Application Engineering

Design Considerations for High Ambient Conditions

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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

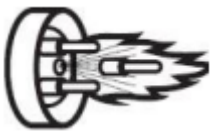
• OEMs are responsible for system design, selection of appropriate components, integration of this component into the system, and testing the system. OEMs must ensure that staff involved in these activities are competent and qualified.

• 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

Design Considerations for High Ambient Conditions

A compressor's ability to survive under adverse ambient conditions varies with both compressor and system design. The system designer must realize that a unit that might operate quite satisfactorily with a low failure rate under mild ambient conditions may be completely unsuitable for operation in an extreme environment, whether it might be in northern Canada or the Arabian desert. The heat pump failure fiasco in the United States in the late 1950's and early 1960's should serve as a chilling reminder of what can happen when a product is thrown into a marketplace without sufficient regard for its operating limitations.

With the increasing importance of the Mid-East and equatorial Africa in world air conditioning and refrigeration markets, any company exporting or designing air-cooled equipment for those areas should review their design standards to be sure they are adequate. In areas close to the equator, radiation from the sun's rays and reflection from a roof top or concrete can result in effective air temperatures entering an air-cooled condenser considerably in excess of the measured air temperature. Knowledgeable engineers with experience in the Mid-East feel that a unit to be safely applied without restriction in that area must be capable of continuous operation with entering air temperatures of 125°F.

Obviously the most critical area of unit design for high ambient is the condenser. The higher the condensing pressure for a given evaporator pressure, the higher the compression ratio and the more critical the discharge temperature. In general, for high ambient areas, Copeland would recommend an air to condensing temperature difference of 10°F for low temperature units, 15° to 20°F for medium temperature, and 20° to 25°F for high temperature. A direct air blast on the compressor will help in maintaining acceptable oil temperatures, and minimum superheat in the suction vapor entering the compressor is advisable. In critical applications it may be necessary to insulate the suction line.

Recent field investigation in the Middle East indicates two specific areas where system design may be improved to obtain better reliability.

Single phase motor failures appear to be closely related to starting difficulty under low voltage and high-pressure differentials. It is recommended that supplementary start devices be applied with all single-phase compressors. The solid-state PTC devices now on the market offer a reasonable increase in starting torque with no penalty in electrical reliability.

On through-the-wall window air conditioners, units with side air inlets are extremely vulnerable to thick walls and sloppy installations. It would be our recommendation that all through-the-wall units intended for the Mid-East market be designed with both air inlet and discharge on the face of the unit to achieve better air flow over the condenser.

Users should not be expected to be compressor experts, but certainly system designers should have the engineering expertise and sophistication to evaluate alternate compressor designs with regard to durability and reliability. There are fundamental differences in design between a welded as opposed to an accessible hermetic compressor, differences which are reflected in both cost and performance. From an operating standpoint, the most significant difference is the ability of the compressor to reject heat to the surrounding air. An accessible hermetic compressor has the motor in direct physical contact with the compressor body, so heat conductivity to the external surface is highly efficient. Of even more importance, the compressor head where gas is discharged from the cylinder at its highest temperature is directly exposed to the ambient air. In contrast, on a welded compressor both the motor and the compressor head are totally surrounded by refrigerant vapor, there is very little direct metal to metal conduction to the outside shell, and the greatest proportion of the heat rejected goes directly into the refrigerant vapor.

In high ambient areas where effective heat rejection is critical for compressor survival, conservative system design may be critical in the survival of any compressor, and certainly is far more critical with welded compressor design than with accessible-hermetic.

Users frequently ask for critical temperature limits in compressor application, with the optimistic hope that there

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is a magic black and white guideline that will insure satisfactory operation. As with most things in life there is no easy answer, since the time a compressor must operate at extreme stress conditions is of equal importance.

It might be helpful to visualize a compressor's life expectancy in terms of concentric circles, much like the life rings on a tree trunk. The center would be the most optimum operating conditions, normally the midpoint of the compressor's design operating range. The outermost circle would represent the limit of the compressor's operation, which might be determined by marginal temperature, voltage, motor loading, or lubrication. Assume the compressor's life expectancy at the center to be 25 years, and at the limits to be 25 days. Operation at those limits for many hours might not be harmful if the majority of the operating hours were well within the limits of easier operating conditions. But under continuous or long-term operating conditions, the compressor's life expectancy is going to be decreased as the operating limits are approached, and the design engineer who assumes the same life expectancy at the limits of compressor operation that might be expected in the center of the operating range is being unrealistic.

The most critical temperature conditions are probably not at maximum load, but at the higher compression ratios created by high condensing temperatures and low evaporating temperatures. For high ambient applications, operating tests should be run to evaluate the performance of the system at normal evaporating temperatures and high condensing temperatures.

Most refrigeration oils will start to break down or carbonize at temperatures of 350°F. The rate and degree of chemical reaction are undoubtedly related to the amount of oxygen and moisture in the system. Since the practical environment existing in an operating compressor of larger horsepower size is seldom contaminant free, field vulnerability may be much greater than in a carefully controlled laboratory experiment.

The hottest temperature exists at the discharge valve port, and normally the discharge line within 6 inches of the compressor outlet will be from 50°F to 75°F cooler than the discharge port. Therefore 275°F discharge line temperatures represent an extreme temperature condition, 250°F is usually considered a danger level, and 225°F and below is desirable for reasonable life expectancy.

There are two schools of thought in the industry on oil sump temperatures. The more conservative view is that oil temperatures of 200°F or higher result in greatly decreased viscosity and marginal lubrication. On welded compressors, oil temperatures up to 240°F are considered acceptable on some models. Obviously, the characteristics of the lubricant are critical, and bearings must be capable of withstanding the extreme temperatures. Lower temperatures are generally much more conducive to long life.

In the booming economy of the Mid-East in particular, where high ambient temperatures are a way of life, where technical expertise and service support are going to be stretched to the limit for years to come, reliability under adverse conditions may well become a far more important competitive factor than first cost. The cost of repetitive field failures could very well become prohibitive.

Obviously, the suitability of a unit design becomes a matter of engineering judgment, and good judgment may be vital to a successful product.

Revision Tracking R4

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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