Application Engineering

Design Considerations for Refrigerant Receivers

BULLETIN NO: AE17-1212 R1

Contents

COPELAND

Safety

Important Safety Information

Those involved in the design, manufacture, and installation of a system, system purchasers, and service personnel may need to be aware of hazards and precautions discussed in this section and throughout this document. OEMs integrating the compressor into a system should ensure that their own employees follow this bulletin and provide any necessary safety information to those involved in manufacturing, installing, purchasing, and servicing the system.

Responsibilities, Qualifications and Training

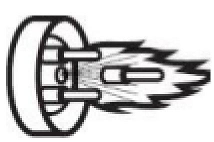
• OEMs are responsible for system design, selection of appropriate components, integration of this component into the system, and testing the system. OEMs must ensure that staff involved in these activities are competent and qualified.

• OEMs are also responsible for ensuring that all product, service, and cautionary labels remain visible or are appropriately added in a conspicuous location on the system to ensure they are clear to any personnel involved in the installation, commissioning, troubleshooting or maintenance of this equipment.

• Only qualified and authorized HVAC or refrigeration personnel are permitted to install, commission, troubleshoot and maintain this equipment. Electrical connections must be made by qualified electrical personnel.

• Observe all applicable standards and codes for installing, servicing, and maintaining electrical and refrigeration equipment.

Terminal Venting and Other Pressurized System Hazards



If a compressor's electrical terminal pin loses its seal, pressurized oil, refrigerant, and debris may spray out. This is called "terminal venting".

The ejected debris, oil, and refrigerant can injure people or damage property. The oil and refrigerant spray can be ignited by electrical arcing at the terminal or any nearby ignition source, producing flames that may project a significant distance from the compressor. The distance depends on the pressure and the amount of refrigerant and oil mixture in the system. The flames can cause serious or fatal burns and ignite nearby materials.

Each compressor has a terminal cover or molded plug that covers electrical connections. The cover or plug helps to protect against electric shock and the risks of terminal venting. If terminal venting occurs, the cover or plug helps contain the spray of refrigerant and oil and reduces the risk of ignition. If ignition occurs, the plug or cover helps contain the flames. However, neither the terminal cover nor the molded plug can completely eliminate the risk of venting, ignition, or electric shock.

See copeland.com/terminal-venting for more details about terminal venting. Additionally, a compressor's refrigerant lines keep refrigerant and oil under pressure. When removing or recharging refrigerant from this component during service, this can pose a pressurized fluid hazard.

Flammable Refrigerant Hazards

If flammable refrigerant is released from a system, an explosive concentration can be present in the air near the system. If there is an ignition source nearby, a release of flammable refrigerant can result in a fire or explosion. While systems using flammable refrigerant are designed to mitigate the risk of ignition if the refrigerant is released, fire and explosion can still occur.

See copeland.com/flammable-refrigerants for more information on flammable refrigerant safety.

Electrical Hazards

Until a system is de-energized, and capacitors have been discharged, the system presents a risk of electric shock.

Hot Surface and Fire Hazards

While the system is energized, and for some time after it is deenergized, the compressor may be hot. Touching the compressor before it has cooled can result in severe burns. When brazing system components during service, the flames can cause severe burns and ignite nearby combustible materials.

Lifting Hazards

Certain system components may be very heavy. Improperly lifting system components or the compressor can result in serious personal injury. Use proper lifting techniques when moving.

POE Oil Hazards

This equipment contains polyol ester (POE) oils. Certain polymers (e.g., PVC/CPVC and polycarbonate) can be harmed if they come into contact with POE oils. If POE oil contacts bare skin, it may cause an allergic skin reaction.

Precautions

• Always wear personal protective equipment (gloves, eye protection, etc.).

• Keep a fire extinguisher at the jobsite at all times.

• Keep clear of the compressor when power is applied.

