Contractor Service Tips

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2006ECT-181 R1 (3/08)

Contractor Service Tips

Tip Card 1

R-12 and Polyol Ester Oil

There seems to be a misunderstanding about using R-12 and POE oil. Many contractors and end users believe it is OK to use them together, but in truth, they may be setting themselves up for some real problems.

Through numerous laboratory and field tests, Emerson Climate Technologies, Inc. has discovered that when moisture is induced into a system using R-12 refrigerant and POE oil, the refrigerant becomes acidic and may plug cap tubes and orifices. For this reason, Emerson Climate Technologies, Inc. does not recommend using R-12 and POE oil together.

Please refer to Form No. 93-11 "Refrigerants/ Lubricants Approved For Use In Copeland® Compressors" for further information.

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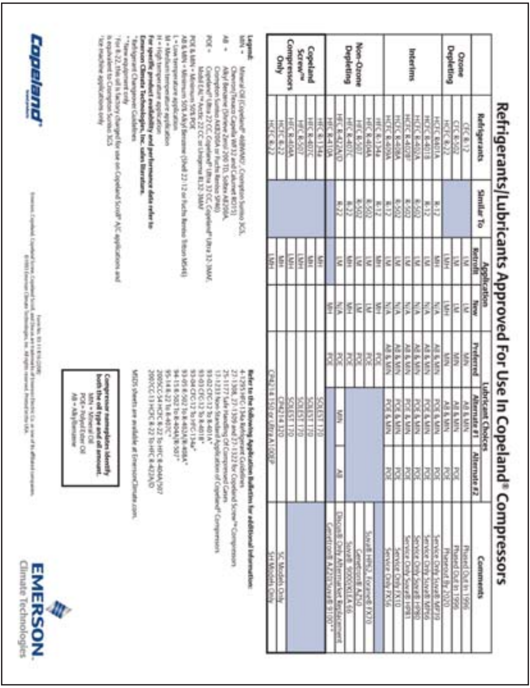

Refrigerants/Lubricants Approved For Use In Copeland® Compressors

The current version of Form# 93-11 can be seen at EmersonClimate.com

Contractor Service Tips

Tip Card 2

Single Phase Burns

Extensive Emerson Climate Technologies, Inc. testing and field experience has proven that single phase motor burns are caused by the malfunction or misapplication of the system contactor(s).

Contactors play a role in any compressor overload protection scheme, but are particularly important when they are part of a pilot-operated protection system.

Contactors have a limited life and should be inspected during routine maintenance and replaced every time a compressor is installed.

The Emerson Climate Technologies, Inc. warranty does not extend to external electrical components furnished by others, and the failure of such components resulting in compressor failure will be taken into consideration by Emerson Climate Technologies, Inc. in determining the warranty status of returned compressors.

Please refer to Copeland® Brand Contactor Application Specifications on the back of this card for additional information.

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Contactor Selection Guide

Copeland® Brand Contactor Application Specifications

The following specifications are based on contactor ratings as listed with U.L.

A. The contactor must meet the operational and test criteria in ARI (Air Conditionings and Refrigeration Institute) Standard 780-78, "Standard For Definite Purpose Contactors."

B. The contactor must be certified by the manufacturer to close at 80% of the lowest nameplate voltage at normal room temperatures (166 Volts for contactors used on 208/230 Volt rated equipment).

C. On single contactor applications, the rating of the contactor for both full load amperes and locked rotor amperes (LRA) must be greater than the corresponding nameplate amperage rating of the compressor motor RLA, plus the nameplate amperage ratings of any fans or other accessories also operated through the contactor.

D. For two contactor applications, each contactor must have a part winding locked rotor rating equal to or exceeding the half winding locked rotor rating of the compressor.

Since half the winding LRA is larger than 50% of the compressor full winding LRA, some definite purpose contactor manufacturers oversize their contactors for two contactor applications. Check with the contactor manufacturer to determine if larger contactors are needed for two-contactor applications.

Time Delay Relays

For part winding start applications, a time delay relay is required between contactors with a setting of 1 second plus or minus 1/10 second. The operation of a delay relay can be affected by low voltage.

In order to ensure reliability, time delay relays listed as meeting Emerson Climate Technologies, Inc. specifications for nominal 208/230 Volt control systems must be guaranteed by the manufacturer to function properly at 170 Volts in a –40°F ambient.

For information on time delay relays, see AE Bulletin 10-1244.

Contractor Service Tips

Tip Card 3

Compressor Overheat

Overheat is has been a major cause of compressor failures. Temperatures in the compressor head and cylinder become so hot that the oil thins and loses its ability to lubricate. This may cause rings, pistons, and cylinders to wear resulting in blow by, leaking valves and metal debris in the oil. It can also cause the stator to ground due to a spot burn.

Cylinder temperatures exceeding 300°F will begin the breakdown of oil and at 350°F oil will be vaporized. To measure cylinder temperature, place your temperature gauge no more than six inches out on the discharge line from the compressor. For most applications the temperature should be below 225°F. This factors in a 50-75 degree temperature drop from the cylinder to the measured point.

To correct for overheat:

1. Correct abnormally low load conditions.
2. Correct high discharge and low suction pressure conditions.
3. Insulate suction lines, clean dirty condensers.
4. Provide proper compressor cooling.
5. Check low pressure control settings.

Pressure controls can help to identify or remedy system problems.

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Copeland® Brand Pressure Controls

Copeland® Brand #	Control	Connection	Range	Differential	Settings
985-CP1A-1K	Single Low Pressure	36” Capillary w/ 1/4” Flare Nut	20” to 42 psig	5 to 30 psid, adjustable	Cut-out 15 psig Cut-in 25 psig
985-CP1A-3K	Single Low Pressure	36” Capillary w/ 1/4” Flare Nut	15” to 100 psig	7 to 70 psid, adjustable	Cut-out 15 psig Cut-in 25 psig
985-CP1A-3A	Single Low Pressure	1/4” SAE Male Flare	15” to 100 psig	7 to 70 psid, adjustable	Cut-out 15 psig Cut-in 25 psig
985-CP1A-5K	Single High Pressure/ Fan Cycle	48” Capillary w/ 1/4” Flare Nut	100 to 450 psig	30 to 200 psid, adjustable	Cut-out 385 psig Cut-in 335 psig
985-CP1A-5A	Single High Pressure/ Fan Cycle	1/4” SAE Male Flare	100 to 450 psig	30 to 200 psid, adjustable	Cut-out 385 psig Cut-in 335 psig
985-CP1U-5A	Single High Pressure/ Limit	1/4” SAE Male Flare	100 to 450 psig	Fixed 50 psid, Auto/Man.	Cut-out 385 psig Cut-in Convertible Auto/Man
985-CP1U-5K	Single High Pressure/ Limit	36” Capillary w/ 1/4” Flare Nut	100 to 450 psig	Fixed 50 psid, Auto/Man.	Cut-out 385 psig Cut-in Convertible Auto/Man
985-CP2M-7K	Dual Pressure	48” Capillary w/ 1/4” Flare Nut	Low Pressure: 15” to 100 psig High Pressure: 100 to 450 psig	Low Pressure: 7 to 70 psig High Pressure Fixed 50 psid Auto/Man.	Cut-out 385 psig Cut-in Convertible Auto/Man
985-CP2M-7A	Dual Pressure	1/4” SAE Male Flare	Low Pressure: 15” to 100 psig High Pressure: 100 to 450 psig	Low Pressure: 7 to 70 psig High Pressure Fixed 50 psid Auto/Man.	Cut-out 385 psig Cut-in Convertible Auto/Man

