

# Application Guidelines for Invotech YF

## Scroll Refrigeration Compressors

### Safety Instructions

These instructions should be kept throughout the lifetime of the compressor. You are strongly advised to follow these safety instructions. The local related regulations and rules should be obeyed, too.

### SAFETY STATEMENTS

- Refrigerant compressors must be employed only for their intended use.
- Only qualified and authorized HVAC/R personnel are permitted to install, make the commissioning and maintain the equipment.
- Electrical connections must be made by qualified electrical personnel.
- All valid standards and codes for installing, servicing, and maintaining electrical and refrigeration equipment must be observed.

### ELECTRICAL SHOCK HAZARD

- Disconnect and lock out power before servicing.
- Discharge all capacitors before servicing.
- Use compressor with grounded system only.
- Pre-Insulated electrical terminals must be used when required.
- Refer to original equipment wiring diagrams.
- Electrical connections must be made by qualified electrical personnel.
- Failure to follow these warnings could result in serious personal injury.

### PRESSURIZED SYSTEM HAZARD

- System contains refrigerant and oil under pressure.
- Remove refrigerant from both the high and low pressure sides before uninstall the compressor.
- Use appropriate back up wrenches on Rotolock fittings when servicing.
- Never install a system and leave it unattended when it has no charge, a holding charge, or with the service valves closed without electrically locking out the system.
- Use only approved refrigerants and refrigeration oils.
- Personal safety equipment must be used.
- Failure to follow these warnings could result in serious personal injury.

### BURN HAZARD

- High temperature on the compressor surface. Do not touch the compressor until it has cooled down.
- Ensure that materials, piping and wiring do not touch high temperature areas of the compressor.
- Use caution when brazing system components.
- Personal safety equipment must be used.
- Failure to follow these warnings could result in serious personal injury or property damage.

## Introduction

Invotech YF Scroll compressors are special designed for the low temperature applications. The features include the special scroll sets design, dynamic discharge valve, injection system, etc. These special designs result in a compressor that is suitable for the most demanding refrigeration applications with high efficiency.

## Nomenclature

The YF scroll model numbers include the nominal refrigeration capacity at standard ARI rating conditions for low temperature (-31.7/40.6°C), 50Hz. For additional information, please refer to the web site at [www.invotech.cn](http://www.invotech.cn).

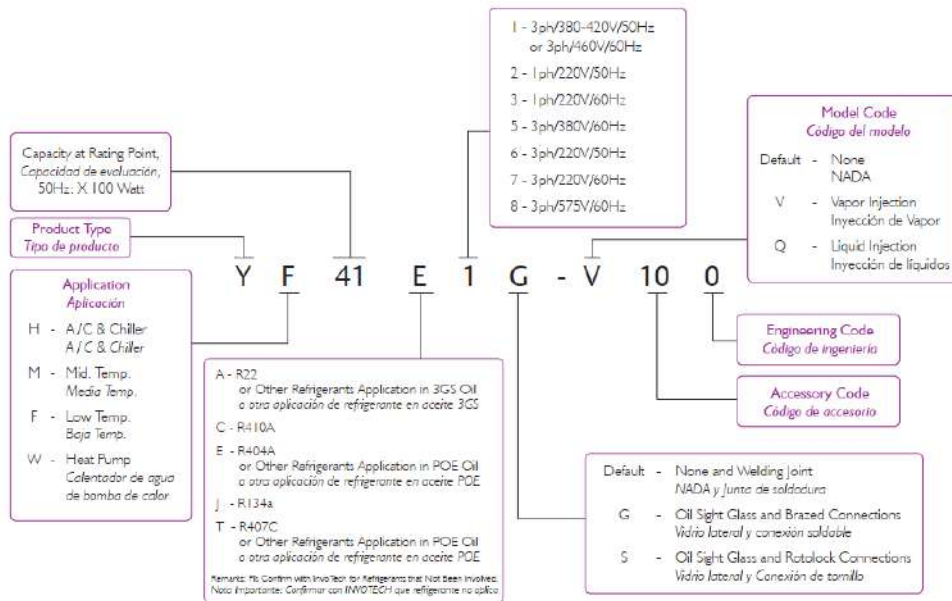


Figure 1 YF Nomenclature

## Operating Envelope

The YF refrigeration scroll compressor models can be used with R22, R404A and other refrigerants depending on the model selected and the lubricant used. Please check with your Invotech Application Engineer if any questions about the suitable refrigerants.

The YF\*\*\* models are intended for low temperature refrigeration applications. The approved operating envelopes are showing below, they are ideally suitable for applications such as cold rooms, environmental test chamber, refrigeration display cabinets and frozen cave, etc. The models and operating envelopes are depicted in Figures 2a and 2b.