> - IMMEDIATELY GET AWAY **if you hear unusual sounds in the compressor. They can indicate that terminal pin ejection may be imminent. This may sound like electrical arcing (sizzling, sputtering or popping). However, terminal venting may still occur even if you do not hear any unusual sounds.**

• Never reset a breaker or replace a blown fuse without performing appropriate electrical testing

- **A tripped breaker or blown fuse may indicate an electrical fault in the compressor. Energizing a compressor with an electrical fault can cause terminal venting. Perform checks to rule out an electrical fault.**

• Disconnect power and use lock-out/tag-out procedures before servicing.

- Before removing the terminal cover or molded plug, check that ALL electrical power is disconnected from the unit. Make sure that all power legs are open. (Note: The system may have more than one power supply.)

- Discharge capacitors for a minimum of two minutes

- Always use control of hazardous energy (lock-out/tag-out) procedures to ensure that power is not reconnected while the unit is being serviced.

• Allow time for the compressor to cool before servicing.

- Ensure that materials and wiring do not touch high temperature areas of the compressor.

• Keep all non-essential personnel away from the compressor during service.

• For A3 refrigerants (R290) remove refrigerant from both the high and low sides of the compressor. Use a recovery machine and cylinder designed for flammable refrigerants. Do not use standard recovery machines because they contain sources of ignition such as switches, high- and low-pressure controls and relays. Only vent the R290 refrigerant into the atmosphere if the system is in a well-ventilated area.

• Never use a torch to remove the compressor. Only tubing cutters should be used for both A2L and A3 refrigerants.

• Use an appropriate lifting device to install or remove the compressor.

• 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.

• Always wear appropriate safety glasses and gloves when brazing or unbrazing system components.

• Charge the system with only approved refrigerants and refrigeration oils.

• Keep POE oils away from certain polymers (e.g., PVC/CPVC and polycarbonate) and any other surface or material that might be harmed by POE oils. Proper protective equipment (gloves, eye protection, etc.) must be used when handling POE lubricant. Handle POE oil with care. Refer to the Safety Data Sheet (SDS) for further details.

• Before energizing the system:

1. Securely fasten the protective terminal cover or molded plug to the compressor, and

2. Check that the compressor is properly grounded per the applicable system and compressor requirements.

Signal Word Definitions

The signal word explained below are used throughout the document to indicate safety messages.

⚠ DANGER	**DANGER** indicates a hazardous situation which, if not avoided, will result in death or serious injury.
⚠ WARNING	**WARNING** indicates a hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION	**CAUTION**, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

Introduction

Design Considerations for Refrigerant Receivers

The refrigerant receiver in a conventional refrigeration or air conditioning system is often accepted as a necessary component in system design with little thought given to any consideration other than receiver size. Surprising as it may seem, the receiver can often be a source of liquid refrigerant control problems, may affect condensing pressure and liquid subcooling, and frequently is a storage reservoir for excessive amounts of liquid refrigerant.

The role of the receiver in system operation in being more closely evaluated in modern design practice. Although small unitary equipment has been applied successfully with capillary tubes and without receivers for many years, today many manufacturers are building and applying systems up to 25 horsepower in size and larger with expansion valves without receivers. In order to minimize receiver connected problems, a thorough understanding of the function a receiver performs is essential.

Liquid Subcooling

For proper system performance it is essential that liquid refrigerant reaching the expansion device be subcooled slightly below its saturation temperature to avoid flash gas and insure a solid head of liquid refrigerant. Therefore, the liquid refrigerant must be adequately subcooled as it enters the liquid line to offset any liquid line pressure drop.

The amount of subcooling required is especially critical where long vertical risers to evaporators are involved, since a head of two feet of liquid refrigerant is approximately equivalent to 1 psi pressure drop.

At normal condensing temperatures the following relation between each 1° F. of subcooling and the corresponding change in saturation pressure applies.

