

Application Engineering

The Effect Of Defrost Control On Compressor Operation

BULLETIN NO: AE17-1195 R2

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Safety

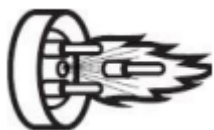
Important Safety Information

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](https://www.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 indicates a hazardous situation which, if not avoided, will result in death or serious injury.



WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.



CAUTION, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

Introduction

On any refrigeration system operating with evaporating temperatures below 30° F., frost will accumulate on the evaporator surface, and some means of defrost must be provided. While air defrost is possible in some medium temperature applications where close temperature control is not too critical and sufficient off cycle time can be provided, most commercial refrigeration applications require a fast, positive means of defrost.

It is important when selecting the method of defrost that the effect on system operation be carefully considered, and adequate provisions must be made to avoid possible damage to the compressor.

Field experience indicates that excessive liquid refrigerant reaching the compressor is probably the biggest single source of compressor failure. On commercial applications the defrost cycle is undoubtedly the cause of most liquid control problems.

Hot Gas Defrost

In the search for fast and efficient means of defrost, designers are always attracted by the tremendous heat potential of introducing hot gas into the evaporator and condensing it to a liquid. But the critical question is, just what do you do with that liquid? An all-too-common practice has been to return the liquid to the compressor, hopefully at a controlled rate, and rely on the motor heat and the heat of compression to evaporate the liquid.

A compressor will tolerate some slight amount of liquid return for a short period of time without serious problems. Unfortunately, it isn't always a slight amount of liquid, and as the size of the compressor and the system increase, the problem becomes more critical. The situation is complicated by the fact that even though sufficient liquid is returning to wash the bearings free of lubricant, the oil pump may still develop sufficient pressure with the mixture of oil and refrigerant to prevent a trip of the oil pressure safety control. There may very well be a condition where the compressor has lost lubrication which no protective device can sense.

The basic solution is to provide some source of heat to re-evaporate this liquid without returning it to the compressor. In the supermarket fixture where multiple evaporator circuits are employed, an ideal solution has been a control system to defrost only a few cases at a time, returning the condensed liquid to operating evaporators. Some type of heat source in the suction line is also an acceptable approach. Proprietary systems of this type are available on the market, but unfortunately have not been widely used.

The majority of systems utilizing hot gas defrost provide only a suction line accumulator. There is growing evidence that the accumulator alone does not represent an acceptable long-term solution, particularly on larger low temperature systems where hot gas defrost is a major source of early compressor failure.

Unless some means of re-evaporating the liquid is provided, the compressor life expectancy may be reduced by a tremendous factor. Compressor failure due to loss of lubrication in systems not providing adequate protection against liquid refrigerant must be considered a customer responsibility.

Electric Defrost

Even with electric defrost, liquid refrigerant control remains a hazard. The most effective means of compressor protection is a pumpdown cycle at the time of defrost, thus isolating the refrigerant charge in the condenser and receiver. If pumpdown control is not used, then at a minimum a liquid line solenoid valve which is closed during defrost should be provided, together with a suction line accumulator capable of holding whatever refrigerant might be in the evaporator.

If the evaporator can become warmer than the suction line during defrost (which might occur due to low ambient temperatures, electric heaters in contact with the evaporator, or insulated suction lines) the resulting pressure difference can force liquid from the evaporator into the suction line with subsequent flooding on start-up. Even if the liquid refrigerant does not leave the evaporator, some liquid flooding from the warm evaporator immediately after defrost is almost impossible to avoid until such time as the system again stabilizes, and the liquid metering device regains control.

Defrosting Truck Eutectic Plates

One of the worst abuses frequently encountered is the practice of defrosting eutectic plates in truck applications with steam or hot water without pumping the system down. Plate circuits are almost always filled with liquid refrigerant because of the low temperature of the frozen eutectic solution, and the high temperature and consequent high pressure of the refrigerant in the plate resulting from the defrost drives the liquid refrigerant into the compressor crankcase, frequently with fatal results for the compressor on start-up.

Because of the large volume of refrigerant in the plates, an accumulator, if provided, is frequently flooded. Pumpdown prior to defrost is the only safe solution.

Air Switch Controls

Defrost controls actuated by air switches sensing either velocity or pressure may create oil return problems in systems not properly designed for this type of control. The air switch is actuated only when sufficient amount of frost has accumulated on the coil, and depending on the circumstances this may occur in a few hours or a few days.

On many low temperature systems, a portion of the oil in circulation gradually accumulates in the evaporator and suction line during operation. Refrigerant velocities often are not high enough to prevent some oil logging, but usually this is not a major problem since normally the oil lying in the evaporator will be returned during a defrost cycle because of the increased liquid refrigerant flow. If the defrost cycles occur at regular and frequent intervals, an adequate oil level can be maintained in the compressor despite some loss of oil between defrosts. But with the air switch control, defrost may occur infrequently, and the compressors may run completely out of oil before the next defrost cycle occurs.

The only positive cure for this type of problem is the proper design of the evaporator and suction piping to ensure gas velocities which will return 100% of the oil in circulation to the compressor. If this is not possible, an oil separator may greatly lengthen the safe operating period between defrosts.

WARNING: Before using a defrost control system which can result in long periods of time between defrost cycles, the system operation must be analyzed to make certain the system design will insure adequate oil return to the compressor. If oil trapping can occur, tripping of the oil pressure safety control or failure of compressors without such controls can be expected due to lack of lubrication.

Ultra-Low Temperature Applications

At ultra-low temperature conditions, -60°F. and below, it may be impossible to return oil without warming the evaporator. An oil separator must be used on ultra-low temperature applications in order to minimize the oil circulation. Since oil separator efficiencies are considerably less than 100%, in extremely critical applications, two or more oil separators can be used in series to increase the overall efficiency and prolong the periods of safe operation, but for continuous operation, regular defrost periods are usually a necessity.

On two-stage systems, since the suction gas returns directly to the low stage suction chamber, without passing through the motor chamber, liquid refrigerant control after defrost is even more critical. Suction accumulators are recommended on all two-stage systems for protection against liquid flooding.

Motor cooling on two-stage compressors is dependent on an adequate feed of liquid refrigerant from the desuperheating expansion valve. If a hot gas defrost system is used, it is imperative that a solid head of liquid is maintained at the desuperheating valve at all times. In general, an electric defrost system on two stage systems is much less complicated and therefore usually more dependable and is recommended on all field installed systems.

Revision Tracking R2

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.

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