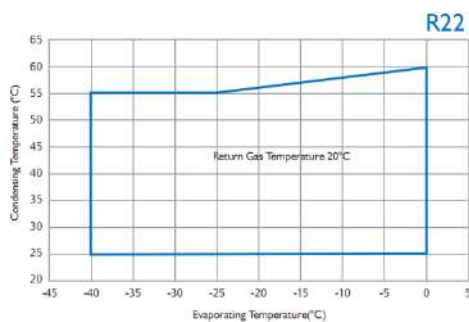


Figure 2a

YF\*\*A Application Envelope for R22

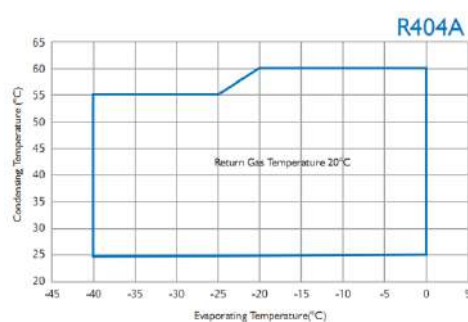


Figure 2b

YF\*\*E Application Envelope for R404A

### Liquid Injection

The YF\*\*\*\*Q\*\*\* scroll compressor is provided with an injection port to connect to a source of liquid refrigerant. Internally, this port is connected to an inner pocket of the scroll chamber. Since this pocket is separated from the suction inlet, no loss of displacement results from the liquid injection.

### DTC Valve Introduction

The compressor is delivered with a TXV type valve to realize the liquid injection. This special type of TXV valve is called DTC valve.

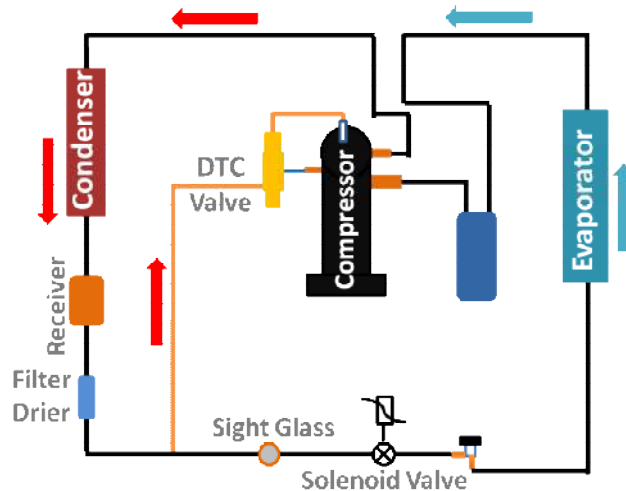


Figure 3 Reference LT system diagram with DTC Valve

### DTC Valve specifications

Opening Set point: 90°C, Considering the influence of ambient temperature and sensing deviation, the actual operation temperature may be varied in a small range.

When the discharge temperature is higher than the settings, the valve will open and allow the refrigerant feed into the scroll and control the discharge temperature. The valve opening degree is based on the discharge temperature detected by the sensor. Liquid refrigerant will be fed into the injection port and decrease the discharge temperature, the injection flow will be changed according to the sensor (discharge) temperature.

The valve sensor must be installed in the well on the top cap to adequately control scroll temperatures. The valve should be tightened on the injection fitting with a torque of 25 - 28 Nm. A 90° orientation on the valve is recommended, however it will operate properly in any orientation. The capillary tube connecting the valve to the sensor should be positioned such that it does not contact the compressor shell during operation. Do not bend the capillary tube within 30mm at both ends.

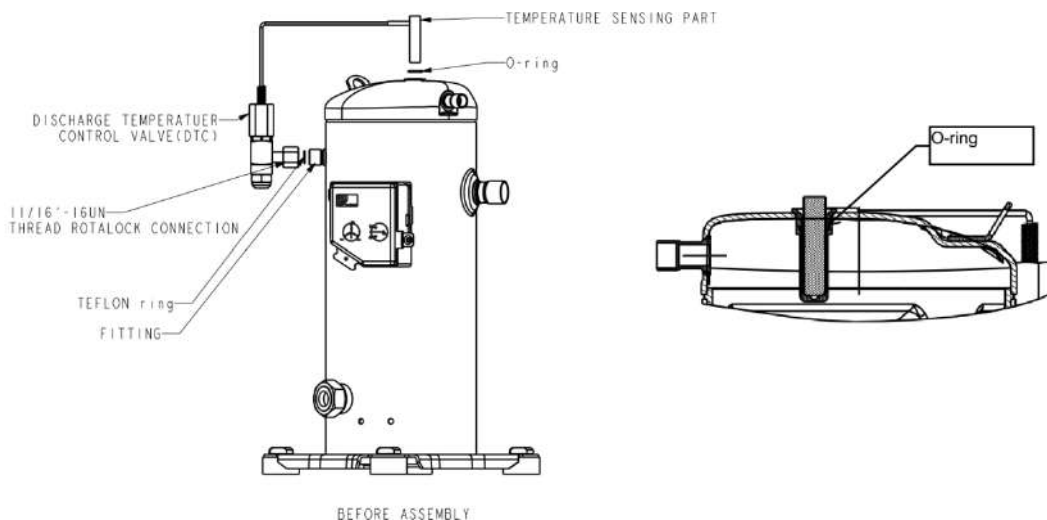


Figure 4 DTC Installation Sketch

### **Suggested Application Techniques**

For the most efficient thermal sensing, it is suggested to spread a thin film of thermal grease around the DTC Valve sensor before installing it into the top cap well.

