Application Engineering

Low Ambient Compressor Operation

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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

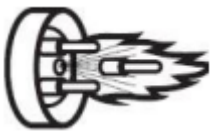
• OEMs are responsible for system design, selection of appropriate components, integration of this component into the system, and testing the system. OEMs must ensure that staff involved in these activities are competent and qualified.

• 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 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.

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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.**

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• 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.

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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.

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Introduction

Low Ambient Compressor Operation

Any refrigeration or air conditioning system utilizing an air-cooled condenser which must operate during spring, fall or winter months must be designed to properly control liquid refrigerant fed to the evaporator under widely varying ambient conditions. Since the flow characteristics of capillary tubes and expansion valves are proportional to the differential pressure across the capillary tube or valve, the problem is most critical under low outdoor ambient conditions when the condensing pressure can fall to very low levels without some means of control.

With a conventional restrictive device, excessively low condensing pressure will reduce the refrigerant flow rate to a point where evaporating pressures can fall to a dangerously low level, and can result in evaporator frosting, compressor short cycling, liquid refrigerant floodback and other malfunctions; all of which can lead to compressor failure.

In order to maintain satisfactory operation under low ambient conditions, a number of approaches are possible, each of which has both advantages and disadvantages. Normally some type of outdoor precautions must be taken if compressor operation is anticipated on air-cooled systems in ambients of 50° F or below.

1. Maintaining Constant Air Temperature to Condenser

   An approach that has proven to be highly satisfactory on supermarket installations and other applications where large numbers of compressors are involved is to locate the entire condensing unit inside a machine room. The temperature in the machine room then can be controlled within reasonable limits by means of a thermostat controlling automatic air inlet louvers and exhaust fans. In effect, the condensing unit sees a continuous stable operating environment.

   Obviously this involves space and expense, and is used only when sufficient units are involved to provide a continuous source of heat.

2. Reducing condenser Capacity by Flooding With Liquid Refrigerant

   A number of manufacturers offer valves to maintain head pressure by partially flooding the condenser with liquid refrigerant. Various combinations of valves may act to restrict or stop refrigerant flow through the condenser while at the same time bypassing discharge gas directly to the receiver as necessary to maintain a preset condensing pressure. Under normal ambient conditions, the bypass valve is closed and refrigerant flows freely through the condenser.

   Under operating conditions, the flooding type control provides good modulation and stable head pressure conditions. However systems of this type do require a considerable quantity of extra refrigerant in order to flood the condenser, possibly requiring an oversize receiver. If insufficient refrigerant is available to flood the condenser, the hot gas bypass valve may feed continuously, and this can create major problems with expansion valve control. If excessive refrigerant is added to the system, it may be impossible to pump the system down and isolate the refrigerant in the receiver and condenser.

   Due to the large refrigerant charge in the system a pumpdown control is highly advisable for proper compressor protection against liquid refrigerant migration and slugging on startup.

3. Reducing Condenser Capacity by Reducing Condenser Air Flow

   Another means of maintaining adequate condensing pressure which has the advantage of not flooding the condenser is provided by limiting the air flow over the condenser surface.

   This can be accomplished most simply and economically by cycling the condenser fan from a reverse acting high pressure control, but the resulting

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rapid fluctuation in head pressure can result in erratic liquid refrigerant control. Where variations in ambient temperature are not too severe, this may provide adequate control, but for larger systems and particularly where air temperatures entering the condenser of 0°F and below may be encountered, better modulation of control is required to prevent potential compressor problems.

Suction-cooled compressors operating with evaporating temperature below 0°F and air-cooled compressors at any evaporator temperature, require constant airflow across the compressor for adequate cooling. Fan cycling on these applications is not acceptable unless auxiliary cooling of the compressor is provided. Cylinder and head temperatures are most likely to be extreme at high compression ratios, and the probability is that reduced loads and increased compressor capacity are most likely to result in high compression ratios during low ambient conditions.

Where condensers with multiple fans are used, cycling of individual fans on a staggered basis gives more stable pressure control, but problems still exist if conditions are such that the last fan can cycle on and off.

Better modulation can be obtained by varying the fan motor speed, and this is now possible with available solid state controls and suitable motors.

However even if the condenser fan is completely stopped, the condenser must be protected from the wind to avoid loss of control on cold windy days, and a suitable shroud must be provided.

Another very effective means of reducing air flow over the condenser is by means of power operated shutters actuated by the refrigerant pressure.

Even though extra refrigerant is not required for systems utilizing fan control or shutters, pumpdown control is still highly recommended for any unit in which the compressor and suction line are exposed to cold ambient conditions, where the compressor must start and operate under such conditions.

4. Starting At Low Ambient Temperatures

At times, the temperature to which the condenser and receiver may be exposed is so low that there is insufficient pressure available to start the feed of liquid refrigerant to the evaporator on start up.

As a result the compressor may pull a deep vacuum on the system within a matter of seconds, and short cycle on the low pressure control. If the low pressure cut- out is set low enough to prevent short cycling, then the setting may be so low that it no longer provides adequate protection for the compressor, and cannot be used for pumpdown control.

It is possible to use a low pressure control with a time delay. This may provide sufficient time to build up head pressure so the unit can then operate normally, but if the same time delay is effective during pumpdown, this can allow the compressor to pull an undesirable deep vacuum prior to shutdown.

One proprietary system provides quick receiver pressure by diverting the compressor discharge gas directly to the receiver on start-up, bypassing the condenser until a preset pressure is obtained. This provides excellent start-up pressure under all weather conditions.

Another solution to the start-up problem is the use of a small electric heater band or element on an insulated receiver to maintain a temperature such that the saturated pressure will be adequate to insure refrigerant flow to the evaporator on start-up. The heater can be controlled by a thermostat, while backflow to the condenser can be prevented by a check valve.! **Warning!** Heated refrigerant in a trapped volume may produce very high pressures. A pressure relief valve must be used. This type of start-up control, in conjunction with a condensing pressure control, deserves more widespread consideration and usage than it has received.

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5. Operating With Low Head Pressure

   Some proprietary systems are utilizing expansion valves designed to operate at very low differential pressures in order to take advantage of the increased capacity and reduced power consumption resulting from compressor operation at low condensing pressures. Since a valve with less restriction will also be less sensitive in its control characteristics, additional system protective features such as suction accumulators and heat exchangers may be necessary to prevent excessively wet refrigerant vapor from reaching the compressor. A minimum of 15° F to 20° F superheat at the compressor is essential to insure proper lubrication.

6. Use Of Crankcase Heaters

   Crankcase heaters are strongly recommended on all refrigeration systems where the compressor is exposed to cold ambient temperatures, on all split air conditioning systems, and on package air conditioning equipment 5 H.P. and larger. As the refrigerant charge increases, the start-up problems associated with liquid refrigerant become more critical.

   The crankcase heater will minimize liquid migration to the crankcase during periods when the compressor is not operating. Another important function of the crankcase heater on outdoor units is to keep the compressor oil warm enough so it remains fluid. On rooftop units exposed to winter winds, the oil may become so viscous without a crankcase heater that the compressor cannot develop oil pressure.

   In summary, a number of different approaches for proper cold weather control may be acceptable if properly applied. Such factors as system size, type of application, severity of weather conditions to be expected and unit location must be taken into consideration. The design goal must be to maintain operating conditions under the most adverse weather conditions which will allow the compressor to operate safely.

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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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