Contractor Service Tips

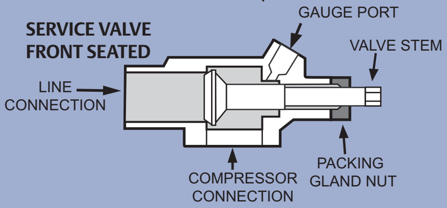
Tip Card 4

Service Valves

The typical service valve is composed of four essential parts:

- Line connection
- Valve stem
- Service opening or gauge port
- Compressor connection

SERVICE VALVE FRONT SEATED



Typically, the service valve has a common connection that is always open. When the valve is back-seated (the stem is all the way out), the gauge port is closed and the valve is open, allowing refrigerant to flow through the system. If the valve is front-seated (stem all the way in), the gauge port is open to the compressor connection and the refrigerant line (suction or discharge) connection is closed. In order to read the pressure while the valve is open, the valve should be back-seated, then turned once or twice to slightly open all three connections: the gauge port, line, and compressor. This allows both the compressor and refrigerant line to be open and vapor pressure to flow through. At the gauge port, you can check system pressure and charge or reclaim refrigerant.

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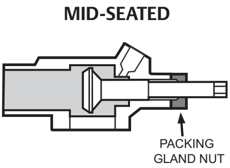
When brazing a service valve:

Make sure the valve is mid-seated before brazing. The heat from brazing a fully front-seated or back-seated valve can cause the button of the valve stem (inside the valve) to 'weld' to the seating area on the inside of the body of the valve.

A technique called 'wet-ragging' can also help. Soak a rag in cold water and wrap it around the service valve before brazing. Make sure water does not enter the valve.

When opening a service valve:

Make sure the service valve is secure (in a vice, bolted down, or attached with the rotalock connection) before attempting to open the packing nut or valve stem. *Verify whether the valve employs a packing gland nut (many Copeland® brand service valves do).* The packing nut helps to ensure a leak free seal. It is typically brass and is found at the base of the valve stem (see illustration on other side). It must be loosened by a 1/4 to a full turn before opening the valve. Make sure to tighten the nut when you are finished manipulating the valve stem.



Use the right tools! Service valves on Copeland® brand condensing units have a torque requirement of 22-25 ft lbs. in order to have a leak free seal when the units leave our plant. You will only be able to open a service valve with the appropriately sized service valve wrench. Do not attempt to open a service valve with an adjustable wrench. You may round the valve stem edges and the valve will be useless.

If all else fails and the stem appears stuck, *lightly* tap the end of the valve stem with a hammer and the valve should open.

NOTE: If the packing gland nut is not loosened, the valve could be damaged.

Contractor Service Tips

Tip Card 5

TXV Selection

Q: How do I select a TXV for a particular application?

In order to make an accurate TXV selection it is necessary to match the flow rate (in tons) of the TXV to the tonnage rating of the evaporator coil. The following procedure is recommended:

- Determine system refrigerant
- Determine tonnage rating of the evaporator coil at the operating temperature
- Determine liquid refrigerant temperature at the TXV inlet
- Calculate the pressure drop across the TXV by subtracting suction (low side) pressure from condensing (high side) pressure. Also subtract pressure drop from a distributor, if one is used. The difference is pressure drop across the TXV.
- Find the proper extended capacity table in the catalog for the correct refrigerant at the proper evaporator temperature. Then locate the closest pressure drop column and find the nearest flow rate in tons (to the evaporator tonnage). Go to the left to select the nominal tonnage rated valve. You will have to recalculate the flow rate in tons using the Liquid Correction Factor Table if the actual liquid temperature is different from 100F used as the standard rating point.

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Tip Card 6

Suction Accumulators

Q: What is the purpose of a suction accumulator?

A suction accumulator is used to prevent liquid refrigerant flood-back to the compressor. Accumulators are commonly used on heat pumps, transport refrigeration, low-temp supermarket refrigeration systems and any place that liquid refrigerant is a concern.

The accumulator is installed in the suction line close to the compressor. It usually is a vertical container with top connections. An internal U-tube reaching down near the bottom is installed on the compressor outlet connection so that the inlet of the tube is near the top of the container. This allows the accumulator to be almost completely full before flood-back can occur.

A small diameter hole is drilled in the U-tube near its lowest point. This hole allows controlled metering of any liquid refrigerant or oil back to the compressor by a siphoning action.

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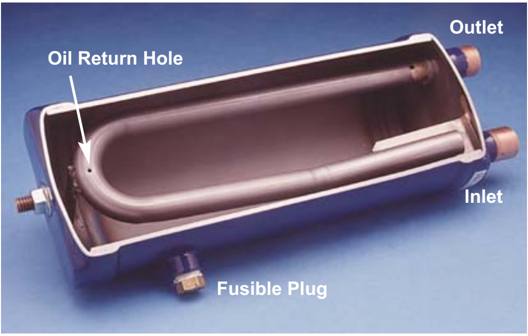
To work best, it is sometimes advisable to have a source of heat on the vessel to assist in evaporating the liquid refrigerant. This may be either an electric heat tape or pad. Some accumulators have connections so that a liquid line loop can be piped into the bottom of the accumulator. This improves the performance of the system by subcooling the liquid refrigerant and protects the compressor against liquid slugging by providing additional superheat to the suction gas.

Cutaway of Typical Accumulator



Contractor Service Tips

Tip Card 7

Expansion Valves

Q: What is the difference between an 'automatic expansion valve' and a 'thermal expansion valve'?

The automatic expansion valve was the first valve developed to eliminate the need of having a refrigeration engineer manually adjust a hand-operated expansion valve. The valve is designed to maintain a constant pressure at the outlet of the valve. By keeping thepressure constant, it indirectly controls the temperature as well.