A continually enough liquid supply is the key to the proper operation of the DTC valve. A liquid line sight glass could be applied to inspect visually of the status of liquid supplied.

If the compressor is failed, it is recommend to replace both the DTC Valve and the compressor at the same time. If the existing DTC Valve is supposed to re-use, the valve filter should be taken out and cleaned, and should be replaced if necessary.

Replacing a DTC Valve on YF compressors:

Before replacing the DTC Valve, clean and/or change the filter to verify if there is an unobstructed column of liquid to the valve.

It is suggested to install a hand valve in the liquid line just before the DTC Valve, in case the DTC valve need be replaced in the field.

### **Suction Line Accumulators**

Invotech Scroll can handle liquid refrigerant for some conditions such as flooded start and defrost cycles. If the working conditions are stable and the system is charged with limited volume of refrigerant, accumulators may not be necessary.

An accumulator is required on single compressor systems when the charge volume exceeds 3kg for YF13 ~ YF20, 3.6kg for YF25 ~ YF45, 6kg for YF56 ~ YF80. For some systems, such as with defrost schemes or transient operations that allow prolonged uncontrolled liquid return to the compressor, a suction line accumulator is necessary.

Excessive liquid flood back or repeated flooded starts will dilute the oil in the compressor and cause inadequate lubrication, the internal parts and bearing will be worn. Proper system design will minimize liquid flood back, thereby ensuring maximum compressor life.

A proper superheat at the compressor suction inlet should be maintained in order to avoid liquid refrigerant return to the compressor during the running cycle. Invotech recommends a minimum of 10K superheat for the low temperature application, the suction line temperature should be measured on the suction line 150mm away from the suction port.

Another way to determine whether there is liquid refrigerant returning to the compressor is to measure the temperature difference between the compressor oil crankcase (oil temperature) and the suction line. During continuous operation we recommend that this difference will be a minimum of 25K (for example, if the suction line temperature is 0°C, the minimum oil temperature should be 25°C). To measure oil temperature through the compressor shell, place a temperature sensor on the bottom center (the opposite side of the suction port) of the compressor shell and insulate from the ambient.

During rapid system changes (such as defrost or ice harvest cycles), this temperature difference may drop rapidly in a short period of time. When the oil temperature difference falls below the recommended 25°C, our recommendation is the duration should not exceed a maximum (continuous) time period of three minutes and should not be lower than a 12°C difference.

### **Screens**

Screens with a mesh size finer than 30 x 30(550um openings) should not be used anywhere in the refrigeration system with these compressors.

### **Crankcase Heaters**

Crankcase heater is suggested to be installed on the compressors for refrigeration application. The crankcase heater should be powered on 12 hours before the initial start or restart after long time off duration.

### **Discharge Temperature Protector**

A discharge temperature protector is recommended for the refrigeration system. Its cut out temperature setting should be lower than 120°C. The temperature sensor should be installed about 150mm on the

discharge line to the discharge port and should be insulated well.

**Pressure Controls**

Both high and low pressure switches are required on the system. The suggested cut out settings see table 2.

Control Type	R404A	R22
Low	3 PSIG min.	0 PSIG min.
High	420 PSIG max.	400 PSIG max

Table 2 high and low pressure switches setting

**Pump Down Recommendations**

There is an internal check valve to prevent high-pressure flush into the low side when the compressor is off. For the three phase compressors, this check valve can prevent system pressures from equalizing and pump down can be achieved. If short cycling cannot be avoided, using a 3-minute time delay will limit the cycling of the compressor to an acceptable level.

For the Single phase compressors, there is a balance port on the internal check valve to allow pressure equalizing during the off cycle. To avoid the short cycling condition on the single phase models with Pump Down controls, it is recommended to add an external low leakage check valve on the discharge line close to the discharge port.

**Startup for Single Phase Compressor**

Invotech deliver the start kits (including a start capacitor, start relay and run capacitor fixed inside a box) for the single phase YM and YF compressors, the wiring diagram is showing on figure 5.