Refrigerant	Subcooling	Equivalent Changes In Saturation Pressure
R-12	1° F	1.75 psi
R-22	1° F	2.75 psi
R-502	1° F	2.85 psi

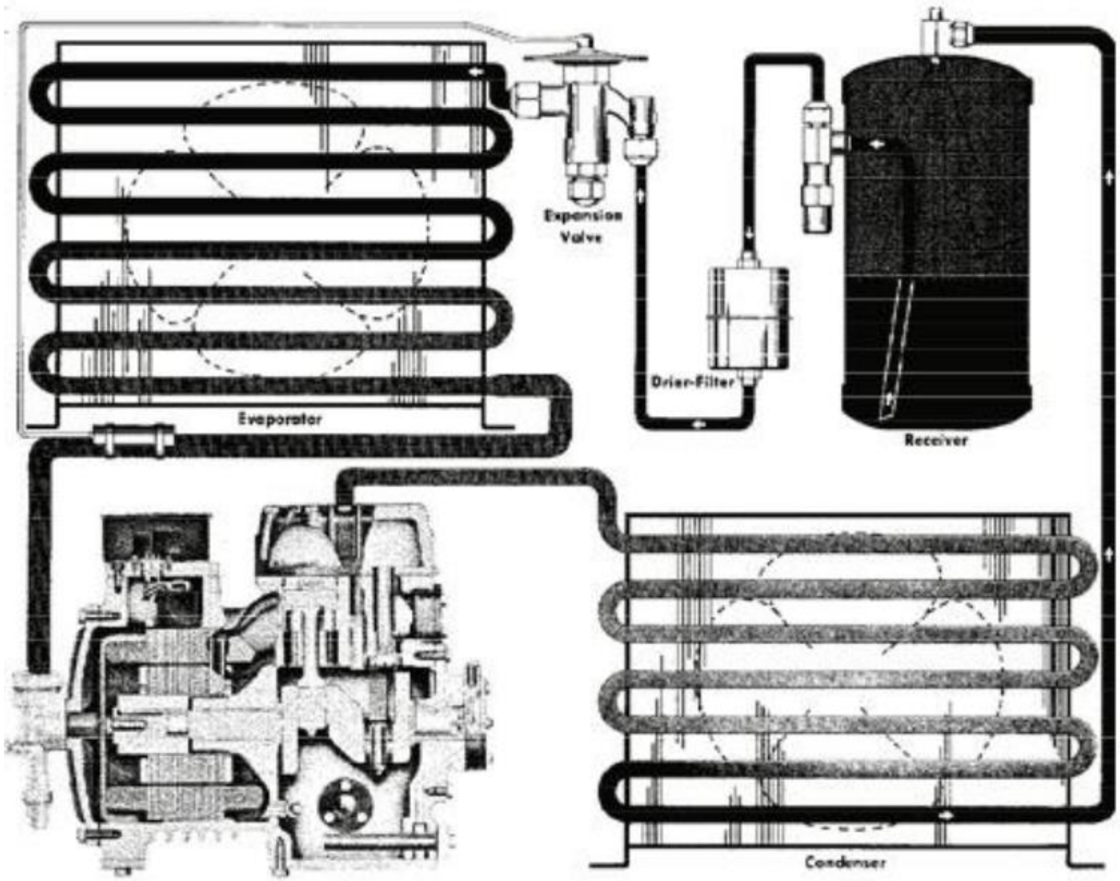
On most systems the liquid refrigerant is sufficiently subcooled as it leaves the condenser to provide for normal system pressure drop. What few users realize is that part of the subcooling may be lost in a receiver unless the receiver is almost completely full of liquid refrigerant.

A schematic diagram of a typical air-cooled compression refrigeration system is shown in Figure 1. Assume the unit is operating in an ambient temperature of 85°, with refrigerant R-12, the condensing pressure being 126.8 psig, equivalent to 105° F. To simplify the example, let us consider the pressure only at the condenser outlet and further assume the pressure drop between the condenser outlet and the receiver is negligible. Therefore, the pressure of 126.8 psig should exist both at the condenser outlet and at the receiver inlet.

If the liquid leaving the condenser is subcooled to 100° F. and enters the receiver at that temperature, what happens to the refrigerant vapor in the receiver? At a pressure of 126.8psig, it will condense at 105° F., and it is being exposed to a 100° F. liquid. A portion of the vapor will condense, tending to raise the liquid temperature and lower the receiver pressure.

The exact equilibrium condition resulting is not entirely certain, since flow through the receiver creates a dynamic condition rather than a static one might exist in a storage drum. However, it is clear that if a combination of liquid and vapor exists in the receiver, the mixture would tend to approach saturation conditions, with the liquid at a slightly higher temperature and slightly lower pressure than liquid at the condenser outlet.

