CO₂ / AMMONIA BRINE SYSTEM FOR DISTRIBUTION CENTER

CASE STUDIES
INTRODUCTION

CIMCO’s specialties were fully utilized when it was challenged by Canadawide to design an ammonia/CO₂ system for Canadawide’s growing distribution center. This case study looks at Canadawide’s expansion and its new state of the art refrigeration system, installed at its Montreal warehouse.

Canadawide is a national wholesaler of fruits and vegetables. The company history is as follows:

• 1961 - Green Grocery is founded by Greek immigrant John Pitsikoulis as a grocery store in Montreal, focusing on top quality produce to local clientele
• 1960’s - Green Grocery expands to several locations throughout Montreal
• 1979 – First 15,000 sq. ft. warehouse is opened
• 1983 – Name is changed to Canadawide to increase emphasis on the company as a distributor
• 1989 – Retail division is sold to focus on the wholesale division
• 2001 – Canadawide establishes its premises at the Marche Central. This location is refrigerated by R-22.
• 2011 - Canadawide undertakes an expansion of a brand new cold storage.

ORIGINAL SPECIFICATION

The original specification was based on a Freon/glycol system. The client’s objectives were to install a system with the following criteria:

• Lowest annual operating costs
• Lowest maintenance costs
• Increased efficiency/heat reclaim
• Employee comfort
• Maintain a timely construction schedule

The cold storage building has a total capacity of 984 kW with the following layout:

• 5,575 m² (60,009 sq. ft.) of refrigerated space
• 8 coolers from -4°C to 5°C (24.8 to 41°F)
• 17 door loading docks
• 8 banana rooms
• 3 process rooms with personnel
• Dry storage
• Fresh air for the process rooms

Although R-22/Glycol was initially preferred, other approaches, such as direct ammonia, Freon commercial, and ammonia/secondary fluid loop, were considered. However, despite its original preference, Canadawide found that an ammonia/CO₂ brine system would actually align best with their objectives. The contract was awarded to CIMCO in December 2011, with the intent to be operational by April 2012.

ABOUT THE SYSTEM

The designed system uses medium temperature ammonia as the primary refrigerant to cool a single loop of re-circulated CO₂ which feeds the various evaporators.

The mechanical room, located on the second floor, is 6 x 14m (19.7 x 45.9ft) and has a height restriction of 3.9m (12.7ft) under the beams.

To respect the provincial refrigeration code requirements, two 150 kW industrial screw compressors, with ammonia evaporation at -11°C (51.8°F) and ammonia condensation at 35°C (95°F) were selected. In order to increase efficiency, the screws utilize the economizer port to sub-cool the liquid. The heat is rejected via an evaporative cooled condenser located outside, slightly above the mechanical rooms. The condenser was selected with a low-height centrifugal motor, to accommodate the architectural constraints of a 3m (9.8ft) roof height. An internal water sump tank and pump is used because of the rigorous winter conditions in the area. To limit the refrigerant change, the system was designed with a critical charge of ammonia. A high side pressure float feed is used for the ammonia/CO₂ cascade cooler.

Considering the height limitations, a CIMCO shell and tube one-pass cascade cooler with an increased length was selected, in order to have the minimal diameter size. To keep the efficiency of the system as high as possible, the temperature difference is lower than the average 4.4°C (39.9°F), producing CO₂ at -6.6°C (20.1°F). The CO₂ pump receiver is located directly underneath the heat exchanger and low static head CO₂ pump is utilized. The CO₂ is pumped in the main distribution loop for the entire facility. The main CO₂ collector for liquid is 100mm (3.93 inches). The piping located in the mechanical room is all carbon steel, high pressure welding, while the CO₂ piping in the cold storage area is stainless steel.

Each refrigeration evaporator is equipped with modular valve assemblies. The higher temperature 7°C (44.6°F) rooms use ambient air defrost, while the lower temperature rooms are equipped with electric defrost. Since the entire system is fed via one loop of recirculated CO₂ at -6.6°C (20.1°F), special care had to be taken to minimize the dehydration of the higher temperature rooms with greater operating TD. Special modulating liquid solenoid valves were installed for those applications.

Additionally, the banana room has special requirements to insure quality of the product. Conscious about providing the customer with the best performance and most reliable system, CIMCO installed a plate and frame ammonia/glycol cooler to provide the cooling for the banana room evaporators. This special feature allows the system to operate at a higher temperature, respecting the temperature limit for ensuring the safe preservation of the product.

Safety:

One of the safety concerns associated with CO₂ is the high pressure throughout the system. CIMCO mitigated the safety risks by installing the following safety features:

• High pressure pipe burst: Installed relief valves at critical points for controlled release
• Ammonia system electrical failure: Installed a 3 kW R-404A condensing unit on the CO₂ re-circulator to keep the pressure at the design conditions of 40 bar.

Piping Costs:

CO₂ systems require a higher grade piping due to the higher pressures. Compared to traditional systems, the higher priced piping is offset by smaller diameter size, faster onsite installation, easier layout of the piping route, and less thermal insulation.

Performance:

The complete system has been operating for several months now, and CIMCO is pleased to report that the monthly energy consumption is lower than the original Freon design. More importantly, the room temperature is perfectly maintained, and the humidity level is within the expected levels. The owner had expressed his complete satisfaction, and is planning on using the same design for his phase two expansion.

During the start up procedure, Patrick Ianniciello, the Project Manager, made the following comments:

“In my entire career I have never seen room temperatures going down so fast, this system is operating like crazy, and I would recommend this system over any other I’ve seen.”

CIMCO is pleased to have been the design-build supplier and installer of this innovative and energy efficient ammonia/CO₂ system. This allowed the company to demonstrate that the CIMCO system is a viable alternative, when a direct ammonia system is not the desired option.