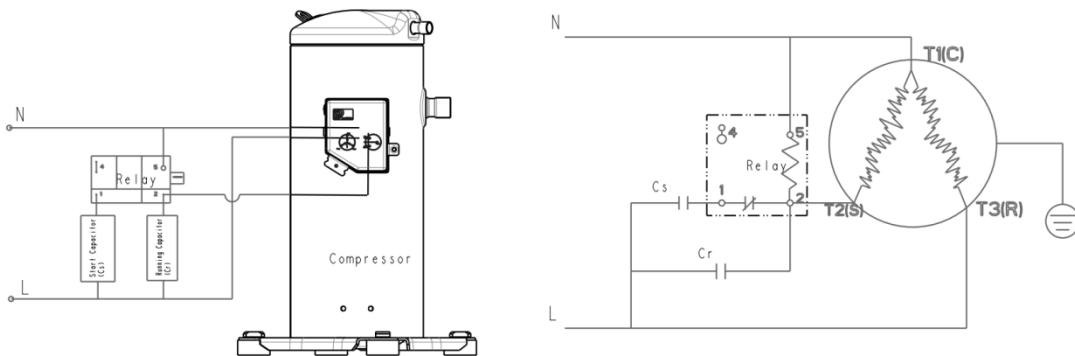


Figure 5 Wiring Diagram of start kits

**IPR Valve**

All Invotech three phase scroll compressors have internal pressure relief valves, which will open when the pressure differential between discharge and suction is  $2.93 \pm 0.17$ MPa. If the IPR valve is active, the hot gas in the discharge side will rush into suction side of the compressor and the motor protector will be tripped to remove the motor from the line. There are no IPR valves for the single phase compressors.

**Motor Protection**

An internal line break motor protector is provided for Invotech YF serials compressors.

**Oil Types**

Polyolester lubricants must be provided for the YF\*\*E scroll compressor is to be used with HFC refrigerants. YF\*\*A compressors are intended for use with R22 and are supplied with mineral oil.

POE must be handled carefully and the proper protective equipment (gloves, eye protection, etc.) must be used when handling POE lubricant. POE must not come into contact with any surface or material that might be harmed by POE.

The system with POE oil should not be open to the air more than 10 minutes. Don't remove the suction/discharge plugs until the compressor is ready to be brazed.

### Oil Charges

The initial oil charge and the re-charge volume can be checked on the nameplate.

### Oil Management for Rack Applications

Invotech Scroll refrigeration compressors may be used on multiple compressors parallel rack applications. An oil management system to maintain proper oil level in each compressor crankcase is required for Rack application. The oil sight glass connection supplied can accommodate the mounting of the oil control devices via an adaptor.

Scroll compressor requires an external electronic type oil level controller, when the oil level is lower than the setting point and can't be refilled on time, the electronic oil level controller will trip the compressor and output an alarm.

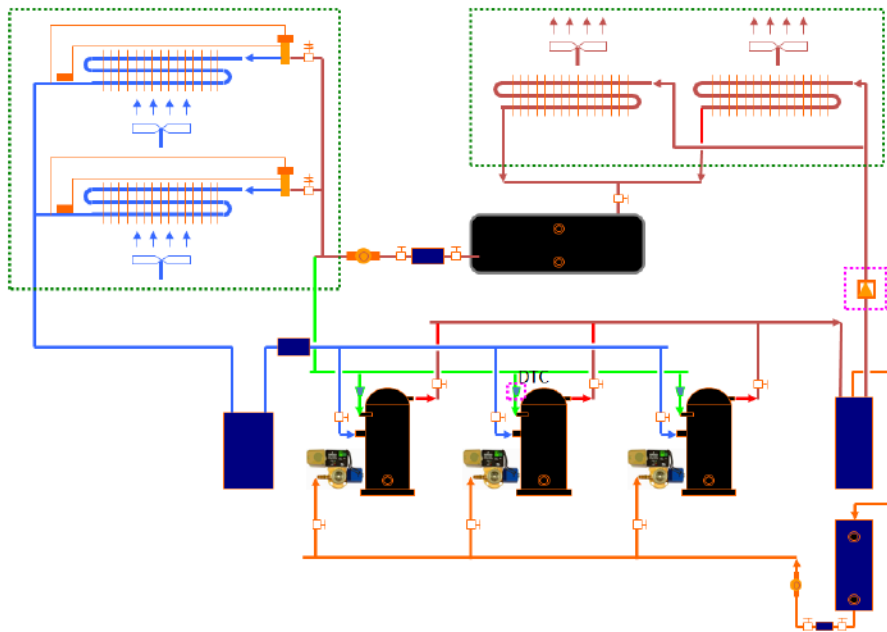


Figure 6 Reference Rack system diagram with DTC valve

Mounting for Rack Systems - Specially designed steel grommets are available for Invotech Scroll for rack applications. The rigid grommet limits the compressors motion thereby minimizing potential problems of excessive tubing stress. The damping pads are required between the unit and base, to isolate the vibration being transmitted to the mounting structure.

### Compressor Tubing and Mounting

Invotech compressors delivered with standard soft grommets for most applications. The recommended torque to tighten the mounting kits is  $13 \pm 1$  N.m.

The standard soft grommets are not recommended for refrigeration scroll rack installations.

### Tubing Considerations

Proper tube design is very important to ensure the reliability of the system. The tubing should have enough "flexibility" to allow normal starting and stopping of the compressor without exerting excessive stress on the tube joints. In addition, it is desirable to design tubing with a natural frequency away from the normal running frequency of the compressor to avoid resonant vibrator. Figure 7 shows examples of

acceptable tubing configurations.

These examples are provided as a guide only to describe the flexibility requirements in tube design. In order to correctly determine whether the design is suitable for a given application, the samples should be tested and evaluated for stress under various usage conditions (including voltage, frequency and load fluctuations, and transportation vibration). The above guidelines may be helpful; however, every system designed should be tested.



