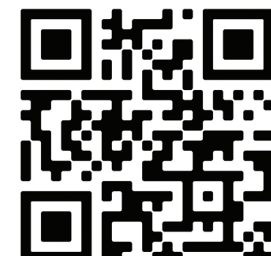




Application Guidelines for Invotech YF Scroll Refrigeration Compressors

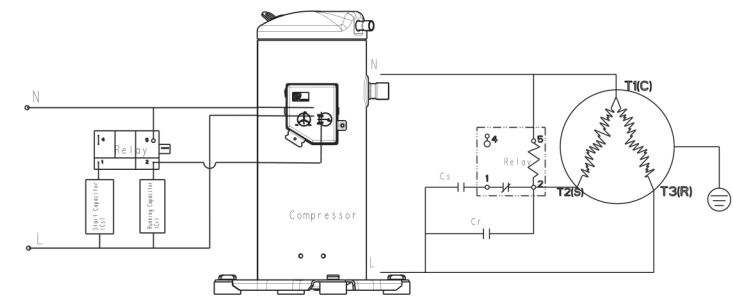


SCAN THE QR CODE TO
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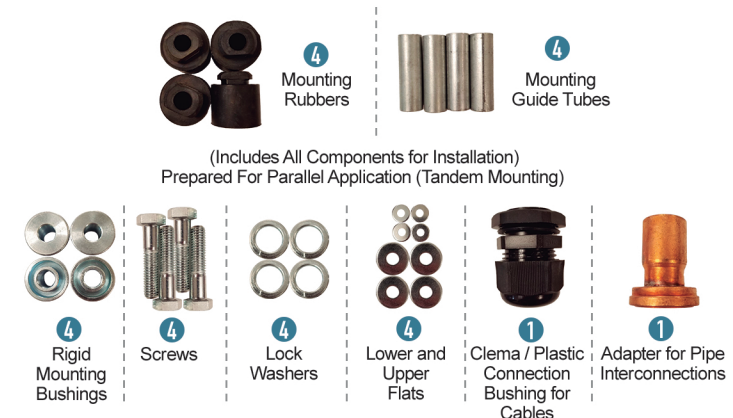


IMPORTANT

REGISTER & ACTIVATE YOUR 12-MONTH WARRANTY FIRST



COMPONENTS INCLUDED WITH INVOTECH SCROLL COMPRESSORS



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. Disconnected 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 these 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 cases of an assembly line repair, technicians must remove the refrigerant from both the high and low side and then verify using pressure gauges. Instructions should be provided in appropriate product literature 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..

INVOTECH SCROLL FUNCTIONAL CHECK

Do not perform functional compressor tests to check how low the compressor will pull suction pressure. Never energize the compressor before charging the refrigerant. Do not test the compressor with the suction and discharge port open to air. Any testing of this nature can cause irreparable damage to the compressor. The following diagnostic procedures are 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. Suction pressure
 - a. Single-Phase Compressors
 - i. If the suction pressure does not drop and the discharge pressure does not rise to a normal level, the compressor is malfunctioning.
 - b. Three-Phase Compressors
 - i. 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 exceeding $\pm 20\%$ from published values may indicate a faulty compressor.

NEW INSTALLATIONS

- The brazing method of copper-coated steel suction, discharge, and injection fittings on scroll compressors are approximately the same as any copper tubes.
- Recommended brazing material - Any Silfos material is recommended, preferably with a minimum of 5% silver.
- A continual low pressure ($\sim 0.15\text{bar}$) of dry nitrogen flow into the pipes assists in avoiding the possibility of oxide skin buildup on internal tube surfaces.
- Wet rags are recommended during brazing to avoid overheating of the paint and other surface areas not requiring brazing.
- Ensure the I.D. of the process tube fittings, and the O.D. of the process tubes are clean before assembly.
- Remove the discharge plug 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 the joint area should be minimal.
- As with any brazed joint, overheating should be avoided.

