HUSSMANN®

Pumped Liquid CO_2 Secondary Refrigeration in Low and Medium Temperature Display Cases

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GLOSSARY

Refrigerant
A fluid used to freeze or chill (a food) for preservation.

Primary Refrigerant
A fluid such as R404A used in a vapor compression system to cool a secondary coolant.

Secondary Coolant (Refrigerant)
A fluid such as Carbon Dioxide (CO_2) used to remove heat from cases and unit coolers and transfer the heat to the primary refrigerant through a heat exchanger. Secondary coolants used with these systems are for Low and Medium Temperature applications. Typically, the Low Temperature secondary coolant supply temperature is -20°F and the Medium Temperature secondary coolant supply temperature is 20°F.

Pump
This is a device that circulates the secondary fluid throughout the system.

Pressure Relief Valve
This device is to control or limit the pressure in the system which can build up due to power outage, instrument or equipment failure, or fire. The pressure is relieved by allowing the pressurized fluid to flow from an auxiliary passage. The relief valve is set to open at a predetermined pressure to protect pressure vessels and other equipment from being subjected to pressures which exceed their design limits.

Cascade Heat Exchanger
This is a device built for efficient heat transfer between the primary refrigerant and secondary refrigerant. Heat exchangers may be classified according to their flow arrangement such as parallel flow, counter flow, or counter current design. For efficiency heat exchangers are designed to maximize the surface area of the wall between the two fluids while minimizing the resistance to fluid flow through the exchanger.

Liquid \ Suction Heat Exchanger
This is a device built for efficient heat transfer between the liquid line and suction line of the primary refrigerant. This device also subcools the liquid refrigerant and aids in the complete evaporation of the suction gas.

Liquid \ Vapor Separator
This is a vessel designed to separate the vapor and liquid phases of the secondary refrigerant. Gravity causes the liquid to settle to the bottom of the vessel where it is withdrawn to enter the inlet of the pump.

Electronic Expansion Valve
This is a device built to control the amount of superheat at the outlet of the primary side evaporator. In this system the Cascade Heat Exchanger is the evaporator for the primary refrigerant.

Liquid Filter Drier
This is a device designed to filter impurities and absorb moisture from the refrigerant in the liquid line.

INSTALLATION

General

This manual is written as a basic guideline for the installation and operation of low and medium temperature display cases using pumped liquid Carbon Dioxide (CO_2) as a secondary refrigerant. The primary refrigerant (for example, R404A) can vary depending on the customer's requirements. For detailed information regarding a specific component or application, contact your Hussmann representative. This manual is provided in addition to the standard Installation and Operation manual supplied with the display case, to cover specific instructions and safety precautions that apply to pumped liquid CO_2. Please refer to the installation instructions provided with the CO_2 pumping station for details related to the pumping station and primary system, and to the display case installation and service manual for more details regarding installation and operation.

For optimum safety and performance, it is recommended that only Hussmann pumping stations be used as these have been tested and certified for use with pumped liquid CO_2 for Hussmann display cases.

All components must be installed according to manufacturer's specifications. All materials used must be compatible with the secondary coolant. Installation must comply with ANSI/ASME B31.5 *Refrigeration Piping and Heat Transfer Components*, ANSI/ASHRAE *Standard 15 Safety Standard for Refrigeration Systems,* and local building codes.

Inspect all components prior to installation to ensure that they are free from defects or foreign materials and to confirm that they comply with all pressure and temperature ratings.

PIPING GUIDELINES

Piping Materials

Any piping material that meets all pressure and temperature ratings, material compatibility requirements and state and local building codes may be used for pumped liquid CO_2 applications. The design pressure of the system is 600psi. These materials include:

1. ***Copper***
   a. Type K or L may be used with outside diameter no larger than $^7/_8$-inch.
   b. Copper to copper joints may be soft soldered or brazed so long as the braze/solder material contains no zinc or zinc chloride. Soft solder must be used where the component manufacturer's installation instructions recommend.
   c. Soft solder flux materials must contain no zinc and must also be water soluble.

