

System Design Considerations for Frozen Beverages and Soft Serve

Introduction

A compressor's ability to survive under adverse ambient conditions varies with both compressor selection and system design. The application of Copeland Brand compressors into the frozen beverages and soft serve systems should have extra considerations taken as described in this document due to the high cycle rates, varying loads, and space restrictions.

Compressor Capacity

This application usually requires an oversized compressor capacity due to a requirement of fast pull down for the removal of the large latent heat load. Therefore, the compressors operational envelope should always be followed during the entire operating spectrum of the system.

Superheat Requirements

In order to assure that liquid refrigerant does not return to the compressor during the running cycle, attention must be given to maintaining proper superheat at the compressor suction inlet. Emerson recommends a minimum of 20°F (11°C) superheat, measured on the suction line 6 inches (152mm) from the suction valve, to prevent liquid refrigerant floodback.

Another method to determine if liquid refrigerant is returning to the compressor is to accurately measure the temperature difference between the compressor oil crankcase and the suction line. During continuous operation we recommend that this difference be a minimum of 50°F (27°C). This "crankcase differential temperature" requirement supersedes the minimum suction superheat requirement in the last paragraph. To measure oil temperature through the compressor shell, place a thermocouple on the bottom center (not the side) of the compressor shell and insulate from the ambient.

During rapid system changes, such as defrost or ice harvest cycles, this temperature difference may drop rapidly for a short period of time. When the crankcase temperature difference falls below the recommended 50°F (27°C), our recommendation is the duration should not exceed a maximum (continuous) time period of two minutes and should not go lower than a 25°F (14°C) difference.

Contact your Emerson Climate Technologies representative regarding any exceptions to the above requirements.

Evaporator

Due to long periods between defrosts; oil may become logged in the evaporator because of the lower refrigerant velocity therefore, a self draining evaporator is suggested to aid in oil return. The oil usually will return once the unit is defrosted which creates a higher mass flow of the refrigerant returning it to the compressor crankcase. By utilizing the self draining evaporator, the refrigerant will be aided in returning the oil back to the compressor.

Condenser

The condensers on these systems are usually limited to the packaging restrictions. Although this is most times acceptable, special interest must be given to ensure the ability for the airflow to reject the large amount of heat especially when the unit is placed in an air restricted area. Air over the compressor is also suggested to remove additional heat that may build up in the compressor shell.

Compressor Cycling

The largest stress on the compressor running gear is experienced during the compressor startup and shut down periods.

Reciprocating

In design, it must be noted that the inherent design of the spring suspension in reciprocating compressors has a finite life as with any spring suspension.

To reduce the stress on the compressor running gear, a balanced pressure shutdown and subsequent start-up is suggested. This is obtained by equalizing the pressures for a brief period before shutdown and at start-up.

The ideal suggested compressor cycle rate for reciprocating compressors is a maximum of 12 cycles per hour. This includes a recommended off time between cycles of 10 seconds minimum. The recommended minimum run time from startup to shutdown is 5 minutes. For designs outside of these parameters it is suggested to contact the Application Engineering department for review and approval.



Scroll

The ideal suggested compressor cycle rate for scroll compressors is 15-19 cycles per hour. This includes a recommended off time between cycles of 10 seconds minimum. The recommended minimum run time from startup to shut down is 3 minutes. The shutdown time provides protection against powered reverse for single phase scroll compressors. For designs outside of these parameters it is suggested to contact the Application Engineering department for review and approval.

Cycle rate in relation to oil logging

Cycle rate also contributes to oil logging in the evaporator. Each time the compressor starts; there is a quick reduction in the suction pressure and therefore the crankcase pressure. The pressure drop causes a reduction in the saturation temperature, resulting in the oil-refrigerant mixture flashing into foam and vapor with the frequent result that a large percentage of the crankcase oil is pumped out of the compressor.

If the compressor operates for sufficient time to stabilize the system, the oil will return to the compressor, but if the running period is very short, the oil may still be trapped in the system when the compressor cycles off. Under such conditions the compressor can operate without lubrication to the bearings, with the obvious potential for damage.

Starting Components

All of the capacitors should be Heavy Duty Type I. The starting capacitors should have a bleed resistor across them to extend the life of the relay. Increasing the starting capacitors voltage may also help to extend its operational life.

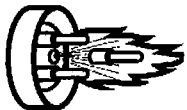
IMPORTANT SAFETY INFORMATION

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 www.Climate.Emerson.com/terminal 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 Climate.Emerson.com/flammable 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.

- Remove refrigerant from both the high and low side 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 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.
- 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