Application Engineering Bulletin

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SYSTEM DESIGN FOR BULK MILK TANK REFRIGERATION

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 increasingly applied on bulk milk tanks. The following design recommendations should be considered on any direct expansion 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 insure 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 15° 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 30° 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.

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