FIELD SERVICE TO DISCONNECTS:

- 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 a 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 the joint.

VAPOR INJECTION

The EVI compressor was developed to provide improved capacity and efficiency for refrigeration applications. The capacity is increased by sub-cooling of liquid refrigerant. The sub-cooling means more enthalpy difference for the refrigerant entering and leaving the evaporator (meaning more heat will be exchanged). This is realized without increasing compressor's displacement. Increased Energy Efficiency Ratio (EER) improves due to the gain in cooling capacity as it is greater than the increase in power input that the compressor consumes.

THEORY OF OPERATION

Invotech EVI scroll compressors are equipped with an injection connection for economized operation. Economized operation is accomplished by utilizing a sub-cooler (normally a plate type heat exchanger). The heat exchanger is used to provide sub-cooling to the refrigerant before it enters the evaporator. This sub-cooling process provides an 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, like liquid injection of standard YF Scroll compressors.

It is necessary to ensure that the vapor injection line will be shut down under the off cycle, to avoid the liquid refrigerant migration into the scroll chamber though the injection line. An EXV or "Solenoid Valve TXV" is recommended to work as the throttle orifice. 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 (see Figure 10) to achieve better sub-cooling effect. The plate heat exchanger should be mounted vertically, and vapor should exit at the top. This provides counter flow to guarantee good heat transfer.

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 cases with a common heat exchanger, a solenoid valve should be installed on each individual vapor injection line.

ECONOMIZER SIZING

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 (Tmi – Tmo)
- Tes- Superheat of injection line (Teo – Tip)
- Q- Mass flow of the evaporator

EXAMPLE OF HEAT EXCHANGER SELECTION YF41E1G-V100 R404A (50HZ, OPTIMIZED AT THE DESIGN CONDITION)

- Step 1: Design Condition $-31.7/40.6/0/18.3^{\circ}\text{C}$ Te/Tc / Cond. SC / Suct. RG
Step 2: Check the mass flow @ design condition $Q = 122.35\text{kg/hr}$
Step 3: Calculate Tip = $0.44\text{Te} + 0.28\text{Tc} - 10 (^{\circ}\text{C}) = -12^{\circ}\text{C}$
Step 4: Use the Tes = 6K To Calculate
- Teo = Tip + $6 = -6^{\circ}\text{C}$
 - The lowest Tmo = Teo = -6°C
 - Based on the design condition, 0 sub-cooling after the condenser
 - Tmi = Tc = 40.6°C
 - HX SC = Tmi – Tmo 46.6°C
 - HX KJ/hr = $Q \times (\text{HIN} - \text{HOUT}) = 122.35 \times (264.32 - 191.46) = 8914\text{KJ/Hr} = 2.47\text{Kw}$

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 $\text{Tip} = 0.44\text{Te} + 0.28\text{Tc} - 10 (^{\circ}\text{C})$. After determining the Tip, a 6°C of condenser sub-cooling and vapor injection line superheat can be used. This is done 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 process can be applied for rack applications to determine the heat exchanger size. If the common Economizer is used, it's 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 connections from the economizer to the compressor injection port. This tube should be as short as possible. A "U" type elbow should be applied to absorb the vibration. The temperature of liquid after the economizer may be much lower, so the liquid line from the economizer to the evaporator should be insulated and kept as short as possible to maintain the sub-cooling gained from the economizer.

For the rack applications, 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 expansion valve that can handle the capacity of the heat exchanger selected in the section above. The Expansion valve should be optimized for designed operating conditions.

When a TXV is chosen, it should be tested so that it has adequate design margins for the entire range of system operations. 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 service purposes. Its nominal diameter should be equivalent to or larger than the vapor injection tube size.

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 and maintain this 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 uninstalling the compressor.
- Use appropriate back up wrenches on Roto lock 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/ www.invotechtexas.com