There are however two major disadvantages to this type of valve. First, as the load decreases (causing a drop in evaporator pressure) the valve will tend to open so as to maintain the outlet pressure. In doing so however, excess refrigerant is fed to the evaporator resulting in liquid slugging and potentially damaging the compressor. Second, as the load increases (causing an increase in evaporator pressure) the valve will tend to close so as to maintain the outlet pressure. Unfortunately this results in starving of the evaporator at a time when the load is highest.

These disadvantages have resulted in the automatic expansion valve being replaced by thermal expansion valves (TXV) in most applications. The TXV responds to the superheat at the outlet of the evaporator and as a result is more responsive to the actual load resulting in a more efficient system.

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Q: So, is there ever an appropriate application for an automatic expansion valve?

There remain some applications where automatic expansion valves offer an advantage. In applications where it is important to prevent the evaporator pressure (and temperature) from getting too low, the Automatic Expansion Valve is a natural. Some examples of this include water coolers and drink dispensing equipment. If the evaporator of a water cooler were allowed to drop below 32 degrees F, it would freeze and potentially rupture, much like the water pipes in your home. To prevent this, Automatic Expansion Valves are often used in these type applications. They are adjusted so as to maintain an operating pressure several psi above the freezing point thereby eliminating the need for secondary controls.

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Tip Card 8

Sensing Bulb Location

Q: What is the correct position for the TXV sensing bulb?

The placement of the remote sensing bulb of the TXV onto the suction line is critical to proper TXV performance. The important points to follow are:

- Clean the suction line near the outlet of the evaporator
- The entire length of the sensing bulb must be in contact with the cleaned portion of the suction line
- The sensing bulb should be placed several inches upstream of the external equalizer connection
- The sensing bulb should be attached at 12 o'clock on any suction line of 7/8" diameter or smaller. On lines larger than 7/8" diameter the bulb should be placed at either 4 or 8 o'clock. The bulb should never be placed at 6 o'clock
- Always insulate the sensing bulb after installation
- A sensing bulb can be installed on a vertical suction line if necessary but never place bulb downstream of a trap. Bulb placement before a trap (upstream) is recommended.

See graphic on reverse side of card.

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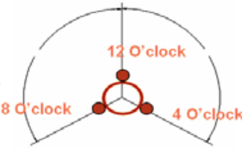
POSITIONING THE TXV SENSING BULB



- On suction lines less than 7/8" diameter, position bulb at 12:00 o'clock
- On suction lines greater than 7/8" diameter, position bulb at 4 or 8 o'clock

Contractor Service Tips

Tip Card 9

Evacuation

Q: What is the purpose for 'evacuating' a refrigeration system?

Evacuating a refrigeration system serves two primary objectives:

1. Removes non-condensables
2. Dehydrates (removes water vapor)

If non-condensables such as air are not removed, the system will operate at higher than normal condensing pressures. This happens because the air is trapped at the top of the condenser, effectively reducing the condenser capacity. Increasing the condensing pressure results in higher compression ratios and higher discharge temperatures, both of which decrease system efficiency and can lead to decreased reliability.

Water vapor must be removed from refrigeration systems for several reasons. The water vapor can cause a 'freeze-up' at the expansion device (TXV or capillary tube) causing a complete loss of refrigeration effect. Moisture, refrigerant and heat can also combine to form acids. These acids mix with oil and metal wear particles resulting in the formation of sludge. This sludge tends to collect at the hottest areas, usually the discharge valve plate and if allowed to build up can prevent the discharge valves from properly sealing.

Q: Does evacuation actually pull liquid water out of the system?

No, evacuation will not pull liquid water out of the system. When you evacuate a system you are actually dropping the pressure sufficiently to allow water to "boil" at room temperature. As the water boils, it of course changes to the vapor state, and this vapor is drawn out by the vacuum pump.

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Q: How low a vacuum do I need to properly evacuate my system?

Modern deep vacuum pumps should be used for this purpose. These pumps have the ability to evacuate down to 20 Microns in field situations. Equipment manufacturers should be consulted to determine their recommended vacuum levels, however, if a vacuum of 250 Microns can be achieved, that is usually considered adequate.

Care must be taken to assure that the vacuum measured at the gauge is equal to the vacuum level in the system being evacuated. Use as large a hose as possible to connect the evacuation equipment to the refrigeration system. It is also advisable to remove any Schrader cores prior to connecting evacuation lines so as to eliminate large pressure drops. Once the system is evacuated, it is also advisable to isolate the pump from the system and observe if the system holds its low vacuum. Some increase is acceptable (up to about 500 microns) but if the system vacuum level exceeds that a second and even third evacuation may be needed. If during the equalization time the system vacuum level goes back to atmospheric it is an indication that a leak is present.

If a vacuum pump is no longer able to pull a deep vacuum, it is usually an indication that the oil in the pump is contaminated and must be replaced. Be sure to use oil specifically produced for vacuum pump applications. This oil has a much lower vapor pressure than conventional oils. It is advisable to replace the vacuum pump oil at regular intervals usually after each use to make certain a low vacuum level can be achieved. The oil should be replaced while still warm enabling better drainage.

Q: What is a micron?

A micron is a metric measure and is defined as 1 millionth of a meter or 1 thousandth of a millimeter.

Most people in the US think of a perfect vacuum as 30 inches of Mercury (Hg). The last inch (from 29-30) of vacuum is equal to 25,400 microns. The micron then is a much more precise method for measuring deep vacuums.

Micron = 0.001 mm Hg = 0.000039 inches of Hg = 1 millitorr

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Contractor Service Tips

Tip Card 10

Evaporator Vs. System Superheat

Q: What is the difference between evaporator superheat and system superheat?

Superheat varies within the system depending on where it is being measured. The superheat that the thermal expansion valve is controlling is the evaporator superheat. This is measured at the outlet of the evaporator. The refrigerant gains superheat as it travels through the evaporator, basically starting at 0 as it enters the evaporator and reaching a maximum at the outlet as the refrigerant travels though the evaporator absorbing heat.

System superheat refers to the superheat entering the suction of the compressor. Some people confuse system superheat with 'return gas temperature.' It should be remembered that superheat varies as the saturated suction pressure of the refrigerant varies. Return gas temperature is a temperature value measured by a thermometer or other temperature-sensing device. It does not vary because of pressure changes.

Q: How much system superheat should I see at the compressor inlet?

Compressor manufacturer's like to see a minmum of about 20 degrees of superheat at the compressor inlet. This is to assure them that no liquid refrigerant is entering the compressor.

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Contractor Service Tips

Tip Card 11

Flooding

Q: What is meant by 'flooding'?

Flooding (also known as 'flood back') is the term used to describe the condition when liquid refrigerant reaches the compressor. This occurs when the amount of liquid fed to the evaporator is more than can be evaporated. There are a number of possible causes of flooding including:

- TXV oversized for the application
- TXV misadjusted (superheat too low)
- System overcharged with refrigerant
- Insufficient airflow through evaporator
- Dirty evaporator
- Evaporator fans not operating
- TXV bulb not properly attached

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Contractor Service Tips

Tip Card 12

Migration

Q: What is 'migration'?