Figure 7 Typical Line Arrangements

### Wiring Connections

Motor terminal connections for single-phase and three-phase refrigeration scroll compressors are shown in Figure 8 and inside the terminal box. The suggested torque to fasten the screw is  $3 \pm 0.5 \text{ N.m}$ .

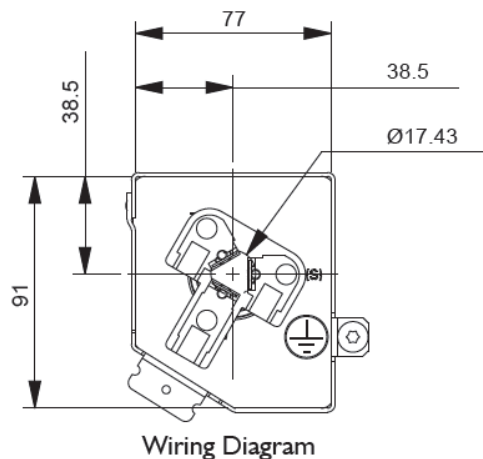


Figure 8 Motor terminal connections

### Shell Temperature

The top shell and discharge line temperature may reach more than  $130^{\circ}\text{C}$  in some cases. Wiring or any other materials, should not contact with the shell and tubes.

### Connection Fittings

Scroll compressors are provided with either braze or Rotolock connections depending on the bill of material selected.

All soldering type connection YF models have copper plated steel suction and discharge fittings for a easier brazing operation.

See section on New Installation for suggestions on how to properly braze these fittings.

### Rotation Direction

Scroll compressors are rotation directional dependent, they can only compress in one rotational direction. On single phase compressors, this is not an issue since they will only start and run in the proper direction (except as described in the section Brief Power Interruptions). Three-phase scrolls, however, will rotate in either direction depending on the phase sequence of power supplied to the compressors. So there is a

50% chance of “wrong rotation direction”.

Under the proper rotation, the suction pressure will drop and the discharge pressure will rise when the compressor is energized. Additionally, if operated reversely, the compressor is noisier and its running current is smaller obviously compared to the normal values.

The running of scroll in reverse direction for short time is not harmful to the compressor, continued operation could result in failure.

All three-phase compressors are wired identically internally. Once the correct phasing is determined, it can be applied to the compressors with same fuse terminals. A phase sequence monitor relay is recommended for the three phase system.

A three minutes time delay is suggested to prevent frequent start/stop.

### **Brief Power Interruptions**

A brief power interruption (less than 0.5 seconds) may cause the single-phase scroll compressor to rotate in the reverse direction. The high-pressure discharge gas expands backward through the scroll when the power is interrupted, causing the scroll to orbit in the reverse direction. If power is re-energized during this reversal, the compressor may continue to run noisily in the reverse direction for several minutes until the compressor's internal motor protector trips. This has no negative impact on durability. After the protector is reset, the compressor will start and run normally.

Invotech recommend to equip a timer relay which can sense brief power interruptions and lock the compressor out of operation for three minutes.

### **Deep Vacuum Operation**

Do not run a refrigeration scroll compressor in a vacuum status. Failure to follow this advice can result in compressor permanent damage.

A low pressure switch is required to protect against vacuum operation. See the section on pressure controls for the proper set points. Never bypass the pressure switch. The compressor should be stopped as soon as the pressure switch trips (no time delay).

Never use scroll compressors (as with any refrigeration compressor) to evacuate refrigeration or air conditioning systems.

### **System Evacuation**

An important step to clean a system before operation is proper evacuation. Air and moisture is very dangerous to refrigeration systems and they must be removed completely before refrigerant charging.

New compressors are shipped with a dry air holding charge, and must be evacuated before being put in the system.

Triple steps evacuation of the system is strongly recommended (evacuate to 1500 microns for the first two steps and evacuate to 500 microns for the final step), breaking the vacuum each time with 30 PSIG dry nitrogen. The vacuum pump must be connected to both the high and low pressure sides of the system through properly sized port, since restrictive service connections may make the process very slow, or may lead to false readings because of pressure drop through the fittings. Use the vacuum gauge to verify the degree of the vacuum, the gauge should be connected far away from the vacuum pump.

### **Charging Process**

Do not power on the compressor before charging refrigerant.

Use the scale to control charge quantity, the charged volume should be recorded. One liquid drier is recommended to connect between refrigerant cylinder and manifold to prevent moisture into system during charging. Connect refrigerant cylinder to both high and low side of the refrigeration system, power on the solenoid valve if possible (do not power on the compressor at this time). Upside down refrigerant cylinder if needed to ensure only liquid can be charged into both high and low sides. Charge the refrigerant to the system as much as needed (at least 50% of total needed) before power on the compressor. Disconnect the high side charge port, turn on the compressor, and continue charge the



liquid from the low side until the refrigerant is enough for the system.

The charge port should be arranged on the connection pipe of suction line accumulator (low pressure side) and receiver (high pressure side), which is on the side far away to the compressor, to avoid the liquid refrigerant flood into compressor directly.

