With service gauges connected to suction and discharge pressure fittings, turn on the compressor. If the suction pressure falls below normal levels the system is either low on charge or there is a flow blockage in the system.

Three-phase Compressor
If suction pressure does not drop and discharge pressure does not rise to normal levels, reverse any two of the compressor power leads and reapply power to make sure compressor was not wired to run in reverse direction. If pressures still do not move to normal values, the compressor is faulty. If the compressor is in a circuit containing a reversing valve, this item may be faulty. Reconnect the compressor leads as originally configured and use normal diagnostic procedures to check operation of the reversing valve. If the reversing valve checks out satisfactorily, then the compressor current draw should be compared to published compressor performance data at the compressor operating conditions (pressures and voltages) and significant deviations (more than ±15%) from published values may indicate a faulty compressor.

## 27 Installation

For single operation, four rubber vibration absorber grommets are supplied with each compressor (see fig. 18). They dampen the start-up surge of the compressor and prevent sounds and vibrations from being transmitted to the compressor base during operation to a large extent. The metal sleeve inside is intended as a guide to hold the grommet in place. It is not designed as a load-bearing member, and excessive torquing can crush the sleeve. Its inner diameter is approximately 8.5 mm to fit e.g. an M8 screw. The mounting torque should be 13 ± 1 Nm. It is critically important that the grommet is not compressed. A clearance space of approximately 2-mm between the bottom of the washer and the top of the grommet spacer is recommended. For multiple or parallel operation please refer to application guidelines “Refrigeration Scroll for Parallel Applications” (C6.2.5/E).

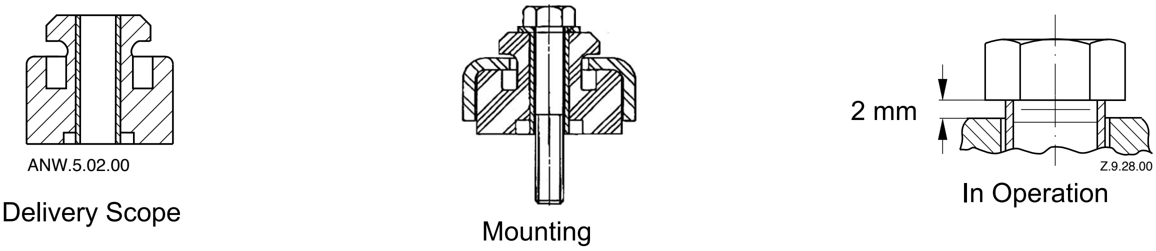
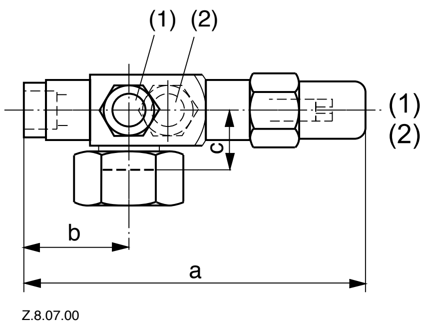


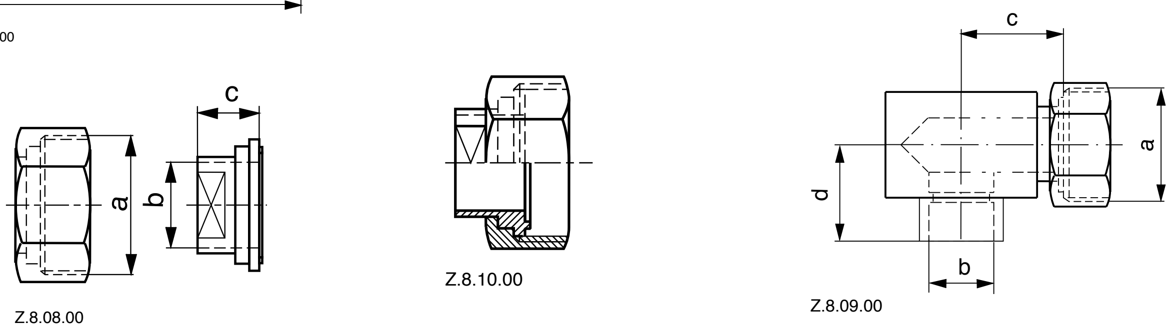

Figure 18 Mounting parts for single operation

## 28 Shut-off Valves and Adapters

The refrigeration scroll compressors are delivered with threads for Rotalock shut off valves. Brazed pipe work can also fit compressors with Rotalock connections using adapters “A” and “B” in either straight or angled “C”.
***It is strongly recommended to periodically re-torque all fixing connections to the original setting after the system has been put into operation.***