Migration is the term used to describe when refrigerant moves some place in the system where it is not supposed to be, such as when liquid 'migrates' to the compressor sump. This phenomenon occurs because refrigerant will always migrate to the coldest part of a system. As an example, in a split air-conditioning system with the compressor/condenser outside, liquid refrigerant from the evaporator will migrate to the compressor during winter months due to the compressor being colder than the indoor (evaporator) temperature. If this is not prevented, then upon start-up in the spring, compressor slugging and damage may occur.

Q: How can I prevent migration?

There are two common methods used to prevent migration:

- Use of a 'pump down system'
- Use of crankcase heaters to 'drive off' any liquid refrigerant

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Contractor Service Tips

Tip Card 13

Oil Separators

Q: What is the purpose of oil separators and how do they operate?

Oil separators are used on refrigeration systems where it is difficult for the oil to return from the evaporator. These typically are field built-up systems, such as in supermarkets, and ultra-low temperature systems.

Oil separators are installed in the compressor(s) discharge line. They are usually a vertical container with the discharge gas connections at the top and an oil return port at the bottom. This return line may be piped directly to the suction line on single compressor units or on multiple compressor racks would be piped to a holding tank called an oil reservoir. Some oil separators have a reservoir built into the bottom portion of the container with the upper portion being the separator.

From the reservoir, the oil is then returned to the compressors by use of a mechanical or electronic oil level control fastened to the compressor crankcase.

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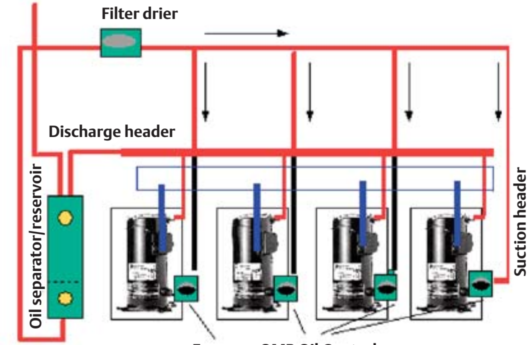
Oil separators use various modes of oil separation methods to remove the oil from the discharge gas as it leaves the compressor. These methods include reduction of velocity, impingement, centrifugal action, or coalescing elements. Oil separators vary in capacity and efficiency depending upon the mass flow that is being pumped through them and no oil separator is 100% efficient.



Typical System Oil Piping Schematic

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Tip Card 14

Pump Down Systems

Q: What is a 'pump down' system and when should it be used?

A pump-down system consists of a normally closed solenoid valve installed in the liquid line and a low-pressure control that senses suction pressure. The system operation is as follows:

- A thermostat is wired to the liquid line solenoid valve. On a call for cooling, the thermostat contacts close. This causes the solenoid coil to be energized, opening the valve. Liquid refrigerant flows into the evaporator and the suction pressure rises above the low-pressure control 'set-point.' The contacts on the low pressure control close and the compressor begins to run.

- When the thermostat is satisfied, its contacts open, causing the solenoid valve to close. This stops refrigerant flow into the evaporator. As the compressor continues to run, refrigerant is pumped out of the evaporator coil and suction pressure falls. When the suction pressure reaches the ‘cut-out’ setting on the low-pressure control its contacts open, stopping the compressor. This removes all refrigerant from the low side of the system during the ‘off-cycle.’

Q: What is the advantage of the pump down system?

The advantage of a pump-down system is that all the liquid refrigerant is stored in the receiver and condenser when the compressor is not operating. This prevents liquid migrating to the compressor crankcase during the off cycle and the ensuing possibility of liquid slugging at compressor start-up.

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Tip Card 15

Subcooling

Q: What is meant by subcooling?

Subcooling is the condition where the liquid refrigerant is colder than the minimum temperature (saturation temperature) required to keep it from boiling and, hence, change from the liquid to a gas phase.

The amount of subcooling, at a given condition, is the difference between its saturation temperature and the actual liquid refrigerant temperature.

Q: Why is subcooling desirable?

Subcooling is desirable for several reasons.

1. It increases the efficiency of the system since the amount of heat being removed per pound of refrigerant circulated is greater. In other words, you pump less refrigerant through the system to maintain the refrigerated temperature you want. This reduces the amount of time, which the compressor must run to maintain the temperature. The amount of capacity boost, which you get with each degree of subcooling, varies with the refrigerant being used.

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2. Subcooling is beneficial because it prevents the liquid refrigerant from changing to a gas before it gets to the evaporator. Pressure drops in the liquid piping and vertical risers can reduce the refrigerant pressure to the point where it will boil or ‘flash’ in the liquid line. This change of phase causes the refrigerant to absorb heat before it reaches the evaporator. Inadequate subcooling prevents the expansion valve from properly metering liquid refrigerant into the evaporator resulting in poor system performance.

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Contractor Service Tips

Tip Card 16

Superheat

Q: What is 'superheat'?

Superheat refers to the number of degrees a vapor is above its saturation temperature (boiling point) at a particular pressure.

Q: How do I measure superheat?

Superheat is determined by taking the low side pressure gauge reading, converting that pressure to temperature using a PT chart, and then subtracting that temperature from the actual temperature measured (using an accurate thermometer or thermocouple) at the same point the pressure was taken.

Q: Why is it important to know the superheat of a system?

Superheat gives an indication if the amount of refrigerant flowing into the evaporator is appropriate for the load. If the superheat is too high, then not enough refrigerant is being fed resulting in poor refrigeration and excess energy use. If the superheat is too low then too much refrigerant is being fed possibly resulting in liquid getting back to the compressor and causing compressor damage.

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Q: When should I check the superheat?

The superheat should be checked whenever any of the following take place:

- System appears not to be refrigerating properly
- Compressor is replaced
- TXV is replaced
- Refrigerant is changed or added to the system

Note: The superheat should be checked with the system running at a full load, steady state condition.

Q: How do I change the superheat?

Turning the adjustment stem on the TXV changes the superheat.

Clockwise - increases the superheat

Counter clockwise - decreases the superheat

Valve Family	Total Turns	Degrees of SH Per Turn					
		R-22		R-134a	R-404A/507		R-410A
		+20 F	-20F	+20F	+20F	-20F	+40F
TCLE	32	0.8	1.5	1.0	0.5	1.0	N/A
HF	10	2.2	4.2	3.8	1.8	3.2	N/A
A	8	3.0	5.0	4.5	2.0	4.0	2.0
TRAE	10	2.2	4.2	3.8	1.8	3.2	N/A

Note: To return to approximate original factory setting, turn adjustment stem counterclockwise until the spring is completely unloaded (reaches stop or starts to 'ratchet'). Then turn it back in ½ the 'Total Turns' shown on the chart.