2. ***Steel***
   a. Schedule 40 carbon steel pipe or stainless steel pipe (or tubing) is acceptable.
   b. Must protect exterior from corrosion.
   c. Additional system cleaning is required.

Use roll-stop couplings for straight line pipe joints. Swaging of pipe joints is not recommended. Swaging weakens the copper at the swage point, reducing the maximum operating pressure rating.

Insulation

Insulation should be used in secondary system piping to reduce the heat transfer to ambient air and to maintain subcooling in the CO_2 liquid supply line to the case. The insulation should be sized to allow for the worst case conditions of heating from showroom lighting and ambient temperatures. In order to minimize the required insulation thickness, install pipe in air conditioned space as much as possible. Do not size insulation for condensation prevention only. Pipe should be insulated according to local codes and customer specifications.

When installing piping that has not been pre-insulated, there are several options for insulation. Closed-cell elastomeric insulation is very popular in refrigeration applications. This type of insulation can also be used in secondary system applications. For detailed information regarding this type of insulation visit the Armaflex website at www.armaflex.com.

Other types of insulation that can be used are TRYMER and Styrofoam insulation. These are both made by Dow and are well suited for insulating pipe. For detailed information regarding this type of insulation, visit the Dow website at http://building.dow.com/styrofoam/na/dowpipe/library/index.htm. Always follow the manufacturer's recommendations for insulation thickness and proper installation.

The internal case piping is insulated to prevent frost from building up on these tubes. Sufficient insulation is required on piping into the display case to eliminate frost on tubes and to minimize temperature rise of CO_2.

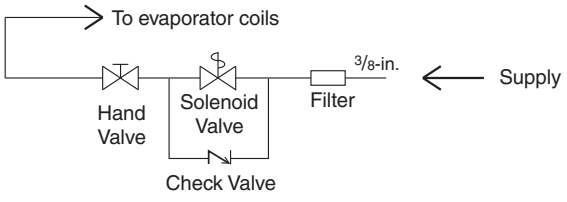
Check Valves

Check Valves are required wherever there is a possibility of trapping liquid CO_2 between valves that may be shut off, including solenoid valves, service valves, and balancing valves. Check valves must be installed to vent high pressure CO_2 back to the system. Hussmann recommends reverse return tubing instead of the use of shutoff valves for balancing purposes, but if shutoff valves are used they must be relieved to the system through check valves.

WARNING

Trapping of liquid CO_2 can result in extremely high pressures and must be avoided to prevent damage to equipment and personal injury.

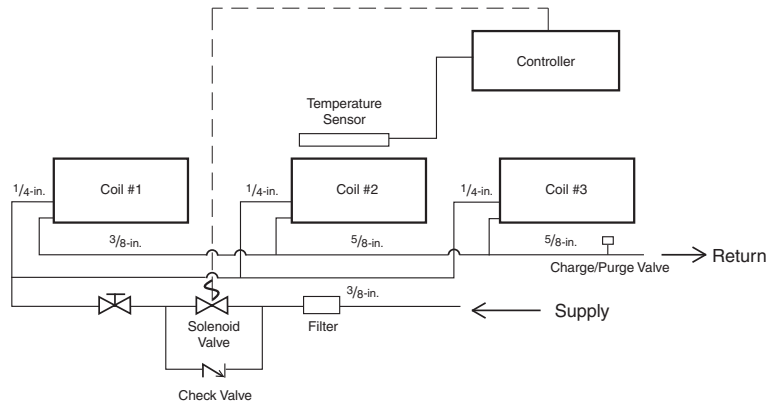
Following is an example of a piping layout if hand valves are used in line with solenoid valves.



Optional Hand Valve and Check Valve

Supply and Return Loop Piping

Hussmann display cases are designed to minimize the pressure drop through the case, with no more than 10 psi pressure drop through the typical display case. Refer to CO_2 application data for pressure drop for specific case models. Field installed piping and store layout must be designed so that the total pressure drop in the liquid supply line and wet return line does not exceed 15psi through the entire circuit.