(1) Pressure control Connection
(2) Gauge Connection




**A** **B** **C**

| | Torque [Nm] |
|---|---|
| Rotalock 3/4"-16UNF | 40 – 50 |
| Rotalock 1"1/4-12UNF | 110-135 |
| Rotalock 1"3/4-12UNF | 135-160 |

Figure 19 Shut off valves and adaptors

## 29 Suction Line Noise and Vibration

Copeland Scroll compressors inherently have low sound and vibration characteristics. However, in some respects, the sound and vibration characteristics differ from reciprocating compressors and, in rare instances, could result in unexpected sound complaints.

One difference is that the vibration characteristic of the Scroll compressor, although low, includes two very close frequencies, one of which is normally isolated from the shell by the suspension of an internally suspended compressor. These frequencies, which are present in all compressors, may result in a low level “beat” frequency, which can be detected as noise coming along the suction line into a house under some conditions. Elimination of the “beat” can be achieved by attenuating either of the contributing frequencies. This is easily done by using one of the common combinations of design configuration described below.

A second difference of the Copeland Scroll compressor is that under some conditions the normal starting motion of the compressor can transmit an “impact” noise along the suction line. This phenomenon, like the one described above, also results from the lack of internal suspension, and can be easily avoided by using standard line isolation techniques as described below.

**Recommended configuration** (Figure 20):

- Tubing configuation: small shock loop
- Service valve: “angled valve” fastened to unit/wall
- Suction muffler: not required

**Alternative configuration:**

- Tubing configuration: small shock loop
- Service valve: “straight-through” valve fastened to unit/wall
- Suction muffler: may be required

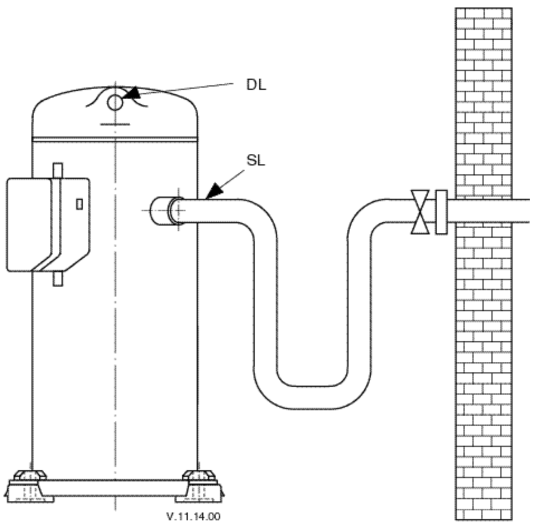



Figure 20 Suction Tube Design

## 30 Shell Temperature

Under rare circumstances, caused by failure of system components such as condenser fans or evaporator fans, loss of charge, and depending on the type of expansion control; the top shell and discharge line can briefly but repeatedly reach temperatures above 177°C as the compressor cycles on its internal protection devices. Care must be taken to ensure that wiring or other materials, which could be damaged by these temperatures, do not come into contact with the shell.

## 31 System Evacuation and Charging Procedure

Before the installation is put into commission, it has to be evacuated with a vacuum pump. During the initial procedure, suction and discharge shut-off valves on the compressor remain closed. The installation of adequately sized access valves at the furthest point from the compressor in the suction and liquid line is advisable. Pressure must be measured using a vacuum pressure (Torr) gauge on the access valves and not on the vacuum pump; this serves to avoid incorrect measurements resulting from the pressure gradient along the connecting lines to the pump. These valves could also be used to measure the operating pressures to ensure there are no excessive pressure drops in the suction line and liquid line, which will also give an indication that the expansion device receives full bore liquid, ensuring the system performs at its most efficiently.