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Contractor Service Tips

Tip Card 17

Alternative Refrigerants and Oils

Q: What is the right oil to use with the new refrigerants?

With the introduction of HFC refrigerants as alternatives to CFC and HCFC refrigerants, the question of the proper oil to use still comes up.

The generally preferred oil for use with HFCs is a polyol ester (POE) that has an additive package for refrigeration applications. Mineral oil (MO) is not recommended, because oil return is considered to be compromised.

Q: Do I have to remove all the MO from the system when retrofitting?

If retrofitting a system to an HFC refrigerant, current recommendations are to remove the mineral oil so that 5% or less is all that remains in the system before changing to POE oil. The percentage can be measured by using a refractometer.

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Q: What about alkyl benzene oils?

Most interim HCFC refrigerants can also use alkyl benzene (AB) oil, if approved by the compressor manufacturer. If in doubt about which oil to use with the refrigerant you are using, always consult the compressor manufacturer. For an example of one manufacturer's recommendation, go to **www.EmersonClimate.com/refrigerantschart** to view the "Refrigerants/Lubricants Approved For Use In Copeland® Compressors" chart, Form No. 93-11.

Contractor Service Tips

Tip Card 18

Bi-Flow TXV

Q: Does an HFES (or other balanced port TXV) bi-flow for use on a heat pump system?

The HFES series (or other balanced port valve) will meter the flow of refrigerant in either direction. The sensing bulb in such a case would have to be located on a common suction line, such as the center tube of a 4-way valve (see figure 1).

Also, for such a system to work properly, the system would have to be "close coupled," meaning that the evaporator and condenser would have to be physically located in close proximity to one another, such as in a packaged system.

For "split" type systems, the long length of tubing between the TXV and the coils makes it impractical to utilize an approach of this type.

For such systems, two expansion valves must be used: one on the indoor and one on the outdoor coil. Check valves must be installed around each TXV to allow flow around the valve when operating in the reverse direction (see figure 2).

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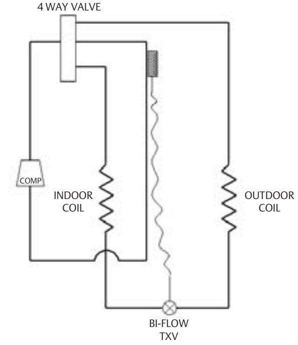

FIGURE 1 - PACKAGED SYSTEM

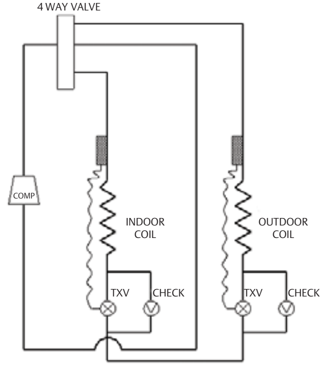

FIGURE 2 - SPLIT SYSTEM

Contractor Service Tips

Tip Card 19

Checking Power Elements of TXV

Q: How can I determine if a TXV still has the proper charge in the power element?

A valve with a low charge (or no charge) in the power element will tend to starve the evaporator. This is because the pressure on top of the diaphragm (opening force) is reduced.

To check for this, the following procedure is recommended:

1. On a valve with an external superheat adjustment, turn the adjustment nut to the full counterclockwise position. Verify that the superheat is still too high before proceeding to the next step.
2. Remove the bulb from the suction line and hold it in your hand for several minutes to warm it up. Observe the suction pressure. If the valve has charge, you should see an increase in suction pressure.
3. If no change in suction pressure occurs, it is reasonable to conclude the valve has lost its charge and must be replaced.

Note: Some valve types have removable power elements which can be replaced in lieu of replacing the entire valve.

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If the power element can be removed, the bulb charge can be checked by trying to depress the diaphragm with your thumb. You should NOT be able to depress this by hand. If you can, the valve has lost its charge.

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Contractor Service Tips

Tip Card 20

Global Warming

Q: What is global warming?

The Environmental Protection Agency (EPA) defines global warming as “an increase in the near surface temperature of the earth.”

Global warming has occurred in the distant past as the result of natural influences, but the term is most often used today to refer to the climatic warming predicted to occur as a result of increased emissions of “greenhouse gases.” The release of refrigerants into the atmosphere is considered to be a significant factor in contributing to the increase in global warming. Scientists generally agree that the earth’s surface has warmed by about 1 degree Fahrenheit in the past 140 years. While this may not seem like much of a change, atmospheric scientists are concerned about this general warming trend and the impact that this has on many aspects of our lives, such as economic prosperity, agricultural production, and pollution.

Q: What is meant by “direct” and “indirect” global warming?

Direct global warming is the measure of global warming potential (GWP) that each greenhouse gas contributes to the warming process if it is released “directly” into the atmosphere.

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Indirect global warming considers the amount of contributing effect to global warming by the manufacture of greenhouse gases and their efficiency of operation. In other words, it takes energy from power plants, which also emit greenhouse gases, to manufacture the gases and operate the equipment that the greenhouse gases are used in. An example of such equipment is an air conditioner with a SEER of 10 versus one with a SEER of 13. The 10 SEER unit has a higher indirect warming potential since it does not operate as efficiently.

Q: What is "total equivalent warming impact" (TEWI)?

TEWI is the sum of a greenhouse gas's direct and indirect GWP. This value takes into consideration both the direct factor of release of the gas into the atmosphere and the indirect factor of the manufacture and lifetime operation of the system in which the gas is used. This factor is important because some greenhouse gases may have a low direct GWP but require more energy to manufacture or do not operate as efficiently as other gases with a higher direct GWP.

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Contractor Service Tips

Tip Card 21

Internal or External Equalized TXV

Q: What is the difference between an "internally" equalized and "externally" equalized TXV?

An internally equalized TXV uses evaporator inlet pressure to create the "closing" force on the valve. An externally equalized valve uses the evaporator outlet pressure, thereby compensating for any pressure drop through the evaporator.

If an internally equalized valve is used in a system with a large pressure drop through the evaporator, the pressure below the diaphragm will be higher, causing the valve to go in a more "closed" position and resulting in a superheat higher than desired (starving).

Q: When should I use an externally equalized TXV?

1. On any large system, generally over 1 ton capacity
2. On any system utilizing a distributor

Note: For field replacement you can always replace an internally equalized valve with an externally equalized type; however, you should never replace an externally equalized valve with an internally equalized type.

Q: If I need to replace an internally equalized valve and all that is available is an externally equalized type, can I simply "cap" the equalizer fitting?

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No, the equalizer must be connected to the suction line near the thermal bulb. Capping the equalizer line will prevent the valve from operating properly.

