Application Engineering

System Design for Bulk Milk Tank Refrigeration

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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

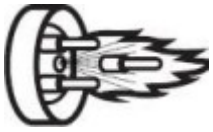
• OEMs are responsible for system design, selection of appropriate components, integration of this component into the system, and testing the system. OEMs must ensure that staff involved in these activities are competent and qualified.

• 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 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

The refrigeration of bulk tanks on dairy farms by its inherent nature is a severe application for a compressor. While the operating range is well within the capabilities of a compressor designed for high temperature applications, the location, installation, and year-round operation of the equipment may result in many potential operating hazards not present in a conventional commercial refrigeration application.

1. The load is extremely variable, from hot milk entering an empty tank to a full tank at 39°F. The result is a wide variation in liquid refrigerant requirements in the evaporator, and possible extreme loading on the compressor motor.

2. Rural areas may have inadequate electrical power supply, with resulting low voltage at the time of greatest need.
3. Operation is required throughout the year under both high and low ambient conditions, and the equipment is seldom if ever located in a temperature-controlled machine room.
4. Although most modern design bulk milk tanks have small refrigerant passages to increase refrigerant flow velocity, older tank designs frequently were the source of oil trapping problems.
5. Installation in or near a dairy barn involves exposure of the condenser to hay, straw, cat fur, and other abnormal dirt conditions.
6. Because of the nature of the equipment, the refrigeration systems usually require field installation and connection. Service personnel normally have little factory service support, and rather than being

   specialists in refrigeration, may spend the major portion of their time servicing other farm equipment.
7. Operating personnel are seldom familiar with refrigeration practice, and frequently throw disconnect switches, shutting off all power to the system between milkings.

Obviously with all of these potential sources of trouble, a compressor on a bulk milk tank can be exposed to a very severe and adverse operating conditions unless proper system design precautions are taken. Accessible hermetic compressors, because of their rugged construction, are undoubtedly better able to live through periods of operating abuse, but because of their lower first costs, welded hermetic motor compressors are being increasinglyapplied on bulk milk tanks. The following design recommendations should be considered on any directexpansion bulk milk installation; they are required on any direct expansion welded hermetic compressor application to insure satisfactory performance and life.

Compressor Electrical Characteristics

Due to the possibility of wide voltage variation during and after peak demand periods, the compressor motor must have an operating voltage range suitable to cover any expected voltage fluctuation.

Location of the Condensing Unit

An ample and unhampered air supply is required for satisfactory operation. The unit should be properly protected against rain and snow, and the air flow should not be obstructed.

Suction Accumulator

Because of the variation in load and operating conditions, liquid refrigerant flooding is a continuing hazard on bulk milk tanks. A generously sized suction accumulator with a means of positive oil return should be located in the compressor suction line. Frequent liquid flooding can adversely affect both lubrication and motor winding insulation.

Pressure Limiting Expansion Valve

To avoid freezing the milk, ample evaporator surface must be provided to ensure a low temperature differential between the milk and the evaporating refrigerant when approaching storage conditions. Due to the generous evaporator heat transfer capacity, the compressor motor can be dangerously overloaded when hot milk is initially introduced into the tank. A maximum operating pressure limiting expansion valve with a setting within the compressor's published operating limits is recommended to limit the motor loading under extreme conditions.

The superheat setting of the expansion valve, or the operation of an accumulator must be such that return gas entering the compressor has at least 15º F superheat.

Crankcase Heater

Since the compressor must operate winter and summer and is exposed to long periods of low ambient conditions, a continuously energized crankcase heater is recommended to keep the compressor crankcase free of migrating refrigerant, and to ensure good lubrication conditions on start up in cold weather.

Quick Disconnect Refrigerant Fittings

Since unit installation is normally done by local dealers who may have service and installing personnel of varying capability, and who may not have proper evacuation equipment, per charged systems with quick disconnect refrigerant connections are recommended to ensure a contaminant free system.

Pumpdown Control

Pumpdown control with a liquid line solenoid is recommended to keep the compressor free of liquid refrigerant during off cycles. Systems designed with a small refrigerant charge may provide adequate liquid protection.

Low Ambient Head Pressure Control

In areas where outdoor temperatures below 30º F. are likely to be encountered, some type of low ambient head pressure control is recommended to maintain good liquid refrigerant feed control. Normally fan cycling or fan speed control will be adequate.

Suction Line Filter

The brazing of stainless-steel evaporator plates frequently results in the formation of numerous small round steel particles or beads in the refrigerant passages. These tend to lodge in compressor valve reeds or other working parts of the compressor and are a frequent source of compressor failure. A suction line filter can provide excellent protection at moderate cost against such contaminants and is recommended.

Liquid Line Filter Drier

As in any field installed system, a liquid line filter drier is recommended to ensure a dry system, and to aid in keeping the system free from contaminants.

High and Low Pressure Controls

Both high- and low-pressure controls should be provided. The low-pressure control is an essential component for pumpdown control, and also provides some measure of protection against a loss of refrigerant charge.

Because of the possibility of the condenser becoming clogged with dirt, a manual reset high pressure control is essential for compressor protection. An automatic reset high pressure control can in itself become a potential threat to the compressor since it can create a short cycling condition in the event of excessively high condensing pressures.

Oil Separator

An oil separator is neither desirable nor recommended on any well-designed bulk milk tank with good refrigerant velocity through the refrigerant passages. However, should the tank design be such that refrigerant velocities are not adequate to return oil and if as a result excessive oil trapping in the evaporator occurs, an oil separator may be the only system design remedy possible.

While the above design precautions cannot absolutely ensure trouble free operation, they can protect the compressor against most of the common hazards to be expected in bulk milk tank operation.

Revision Tracking R3

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