Evacuating the system only on the suction side of a Scroll compressor can occasionally result in a temporary no-start condition for the compressor. The reason for this is that the floating seal could axially seal with the scroll set, with the higher pressure on the floating seal. Consequently, until the pressures equalise, the floating seal and scroll set can be held tightly together.

The installation should be evacuated down to 0.3 mbar/ 0.22 Torr or lower. Subsequently, the factory holding charge of dry air in the compressor is released to the ambient. The shut-off valves are opened and the installation, including the compressor, are once more evacuated as described after the system has been re-charged with dry nitrogen.
Highest demands are placed on the leak proof design of the installation and on the leak testing methods. (Please refer to EN378).

Rapid charging on the suction side of Scroll compressors can occasionally result in a temporary no-start condition for the compressor. The reason for this is that if the flanks of the spirals happen to be in a sealed position, rapid pressurisation of the low side without opposing high side pressure can cause the spirals to seal axially. Consequently, until the pressures eventually equalise, the spirals can be held tightly together, preventing rotation. The best way to avoid this situation is to charge on both the high and low side simultaneously at a rate, which does not result in axial loading of the spirals. The maximum charging rate can be determined through simple tests.

## 32 Unbrazing System Components

If the refrigerant charge is removed from a scroll-equipped unit by bleeding the high side only, it is sometimes possible for the scrolls to seal, preventing pressure equalisation through the compressor. This may leave the low side shell and suction line tubing pressurised. If a brazing torch is then applied to the low side while the low side shell and suction line contains pressure, the pressurised refrigerant and oil mixture could ignite when it escapes and contacts the brazing flame. To prevent this occurrence, it is important to check both the high and low side with gauges before unbrazing, or in the case of repairing a unit on an assembly line, bleed refrigerant from both the high and low side. Instructions should be provided in appropriate product literature and assembly (line repair) areas.

## 33 Compressor Replacement

In the case of a motor burn, the majority of contaminated oil will be removed with the compressor. The rest of the oil is cleaned through use of suction and liquid line filter dryers. A 100% activated alumina suction filter drier is recommended but must be removed after 72 hours. It is highly recommended that the suction accumulator be replaced if the system contains one. This is because the accumulator oil return orifice or screen may be plugged with debris or may become plugged shortly after a compressor failure. This will result in starvation of oil to the replacement compressor and a second failure.
When a single compressor or tandem is exchanged in the field, a major portion of the oil may still be in the system. While this may not affect the reliability of the replacement compressor, the extra oil will add to rotor drag and increase power usage.

## 32 System Evacuation and Charging Procedure

Before the installation is put into commission, it has to be evacuated with a vacuum pump. During the initial procedure, suction and discharge shut-off valves on the compressor remain closed. The installation of adequately sized access valves at the furthest point from the compressor in the suction and liquid line is advisable. Pressure must be measured using a vacuum pressure (Torr) gauge on the access valves and not on the vacuum pump; this serves to avoid incorrect measurements resulting from the pressure gradient along the connecting lines to the pump. These valves could also be used to measure the operating pressures to ensure there are no excessive pressure drops in the suction line and liquid line, which will also give an indication that the expansion device receives full bore liquid, ensuring the system performs at its most efficiently.

Evacuating the system only on the suction side of a Scroll compressor can occasionally result in a temporary no-start condition for the compressor. The reason for this is that the floating seal could axially seal with the scroll set, with the higher pressure on the floating seal. Consequently, until the pressures equalise, the floating seal and scroll set can be held tightly together.

The installation should be evacuated down to 0.3 mbar/ 0.22 Torr or lower. Subsequently, the factory holding charge of dry air in the compressor is released to the ambient. The shut-off valves are opened and the installation, including the compressor, are once more evacuated as described after the system has been re-charged with dry nitrogen.
Highest demands are placed on the leak proof design of the installation and on the leak testing methods. (Please refer to EN378).

Rapid charging on the suction side of Scroll compressors can occasionally result in a temporary no-start condition for the compressor. The reason for this is that if the flanks of the spirals happen to be in a sealed position, rapid pressurisation of the low side without opposing high side pressure can cause the spirals to seal axially. Consequently, until the pressures eventually equalise, the spirals can be held tightly together, preventing rotation. The best way to avoid this situation is to charge on both the high and low side simultaneously at a rate**,** which does not result in axial loading of the spirals. The maximum charging rate can be determined through simple tests.