Q: Will an externally equalized TXV allow system pressures to "equalize" during off cycles?

No, an externally equalized valve will NOT allow system high and low sides to "equalize" during the off cycle. The only way this can be accomplished is through the use of a "bleed" type TXV.

Q: Where should the external equalizer be installed?

The external equalizer line should be installed on top of the suction line before any traps and located within 6 inches of the sensing bulb position. If this is not possible, and a different location is required, it must first be confirmed that the pressure at the desired location is identical to the pressure at the bulb.

Q: What happens if the equalizer tube becomes "kinked"?

If the equalizer line becomes "kinked," the pressure sensed at the underside of the diaphragm will no longer correspond to the evaporator outlet pressure and the valve will not be able to operate as intended.

Q: I have seen some equalizer tubes "frosted." Is that normal?

Frost on the equalizer line is an indication that the packing seal has failed, allowing higher pressure refrigerant to leak past and expand into the equalizer line. Depending on the valve type, either the cage assembly or the entire valve should be replaced.

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Contractor Service Tips

Tip Card 22

Liquid-to-Suction Heat Exchangers

Q: What is the benefit to using a liquid-to-suction heat exchanger?

A liquid-to-suction heat exchanger is beneficial in the following ways:

1. It provides subcooling to the liquid refrigerant prior to its entering the expansion valve. This eliminates the possible formation of “flash gas” in the liquid line and enables the expansion valve to operate with greater stability.

2. The added subcooling that is provided to the liquid refrigerant increases the efficiency of the system.

3. The heat that is transferred from the liquid to the suction increases the superheat of the suction gas, thereby reducing the possibility of liquid “floodback” to the compressor. Liquid floodback is considered one of the major causes of compressor failure, so any steps taken to minimize this will result in improved compressor reliability.

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Contractor Service Tips

Tip Card 23

Moisture Indicators and Sight Glasses

Q: I have a new HMI sight glass that is showing a wet condition, right out of the box. Can I use this in my system and will it give the proper moisture indication?

The element in the sight glass senses the moisture of the atmosphere that it is in. In this case, the air has enough moisture to turn the sensing element pink (wet).

Once a sight glass is put into an operating refrigeration system, it will adjust its color over time to indicate the moisture level of the refrigerant. This change can take several hours to occur...it will not happen instantaneously.

Q: If I pull a vacuum on the system with the wet sight glass, will that change its color back to dry?

Pulling a vacuum by itself will not remove enough moisture from the HMI indicator to effect a color change in a short period of time.

The recommended procedure is to install the HMI in the system with a new EK filter drier and clean, dry refrigerant, and operate the system. Within several hours the indicator will show the moisture condition of the refrigerant. It is recommended, however, to allow the system to operate for 12 hours to attain complete equilibrium.

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Contractor Service Tips

Tip Card 24

Maximum Operating Pressure (MOP)

Q: What does MOP (Maximum Operating Pressure and/or Motor Overload Protection) mean on an expansion valve?

MOP refers to the maximum value to which the suction pressure is allowed to rise before the expansion valve tends to close off and restrict a further increase in flow. This is accomplished at the point where the gas in the expansion valve's power element charge has become superheated and can exert only slightly more opening pressure as the temperature rises.

The purpose of MOP is to prevent the suction pressure from rising so high that the compressor motor cannot start due to an initial load that is too high.

An MOP type valve tends to serve the same function as a crankcase pressure regulating (CPR) valve; however, it will not control as precisely as the CPR valve. Usually it is not recommended to use both a CPR and an MOP type valve on the same system, because there is a possibility that they will "fight" each other as they both try to control.

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Contractor Service Tips

Tip Card 25

System Clean-Up After Motor Burn

Q: What type of filter drier is recommended for cleaning a system after a compressor motor burn?

After a burn, both the liquid and suction line cores (if provided) should be replaced with special "burnout blocks." These cores have an "HH" in their model nomenclatures. The system is then operated with these cores in place until the refrigerant and oil are clean and free of acids. Once this condition is attained, the liquid core must be replaced with a standard type core (UK48 or H48). The suction core should also be replaced with an F-48 filter.

Q: My system does not have a removable suction core and there isn't enough space to install one. What should I do?

On smaller self-contained systems, where a removable suction core cannot be installed, you should put in a hermetic type suction line filter drier (ASK-HH). This must be left in the system only until the refrigerant and oil have been cleaned and then either be removed or replaced with a new one to prevent excessive pressure drop.

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Q: How do I know when the suction core needs to be replaced?

A wet indication in the sight glass or a pressure differential greater than the equipment manufacturer's recommendation dictates the need for replacement. If the equipment manufacturer's recommendation is not available, the following maximum pressure drops are suggested:

System Type	Permanent Installation		Temporary Installations	
	R-22	R-12	R-22	R-12
	R-404A/507	R-134A	R-404A/507	R-134A
HIGH TEMP (A/C)	3	2	8	6
MEDIUM TEMP	2	1.5	4	3
LOW TEMP	1	0.5	2	1

MAXIMUM RECOMMENDED SUCTION LINE FILTER DRIER PRESSURE DROP (PSI)

The pressure drops indicated in the columns titled "TEMPORARY INSTALLATIONS" should be used only during the clean-up operation as an indication when the core needs to be replaced. During normal operation, the pressure drop should not exceed those shown in the column "PERMANENT INSTALLATION." Operating with high pressure drop across a suction filter drier will decrease system efficiency and must be avoided.

Contractor Service Tips

Tip Card 26

TXVs and SEER

Q: What increase in SEER rating is achieved going from a flow rater (fixed metering device) to an expansion valve, provided all else stays the same?

To explain why a system's SEER rating is improved by using a thermal expansion valve (TXV) instead of a fixed orifice device, we need to understand how the SEER is determined. The SEER (seasonal energy efficiency ratio) is a measure of how efficiently an air conditioner or heat pump will operate over an entire cooling season instead of only a single operating condition.

For single speed systems, the SEER is calculated as follows:

$$SEER = EER_b * (1 - C_d/2)$$

Where:

EER_b = energy efficiency ratio at 95/75F (DB/WB) outdoor temp and 80/67F indoor temp

C_d = cyclic degradation coefficient determined through two dry coil tests (one steady state, the other cyclic). This factor quantifies the part load (cycling) efficiency of the system.

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In order to improve SEER, it is important to keep the C_d as low as possible. This can be achieved by minimizing the amount of refrigerant entering the evaporator during the "off"cycle. With a fixed orifice device, the high and low sides of the system equalize during the off cycle, resulting in a high C_d. In comparison, a non-bleed TXV closes tightly when the compressor shuts off, preventing equalization and thereby minimizing the C_d. It is for this reason that TXVs will typically increase the rating of a HVAC system by approximately 0.5 SEER.