Never close the suction service valve when compressor is running.

### **Unbrazing System Components**

During the service procedures, if the refrigerant is removed from a unit from the high pressure side only, it is possible that the scrolls will seal and prevent pressure equalization through the compressor. This may leave the low pressure side pressurized. If a brazing torch is applied to the low side at this time, the pressurized refrigerant and oil mixture could ignite as it escapes and contacts the brazing flame, which is very dangerous to the operator and surroundings. It is important to check both the high and low sides with manifold gauges before un-brazing.

In any cases of an assembly line repair, must remove the refrigerant from both the high and low sides and verified pressure by gauge. Instructions should be provided in appropriate product literatures and assembly areas.

After replacement of the compressor or any other parts, it is suggested to blow out system with dry nitrogen before evacuating the system.

### **High Potential (Hi-pot) Testing**

Invotech scroll compressors are configured with the motor at the lower part of the compressor. When liquid refrigerant is stayed inside the compressor shell, the motor can be immersed in liquid refrigerant to a greater extent. If the compressors are Hi-pot tested under this situation, it is possible to see higher levels of leakage current because of the higher electrical conductivity of liquid refrigerant than refrigerant vapor and oil. This phenomenon can occur with any compressor when the motor is immersed in refrigerant. The level of current leakage does 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 then implement Hi-pot testing again.

Never implement the Hi-pot or Meg-ohm test while the compressor is under a vacuum status.

### **Invotech Scroll Functional Check**

It is not allowed to perform functional compressor tests to check how low the compressor will pull suction pressure. And never energize the compressor before charging refrigerant. Do not test the compressor with the suction and discharge port open to air. However, these kinds of test may damage a scroll compressor. The following diagnostic procedure is recommended to evaluate whether an Invotech Scroll compressor is functioning properly.

1. Verify proper unit voltage to the compressor terminals.
2. Remove the wiring from the compressor, inspect the motor winding continuity and short to ground checks. This inspection will determine if the internal motor protector has opened or if an internal short to ground has developed. If the protector has opened, the compressor must be cooled enough to reset.
3. Connect service gauges to suction and discharge pressure fittings, turn on the compressor. If suction pressure drops below normal levels, the system is either lack of charge or the flow is blocked.

#### **4.1. Single-Phase Compressors**

If the suction pressure does not drop and the discharge pressure does not rise to a normal level, the compressor is malfunctioning.

#### **4.2. Three-Phase Compressors**

If the suction pressure does not drop and the discharge pressure does not rise, reverse any two of the compressor power leads and then reconnect the power supply to make sure the compressors are not wired to run in reverse direction.

The compressor running current can be compared to the published data at the compressor operating

conditions (pressures and voltages). Significant running current deviations (exceeds  $\pm 20\%$ ) from published values may indicate a faulty compressor.

#### **New Installation**

- The brazing method of copper-coated steel suction, discharge, and injection fittings on scroll compressors can be approximately the same as any copper tubes.
- Recommended brazing material - Any Silfos material is recommended, preferably with a minimum of 5% silver. However, 2% silver or even lower is acceptable if the technician has the excellent operation skills.
- A continually low pressure ( $\sim 0.15\text{bar}$ ) dry nitrogen flow into the pipes, to avoid the possibility of oxide skin buildup on internal tube surfaces. Wet rag is recommended to use to avoid the overheating of the painting and other parts not requiring brazing.
- Ensure the I.D. of the process tube fitting, and the O.D. of the process tube is clean before assembly.
- Remove the discharge plug at first, and then remove the suction plug.
- Apply heat in copper tube. As tube approaches brazing temperature, move torch flame to the joint.
- Heat the joint area until braze temperature is attained, moving torch up and down and rotating around tube as necessary to heat tube evenly. Add braze material to the joint while moving torch around circumference.
- After braze material flows around joint, move torch to heat fitting. This will draw the braze material down into the joint. The time spent heating on joint area should be minimal.
- As with any brazed joint, overheating should be avoided.

#### **Field Service**

##### **To disconnect:**

- Recover refrigerant from both the high and low side of the system. Cut tubing near compressor. Check the high and low pressure with pressure gauge to check the pressure inside the system.

##### **To reconnect:**

- Recommended brazing materials – Silfos material (minimum 5% silver) or silver braze material with flux.
- Reinsert tubing fitting.
- Heat tube uniformly in Area of copper tube, moving slowly to the joint area. When joint reaches brazing temperature, apply brazing material.
- Heat joint evenly along the circumference to flow braze material completely around the joint.
- Slowly move torch in fitting to draw braze material into the joint.
- Do not overheat joint.

## Vapor Injection

The EVI compressor was developed to provide improved capacity and efficiency for refrigeration application. EVI compressor systems have the following benefits:

**Capacity Improvement.** The capacity is increased by big sub-cooling of liquid refrigerant, the big sub-cooling means more enthalpy difference for the refrigerant entering and leaving the evaporator, more heater will be exchanged. This is realized without increasing compressor displacement.