CO_2 Merchandiser Piping Example

FIELD ELECTRICAL CONNECTIONS

Case Inlet Solenoid Valve

The 120V case inlet Solenoid valve is normally closed, and must receive a signal from the rack controller to provide temperature control. The solenoid valve must shut off (de-energize) during defrost and when case discharge air temperature is satisfied. For low temperature cases, a 5 minute time delay at defrost initiation allows liquid CO_2 to be pumped out of the coil and case tubing before defrost heaters are energized. This prevents extreme pressures caused by flashing of liquid into gas faster than system tubing can withstand. Settings are provided on the CO_2 application data sheets for each specific case model.

Differential of the controller must be set to 2°F or less to avoid large fluctuations in discharge air temperature. A swing of as much as 5°F total (+/- 2.5°F) will not affect product temperatures.

Liquid line solenoid lead wires are terminated in the raceway and marked with an identification tag.

ADDITIONAL SAFETY DEVICES AND PRECAUTIONS

Hussmann pumped liquid CO_2 cases are rated for a maximum design pressure of 600 psig. Pressure relief valves are shipped with the pumping station, and must be installed according to the manufacturer's instructions. Pressure relief valves are not provided with Hussmann's pumped liquid CO_2 display cases. For optimum safety and performance, it is recommended that only Hussmann pumping stations be used.

If the refrigeration system is de-energized, venting of the CO_2 through the pressure regulating relief valves on the refrigeration system can occur. In such cases, the system may need to be recharged with CO_2, but in any case, the pressure regulating relief valves(s) are not to be defeated or capped. The relief setting shall not be altered.

A sufficient number of pressure relief and pressure regulating relief valves may need to be provided based on the system capacity and located such that no stop valve is provided between the relief valves and the parts or section of the system being protected.

CO_2 Leak Detector: Leak detectors are required anywhere that CO_2 gas may leak or be vented, to provide an alarm if CO_2 is detected at an amount that exceeds the maximum allowable CO_2 concentration. **LEAK DETECTORS ARE NOT PROVIDED WITH THE CASE.** Consult local codes for exact requirements.

Startup and Shut Down: Provisions must be made for startup and shutdown to prevent excessive pressures. Consult the pumping station instructions and local codes for requirements.

A purge valve is provided at the case outlet. Case piping must be purged before shutting off case. Consult local codes.

It is imperitive that the case piping is clean and dry prior to chargin the system with CO_2.

CO_2 QUALITY

1. Use high grade CO_2 only (moisture<15ppm)
2. Moisture in CO_2 systems will create heavy corrosion inside steel piping caused by carbonic acid production.

OTHER INFORMATION

Cases are designed for 100% liquid CO_2 at the inlet and for 50% quality at the outlet.

Operation at other conditions may adversely affect performance.

SAFETY MUSTs

1. Use personal protection equipment (PPE) –gloves, safety glasses, long sleeves, etc.– and be aware of potential freezer burns from liquid CO_2.

2. Pressure Transducers / Leak Detectors / Warning Lights / Sounders / and Plant Room Ventilation must all be operational prior to charging with CO_2.