It should be noted that a system can be designed with a fixed orifice and liquid line solenoid to achieve a SEER rating equal to that with a TXV; however, such a system would not be as efficient over the entire operating range of the equipment as it would with a TXV. The TXV regulates the flow of refrigerant to maximize the efficiency of the evaporator at all operating conditions, whereas a fixed orifice can be optimized only at one particular condition. For this reason, if energy efficiency is the goal, a system incorporating a TXV should be specified.

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Contractor Service Tips

Tip Card 27

Solenoid Valves

Q: What does the "MOPD" rating on solenoid valves mean?

Solenoid valves are rated in terms of Maximum Operating Pressure Differential (MOPD) against which the valve will open. For example, with the valve closed against an inlet pressure of 250 psi and an outlet pressure of 50 psi, the pressure differential across the valve is 250-50 or 200 psi.

The MOPD rating for the valve is the maximum pressure differential against which the valve will reliably operate. If the pressure differential is higher than the rated MOPD for the valve, the valve will not operate.

The temperature of the coil winding and the applied voltage has a significant affect on the MOPD rating. The MOPD is reduced as the coil temperature increases or the voltage decreases. For this reason the MOPD rating is established by operating the valve at 85% of rated voltage after the coil has attained its maximum temperature by operating at full rated voltage.

Q: Why do some valves have a "Min OPD" rating and what does this mean?

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“Min OPD” stands for Minimum Operating PressureDifferential. All pilot operated valves (like our 200 and 240 series) require a small amount of pressure differential to enable the piston or diaphragm to raise off the main seat. Typically, 2 to 5 psig differential is needed to accomplish this. If the pressure differential is less than the Min OPD, then the valve will not open when actuated or will fail to remain open.

If a valve is greatly oversized for the application it can suffer from this affect since the pressure drop across the valve with low flow rates can be below the Min OPD.

Direct operating solenoids (like our 50RB and 100RB) do not have a Min OPD specification since they do not rely on system pressures for operation.

Q: What are some typical problems I can expect with a solenoid valve and how do I recognize it?

Solenoid Valves Troubleshooting Chart

PROBLEM	CAUSE
Won’t Open	Valve Oversized
	Not within 10% Rated Voltage
	Coil Burnout
	Bent Enclosing Tube
	Improper Wiring
Won’t Close	Broken internal Parts
	Installed Backwards
	Foreign Material In Orifice Area
	Manual Stem Front-Seated
Intermittent Operation	
	Transformer Undersized
	Valve Oversized For Application (Pressure Drop Below MinOPD)

Contractor Service Tips

Tip Card 28

Metering Device

Many air conditioning systems incorporate a TXV style metering device as the standard. It is extremely important for the HVAC technician to understand the design and operation of these valves. If proper service practices are not followed, severe system damage will result.

When charging a system, follow the manufacturer's recommendations. If extra charge is required due to long line sets and the system incorporates a TXV metering device, charging should be done with respect to subcooling at highest load. The greatest chance for a TXV to lose control of the evaporator load is during this time. If subcooling is present during highest load, enough refrigerant is circulating throughout the system to control the evaporator loads.

To adjust evaporator coil superheat, follow the manufacturer's recommendations. If these are not available, the following guide lines could apply, depending upon the system design temperature:

High Temp	8°F - 12°F
Medium Temp	5°F - 8°F
Low Temp	2°F - 6°F

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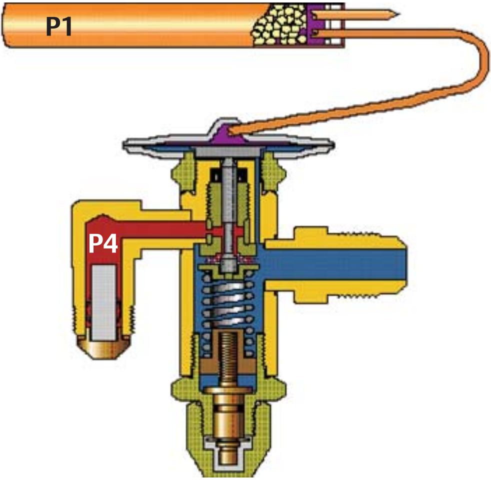
Thermostatic Expansion Valve



P1 = Bulb Pressure (Opening Force)
P2 = Evaporator Pressure (Closing Force)
P3 = Superheat Spring Pressure (Closing Force)
P4 = Liquid Pressure (Opening Force)

TXV Pressure Balance Equation
P1 + P4 = P2 + P3

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Contractor Service Tips

Tip Card 29

Scroll Compressor Safety Controls

Many air conditioning systems incorporate a scroll compressor as the standard. It is extremely important for the HVAC technician to understand the design and operation of scroll compressors. If proper service practices are not followed severe system damage will result.

Scroll compressors incorporate a variety of internal safety controls. It is important to understand these safety features because they actuate the internal line break motor protection. Safety features that you could find in the air conditioning scroll under 7 tons may be:

(1) Temperature Operated Disc (TOD) - This is a bimetallic disc that senses the discharge temperature and opens at approximately 270°F internal plenum temperature.

(2) Internal Pressure Relief (IPR) - This opens at approximately 400 +/-50 pounds differential for R-22. If this pressure differential is exceeded, the IPR will open. On a ZP scroll for R-410A, the IPR differential is set higher, 550 to 625 PSID.

(3) Floating Seal - This separates the high side from the low side, but also can prevent the compressor from drawing into a deep vacuum and damaging the Fusite® electrical terminal.

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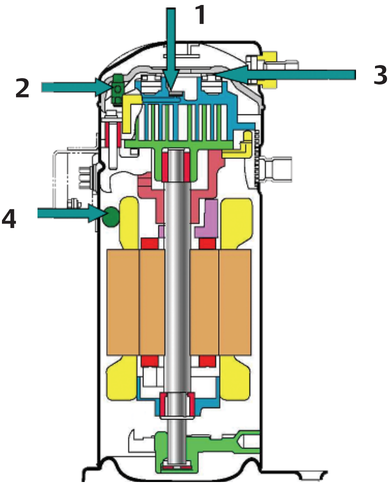
(4) Internal Motor Protector - This is an inherent protector, sensing both internal temperature and amperage. A compressor with a tripped motor protector will exhibit a high shell temperature. Allow the compressor to cool in order to reset the motor protector.

Scroll Compressor Protection



1 = Temperature Operating Disc
2 = Internal Pressure Relief
3 = Floating Seal
4 = Motor Protector

Contractor Service Tips

Tip Card 30

Refrigerants

Many air conditioning systems incorporate an HFC refrigerant as the standard. It is extremely important for the HVAC technician to understand the properties of these refrigerants. If proper service practices are not followed severe system damage will result.