## 33 Unbrazing System Components

If the refrigerant charge is removed from a scroll-equipped unit by bleeding the high side only, it is sometimes possible for the scrolls to seal, preventing pressure equalisation through the compressor. This may leave the low side shell and suction line tubing pressurised. If a brazing torch is then applied to the low side while the low side shell and suction line contains pressure, the pressurised refrigerant and oil mixture could ignite when it escapes and contacts the brazing flame. To prevent this occurrence, it is important to check both the high and low side with gauges before unbrazing, or in the case of repairing a unit on an assembly line, bleed refrigerant from both the high and low side. Instructions should be provided in appropriate product literature and assembly (line repair) areas.

## 34 Compressor Replacement

In the case of a motor burn, the majority of contaminated oil will be removed with the compressor. The rest of the oil is cleaned through use of suction and liquid line filter dryers. A 100% activated alumina suction filter drier is recommended but must be removed after 72 hours. It is highly recommended that the suction accumulator be replaced if the system contains one. This is because the accumulator oil return orifice or screen may be plugged with debris or may become plugged shortly after a compressor failure. This will result in starvation of oil to the replacement compressor and a second failure.
When a single compressor or tandem is exchanged in the field, a major portion of the oil may still be in the system. While this may not affect the reliability of the replacement compressor, the extra oil will add to rotor drag and increase power usage.

**Benelux**
Deltakade 7
NL-5928 PX Venlo
Tel. +31 (0) 77 324 0234
Fax +31 (0) 77 324 0235

**Deutschland/Österreich & Schweiz**
Senefelder Straße 3
D-63477 Maintal
Tel. +49 (0)6109 6059 0
Fax +49 (0)6109 6059 40

**France/Greece & Maghreb**
8, Allee Du Moulin Berger
F-69130 Ecully
Tel. +33 (0)4 78668570
Fax +33 (0)4 78668571

**Italia**
Via Ramazzotti, 26
I-21047 Saronno (va)
Tel. +39 02 961781
Fax +39 02 96178888

**España & Portugal**
Diputacion, 238 AT.8
E-08007 Barcelona
Tel. +34 93 4123752
Fax +34 93 4124215

**UK & Ireland**
Colthrop Way
GB- Thatcham, Berkshire - RG19 4 NQ
Tel. +44 (0)1635 87 6161
Fax +44 (0)1635 877111

**Sweden/Denmark/Norway & Finland**
Östbergavägen 4, P.O.Box 10
S-59021 Väderstad
Tel. +46 (0) 142 70520
Fax +46 (0) 142 70521

**Eastern Europe, Turkey & Iran**
27, Rue des Trois Bourdons
B-4840 Welkenraedt
Tel. +32 (0) 87 305 061
Fax +32 (0) 87 305 506

**Poland**
11A, Konstruktorska
P-02-673 Warszawa
Tel. +48 225 458 9205
Fax +48 225 458 9255

**Russia & CIS**
Malaya Trubetskaya, 8-11th Floor
RUS-119881 Moscow
Tel. +7 095 232 94 72
Fax +7 095 232 03 56

**Middle East & Africa**
PO Box 26382, R/A 8, FD-2
Jebel Ali, Dubai - UAE
Tel. +9714 883 2828
Fax +9714 883 2848

**Asia/Pacific**
10/F, Pioneer Building, 213 Wai Yip Street,
Kwun Tong, Kowloon - Hong Kong
Tel. +852 28 66 31 08
Fax +852 25 20 62 27

**Latin America**
7975 North West 154Th Street - Suite 300
Miami Lakes, FL, 33016 - USA
Tel. +1 305 818 8880
Fax +1 305 818 8888

C6.2.11/ 0504-0904/E

**Copeland Marketing & Sales** - 27, Rue des Trois Bourdons - B 4840 Welkenraedt, Belgium
Tel. +32 (0) 87 305411 - Fax +32 (0) 87 305506 - internet: www.ecopeland.com - email: eCommerce@eCopeland.com