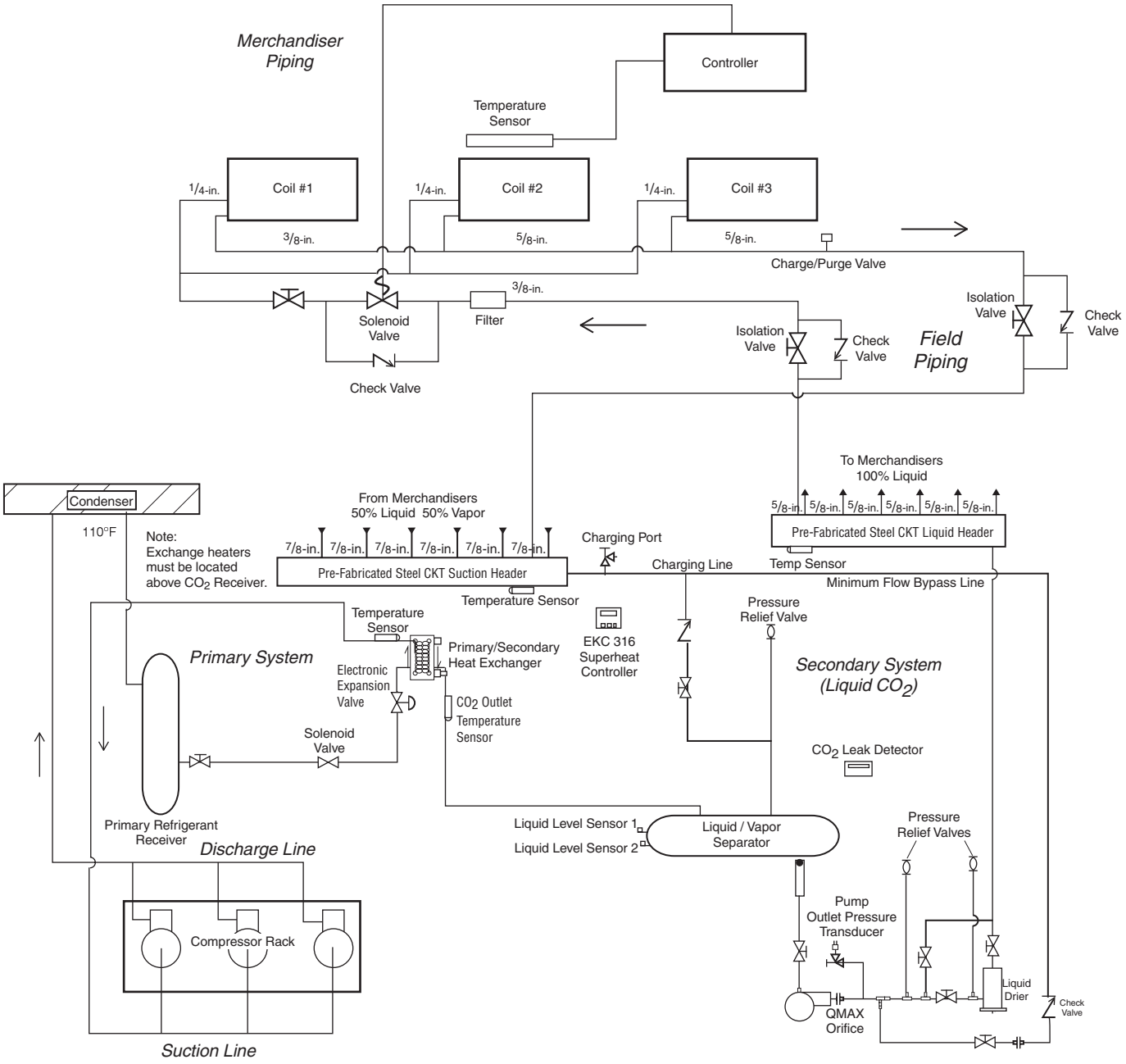
Notes:
2) Pressure Relief Devices or check valves must be located anywhere that liquid CO_2 can be trapped. Trapped CO_2 at –40°C will double in volume if allowed to rise to 30°C.

BASICS OF OPERATION

This section describes the general operation of the centralized CO_2 secondary coolant refrigeration system using carbon dioxide. The CO_2 secondary systems are designed to be used in conjunction with a centralized parallel compressor rack system.

The secondary system circulates liquid carbon dioxide through a case evaporator as it absorbs heat and partially expands. Temperature is regulated using a liquid solenoid valve that holds a relatively constant discharge air temperature. The returning carbon dioxide liquid vapor mixture is condensed to a liquid by the primary refrigerant supplied from the rack. The carbon dioxide is then pumped back through the case evaporator. Hussmann pumping systems are designed to supply CO_2 liquid at –20°F for low temperature and +20°F for medium temperature, although individual cases may operate at other temperatures for optimum efficiency and performance.

Note: Cases are designed for 100% liquid CO_2 at the inlet and for 50% quality at the outlet. Operation at other conditions may adversely affect performance.



Pumped Liquid CO_2 System Schematic