The Air Conditioning market is converting to the new, environmentally friendly refrigerant, R-410A, with the phase-out of R-22 in 2010. R-410A will represent one third of the market in 2006, in conjunction with the new higher efficiency regulation of 13 SEER.

Since R-410A is classified as an HFC, the only recommended oil is polyol ester (POE) oil. POE oil is extremely hygroscopic and will absorb moisture at a rapid rate. Testing has shown that POE oil can be moisture saturated in less then 15 minutes if exposed to a 90% relative humidity environment.

The "Refrigerants/Lubricants Approved For Use In Copeland® Compressors" chart, available online at **www.EmersonClimate.com/refrigerantschart**, lists approved combinations of common refrigerants and lubricants. To maintain compressor warranty, please ensure these combinations are respected when installing or retrofitting a system.

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Contractor Service Tips

Tip Card 31

Single Phase Motor Terminal ID

Many air conditioning systems incorporate a hermetic (welded body) compressor as the standard. It is extremely important for the HVAC technician to identify the correct electrical terminals. If the electrical terminals are not wired correctly, severe compressor or system damage will result.

A standard has been developed for single phase welded compressors. The standard terminal designation is read like a book, from left to right and from top to bottom. The order of these terminals is Common (C) - Start (S) - Run (R).

While protectors are very reliable and do a good job of protecting a compressor motor against normal overload situations, they cannot protect motors against miswiring and defective external components. Miswiring a compressor can cause a motor to burn in as little as 25 seconds. Any motor miswired or used with defective components will ultimately fail.

Be sure to check or replace any electrical components including but not limited to the contactor, run capacitor, relay, and start capacitor. Any of these components could also cause compressor failure.

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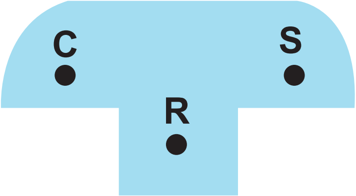
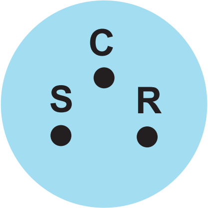
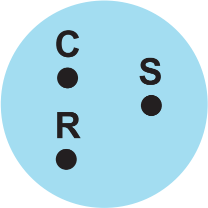
Motor Terminal Identification







On single phase hermetic compressors, the order of these terminals is C - S - R. This is read like a book, from left to right and from top to bottom. The "Common" terminal is always first, followed by "Start" and then "Run".

Contractor Service Tips

Tip Card 32

Refrigerant Floodback

Q: What is refrigerant floodback?

Refrigerant floodback is a result of liquid refrigerant returning to the compressor during the running cycle. The oil is diluted with refrigerant to the point it cannot properly lubricate the load bearing surfaces.

Q: What are the signs of refrigerant floodback in an air-cooled compressor?

Worn pistons and cylinders; and, no evidence of overheating.

Q: How does refrigerant floodback happen in an air-cooled compressor?

The liquid washed the oil off the pistons and cylinders during the suction stroke causing them to wear during the compression stroke.

Q: What are the signs of refrigerant floodback in a refrigerant-cooled compressor?

The center and rear bearings are worn or seized, there is a dragging rotor and shorted stator, a progressively scored crankshaft, and worn or broken rods.

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Q: How does refrigerant floodback happen in a refrigerant-cooled compressor?

The liquid dilutes the oil in the crankcase and the refrigerant rich oil will be pumped to the rods and the bearings through the crankshaft. As the refrigerant boils off, there will not be enough oil for sufficient lubrication at the bearings farthest from the oil pump. The center and rear bearings may seize or may wear enough to allow the rotor to drop and drag on the stator causing it to short.

Q: What can be done to avoid refrigerant floodback?

(1) Maintain proper evaporator and compressor superheat.

(2) Correct abnormally low load conditions.

(3) Install accumulators to stop uncontrolled liquid return.

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Contractor Service Tips

Tip Card 33

Flooded Starts

Q: What are the signs of a flooded start?

Signs of a flooded start are: worn or scored rods or bearings, rods broken from seizure, and an erratic wear pattern on the crankshaft.

Q: What causes a flooded start?

Flooded starts are the result of refrigerant vapor migrating to the crankcase oil during the off cycle. When the compressor starts, the diluted oil cannot properly lubricate the crankshaft load bearing surface causing an erratic wear or seizure pattern.

Q: What can be done to avoid flooded starts?

(1) Locate compressor in warm ambient or install continuous pump down.

(2) Check crankcase heater operation.

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Contractor Service Tips

Tip Card 34

Slugging

Q: What are the signs of slugging?

Signs of slugging are: broken reeds, rods, or crankshaft, and loose or broken backer bolts, as well as blown head gaskets.

Q: What causes slugging?

Slugging is the result of trying to compress liquid refrigerant and/or oil, in the cylinders. Slugging is an extreme floodback in air cooled compressors and a severe flooded start on refrigerant cooled compressors.

Q: What can be done to avoid slugging?

(1) Maintain proper evaporator and compressor superheat.

(2) Correct abnormally low load conditions.

(3) Install accumulators to stop uncontrolled liquid return.

(4) Locate compressor in warm ambient or install continuous pump down.

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Contractor Service Tips

Tip Card 35

High Discharge Temperature

Q: What are the signs of high discharge temperature?

Signs of high discharge temperature are: discolored valve plates, burned valve reeds, worn pistons, rings and cylinders, or a stator spot burn from metal debris.

Q: What causes high discharge temperature?

High discharge temperature is the result of temperatures in the compressor head and cylinders becoming so hot that the oil loses its ability to lubricate properly. This causes rings, pistons and cylinders to wear resulting in blow by, leaking valves, and metal debris in the oil.

Q: What can be done to avoid high discharge temperature?

(1) Correct abnormally low load conditions.

(2) Correct high discharge pressure conditions.

(3) Insulate suction lines.

(4) Provide proper compressor cooling.

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Contractor Service Tips

Tip Card 36

Loss of Oil

Q: What are the signs of loss of oil?

Signs of loss of oil are: all rods and bearings worn or scored, crankshaft uniformly scored, rods broken from seizure, or little or no oil in crankcase.

Q: What causes loss of oil?

Loss of oil is a result of insufficient oil in the crankcase to properly lubricate the load bearing surfaces. When there is not enough refrigerant mass flow in the system to return oil to the compressor as fast at it is pumped out, there will be a uniform wearing or scoring of all load bearing surfaces.

Q: What can be done to avoid loss of oil?

(1) Check oil failure control operation if applicable.

(2) Check system refrigerant charge.

(3) Correct abnormally low load conditions or short cycling.

(4) Check for incorrect pipe sizes and/or oil traps.

(5) Check for inadequate defrosts.

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