Figure 1 - Typical R-12 Refrigeration System with Flow-Through Receiver



Receiver Gas Binding

If the receiver is subjected to a higher ambient temperature than the condensing temperature, liquid refrigerant will be backed up in the condenser until the condensing pressure is greater than the pressure created in the receiver by the heat transfer. This can occur on evaporative or water-cooled condensers with a separate receiver, or on air-cooled condensers with a separate receiver is located in an abnormally warm location.

The best remedy for this problem is to make sure the receiver is always exposed to ambient temperatures lower than the condensing temperature. If this is not possible, the receiver should be insulated to minimize heat transfer.

Determining The Refrigerant Charge

Historically, a sight glass has been used as a means of determining the proper charge for a system, and on many systems it is the only indicator available. When the sight glass is located in the liquid line leaving the receiver, field experience indicates that the interpretation of bubbles in the sight glass as an indicator of insufficient charge may be totally misleading. Systems have been repeatedly encountered, varying in size from 5 to 50 horsepower, on which the receiver has been found to completely flooded with liquid refrigerant during normal cooling operation, the excess refrigerant often amounting to several hundred pounds.

It is true that a lack of adequate charge will result in bubbles and flashing in the sight glass, but many other factors can cause the same condition.

If the liquid in the receiver is close to a saturation condition, in other words if the liquid has very little subcooling as would be the case if the receiver were only partially filled with liquid, any slight pressure drop can cause flashing in the liquid line. Any slight restriction through a solenoid valve or receiver outlet may contribute to such flashing.

The velocity of the liquid flowing in the liquid line requires pressure to create the velocity, and if the vertical height or head of liquid at the receiver outlet is not sufficient to create the outlet velocity, then a pressure drop must occur. Receivers with a dip-stick type have no liquid head available unless the liquid level is above the high point of the outlet passage. Flashing due to this type of pressure drop is most noticeable during a sudden increase in the evaporator feed, for example when the expansion valve is opening or feeding heavily.

Sudden changes in condensing pressure, or head pressure control systems utilizing hot gas bypass into the receiver are other common sources of bubbles in the sight glass, even though the receiver might have a liquid seal at the outlet.

It is quite probable that some means of determining the liquid level in receiver tanks which is more dependable than a sight glass may in many cases more than offset its added cost by savings arising from the elimination of an excessive refrigerant charge.

When A Receiver Is Required

There really is no justification for a receiver in a system unless it is necessary. Obviously on split systems with long refrigerant lines, flooded systems with large refrigerant charges, or systems with multiple evaporators, the refrigerant required is normally such that a receiver is required to pump the system down. Units with head pressure control systems which work on the principle of flooding the condenser with liquid refrigerant to maintain adequate condensing pressures during cold weather conditions also require a storage area for the excess refrigerant under warm ambient conditions.

But on unitary or close coupled systems with single evaporators, operating in reasonably stable ambient conditions, a receiver may serve no useful function. If the condenser has been adequately sized and the evaporator selected for a minimum refrigerant charge, it may be possible to pump the entire charge into the condenser for pumpdown control or maintenance purposes.

Excess liquid refrigerant in a system is a hazard to the compressor. No more refrigerant should be charged into the system than is actually necessary for proper operation. While the refrigerant charge does become more critical without a receiver, a sight glass also becomes much more dependable as an indicator of the proper charge.

If a receiver is required, its size should be held to a minimum. For example, in systems, where shutters or fan cycling are used to control head pressure by reducing the condenser's overall heat transfer ability rather than flooding it with liquid refrigerant, the refrigerant storage capacity required may be fairly small.

The individual system determines the need for a receiver, and if required, its size. In designing a system, it may be advisable to consider a slightly larger condenser or a subcooling pass in the condenser to replace the need for a receiver. Regardless of system design, the function of the receiver should be seriously considered to insure proper system performance.

Revision Tracking R1

The document format has been updated to the new Copeland format

All occurrences of "Emerson" have been removed

A note regarding A3 and R290 venting has been updated