**Increased Energy Efficiency Ratio (EER).** The efficiency improves due to that the gain in cooling capacity is greater than the increase in power input that the compressor consumes.

**Cost Advantage.** Especially for the low temperature application, it is possible to achieve the same capacity by a smaller horsepower compressor (with EVI) as a larger horsepower compressor (without EVI).

## Theory of Operation

This mode of EVI operation increases the refrigeration capacity and the efficiency of the system. The benefits provided will increase when the compression ratio is higher, so more cooling capacity will be gained in summer when the ambient temperature is higher (condensing temperature will be higher accordingly), to meet the more required cooling capacity at same time.

Invotech EVI scroll compressors are equipped with an injection connection for Economizer Operation. Economizing operation is accomplished by utilizing a sub-cooler (normally plate type heat exchanger) and some other components. The heat exchanger is used to provide sub-cooling to the refrigerant before it enters into the evaporator. This sub-cooling process provides the increased capacity gain for the system, as described above. During the sub-cooling process a small amount of refrigerant is evaporated and superheated. This superheated refrigerant is then injected into the mid compression chamber of the scroll compressor and compressed to discharge pressure. This injected vapor also provides cooling at higher compression ratios, similar to liquid injection of standard YF Scroll compressors.

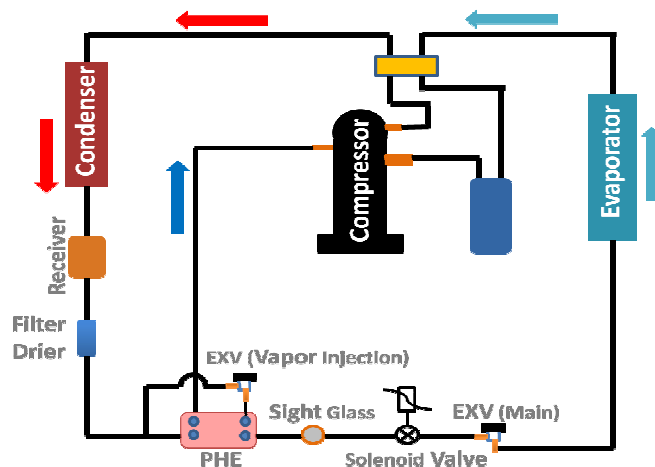
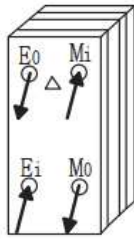


Figure 9 Reference refrigeration system with EVI diagram

It is necessary to ensure that the vapor injection line will be shut down under the off cycle, to avoid the liquid refrigerant immigrate into scroll chamber though the injection line. An EXV or “Solenoid valve + TXV” is recommended to work as the throttle orifice. A current sensing relay can be used, the EXV should be closed to zero step, or the solenoid valve should be shut down to stop the injection at any time if the current isn’t monitored by the sensor.

## Heat Exchanger Piping Arrangement

It is recommended to arrange the plate type heat exchanger as shown (see Figure 10) to achieve better sub-cooling effect. The plate heat exchanger should be mounted vertically and vapor should exit it at the top. With this arrangement, the gas and liquid is provided counter flow to guarantee good heat transfer.



Mi: Liquid Main Line in (from receiver)  
 Mo: Liquid Main Line Out (to Expansive valve and Evaporator, with big subcooling, should be insulated)  
 Ei: Vapor injection line in  
 Eo: Vapor injection out (to the vapor injection connection port of compressor)

Figure 10 Pipe arrangement of the Economizer

### Multiple Compressor Applications

EVI can also be used in RACK applications.

Multiple EVI compressors can be used with either an individual 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 vapor injection line.

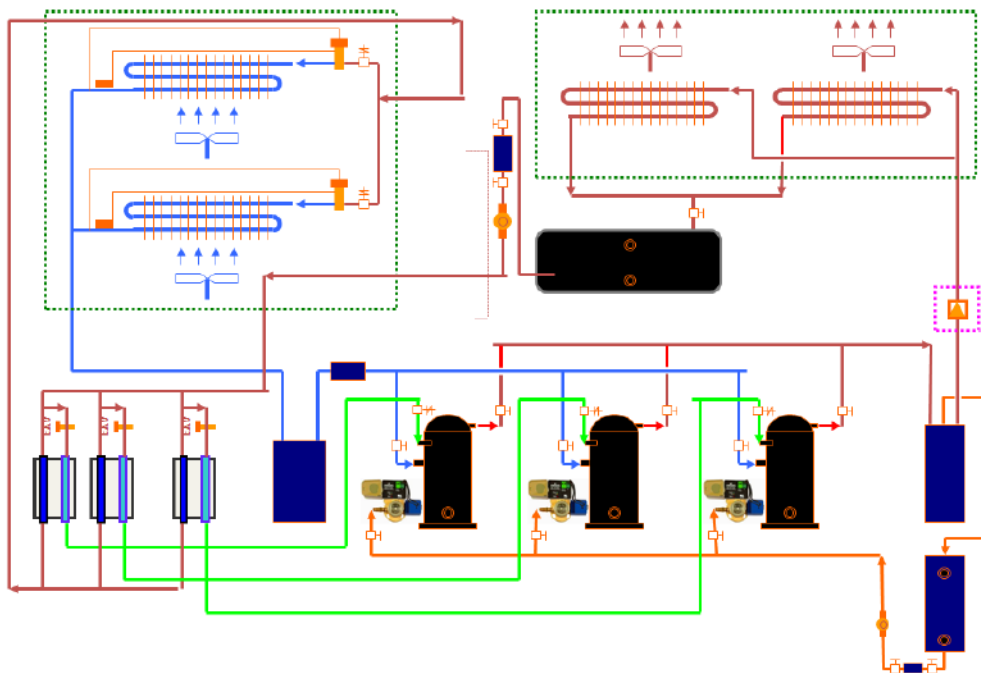


Figure 11 Typical Scroll Rack System, Vapor Injection with Individual Economizer

### Economizer Sizing

The heat exchangers worked as economizer should be sized so that adequate design margin for the full range operation, normally it will be optimized at the designed operating conditions and re-checked for other working conditions. The parameters used to select the heat exchanger and the suggested calculation processes are described below:

- Tc Condensing Temperature
- Tmi Temperature after the condenser
- Tmo Liquid temperature after the economizer (main line)

- Pi Saturated pressure of injection line
- Tip Economizer Saturated temperature at its outlet pressure (injection line)
- Teo Temperature outlet of the economizer (injection line)
- Tmc Sub-cooling gained by Economizer ( $T_{mi} - T_{mo}$ )
- Tes Superheat of injection line ( $T_{eo} - T_{ip}$ )
- Q Mass flow of the evaporator

**Example of Heat Exchanger Selection YF41E1G-V100 R404A (50Hz, Optimized at the design condition)**

Step 1

- Design Condition  $-31.7/40.6/0/18.3^{\circ}\text{C}$   $T_e/T_c$  / Cond. SC / Suct. RG

Step 2

- Check the mass flow @ design condition  $Q = 122.35\text{kg/hr}$

Step 3

- Calculate  $T_{ip} = 0.44T_{eo} + 0.28T_c - 10 (^{\circ}\text{C}) = -12^{\circ}\text{C}$
- Step 4
- Use the  $T_{es} = 6\text{K}$  To Calculate
- $T_{eo} = T_{ip} + 6 = -6^{\circ}\text{C}$
- The lowest  $T_{mo} = T_{eo} = -6^{\circ}\text{C}$
- Based on the design condition, 0 sub-cooling after the condenser
- $T_{mi} = T_c = 40.6^{\circ}\text{C}$
- HX SC =  $T_{mi} - T_{mo} = 46.6^{\circ}\text{C}$
- HX  $\text{KJ/hr} = Q \times (H_{IN} - H_{OUT})$   
 $= 122.35 \times (264.32 - 191.46) = 8914\text{KJ/Hr} = 2.47\text{Kw}$

The key parameter in determining the proper heat exchanger is the Saturated Injection Temperature (Tip). The value of Tip can be approximated by the function  $T_{ip} = 0.44T_{eo} + 0.28T_c - 10 (^{\circ}\text{C})$ . After determining the Tip, a  $6^{\circ}\text{C}$  of Condenser Sub-cooling and vapor injection line Superheat can be used. This is done in order to optimize system performance while at the same time maintaining system reliability and functionality. Once these parameters have been established, the heat exchanger capacity can be calculated, then the required heat exchanger can be chosen.

The same processed can be applied for Rack applications to determine the heat exchanger size. If the common Economizer is used, its required capacity can be added together by the individual heat exchanger capacities for each compressor.

**Line Sizing**

In single compressor applications, it is suggested to use  $3/8" - 1/2"$  copper tube connect from the economizer to the compressor injection port. This tube should be short as possible. The U type elbow should be applied to absorb the vibration.

The temperature of liquid after the economizer may be quite lower, so the liquid line from the economizer to the evaporator should be insulated and kept as short as possible in order to maintain the sub-cooling gained from the economizer.

For the rack application, if a vapor injection common header is used, the header diameter should be such that the cross-sectional area is equal to the sum of the cross sectional areas of the individual cross-sectional lines to the compressor. For example, for four compressors, each with a  $3/8"$  vapor injection line, the header tube diameter should be a  $7/8"$  tube.

### **Economizer Expansion Valve Sizing**

Select an Expansive Valve which is able to handle the capacity of the heat exchanger selected in the section above. The Expansive valve should be optimized for designed operating conditions.

When a TXV is chosen, it should be tested so that it has adequate design margin for the entire range of system operation. A solenoid valve is required to stop the refrigerant flow from the system to the compressor when the compressor is in the off cycle. The nominal diameter of the solenoid valve must be equivalent to or larger than the vapor injection tube size.

EXV is recommended in the case of requiring wet injection under tough working conditions.

### **Ball Valve**

A hand valve is also recommended in the vapor injection line for the service purpose. Its nominal diameter should be equivalent to or larger than the vapor injection tube size.