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2015

CARNOT REFRIGERATION CO_2 PROJECTS IN DATA CENTRES, COMMERCIAL AND INDUSTRIAL REFRIGERATION

— CASE STUDIES

CO_2 transcritical Aquilon is emerging for Bell Canada's server rooms

INTRODUCTION

In summer 2012, Bell Canada, a Canadian telecommunications company, asked Carnot Refrigeration to develop the very first CO_2 transcritical refrigeration system for server rooms. Bell Canada saw Carnot Refrigeration as a company capable of exceeding expectations with the installation of this one-of-a-kind system.

ABOUT THE SYSTEM

The project involved replacing an R22 refrigeration system with a CO_2 transcritical system with a cooling capacity of 105 kW. The R22 system had to remain in operation until the Aquilon system was fully installed. The work took place in an Ottawa server room owned by Bell Canada, and the entire turnkey project was orchestrated by Carnot Refrigeration. The end result is a new system that is greener, more energy efficient, 100% CO_2, cheaper to maintain and less likely to leak refrigerant.

The process began with the development of a prototype in Carnot's laboratory and involved in-depth construction in areas such as the mechanical design, the electrical boxes and the integrated control system. This development involved close collaboration between the engineering departments of Bell Canada and Carnot Refrigeration, and the construction was optimized for maintenance, so all parts and equipment are placed deliberately to allow for easy maintenance. Additionally, each part can be withdrawn from the front of the machine.

This process resulted in an Aquilon system of 105 kW that is equipped with

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ABOUT THE COMPANY

Carnot Refrigeration is a Canadian company headquartered in Quebec and established in 2008 with the goal of addressing the HVAC&R industry's failure to provide industrial and commercial clients with a thermodynamic option that would diminish environmental impact. Carnot Refrigeration makes a conscious effort to design refrigeration systems and heat pumps that cut down on the use of polluting refrigerants. It has taken the lead in its field by creating high-efficiency refrigeration systems designed by specialized engineers and manufactured in an environmentally controlled plant or at a constraint-free site. Carnot Refrigeration is experienced in meeting the needs of sports facilities (arenas), supermarkets, distribution centers and the agri-food industry.

two semi-hermetic reciprocal compressors, an integrated control system and stainless steel piping. The system is designed to withstand a pressure of 120 bar, which means it can be shut down and maintain its refrigerant charge without issue. In addition, the system integrates Rain Cycle technology, patented by Carnot Refrigeration, which allows for the continuation of refrigeration in the room without using the compressors, resulting in significant energy savings when outside conditions permit.

The installation of Aquilon was a turnkey project entirely managed by Carnot Refrigeration in terms of electricity, refrigeration, structure, ducting, commissioning as well as in obtaining permits and accreditations from the Canadian Technical Standards and Safety Authority (TSSA). When designing the system, everything has been thought of to minimize installation costs and time of installation on site.

RESULTS

After more than seven months of operation, from October 2014 through April 2015, the 105 kW Aquilon system has operated without its compressors using the Rain Cycle technology during 3,846 hours out of a possible 4,008 hours, more than 95% of the time. Until now, the total electricity consumption is 20,191 kWh, and the temperature of the server room is maintained at 25°C. Although Aquilon has not gone yet through its first summer, the first results are very promising and go beyond expected performances. Several other projects are already underway between Bell Canada and Carnot Refrigeration, clearly demonstrating that the first results have impressed Bell Canada.

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Transcritical CO_2 system as replacement to R22 at Alexis-Nihon Plaza

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INTRODUCTION

CO_2 transcritical refrigeration in supermarkets is not a new concept in North America. However, while the technology is reliable and proven it has yet to prove itself in particular circumstances. Sobeys had, in its projects, one of those challenges that would make CO_2 transcritical refrigeration more mature. In the heart of downtown Montreal, IGA Atwater supermarket is doing business within the Alexis-Nihon Plaza, corner of St. Catherine and Atwater. With its traditional refrigeration system becoming obsolete, measures had to be taken to replace it. Sobeys, for financial, ecological and efficiency reasons, has made CO_2 transcritical its default refrigeration solution, both for renovations and new constructions. The challenge in this case was to retrofit the refrigeration system in one of the busiest supermarkets in the province of Quebec without stopping operations. The challenge was at several levels, logistically and technically, and many departments at Carnot Refrigeration were tested: engineering, project management and production.

ABOUT THE SYSTEM

The project consisted of replacing the two old R22 systems with a CO_2 transcritical system with a capacity of 400 kW. As store operations needed to continue during the project, it was necessary to transfer the R22 load of the system to the CO_2 system gradually and progressively. Carnot Refrigeration and its subcontractors orchestrated the complete refrigeration part of the project. The new system is more environmentally friendly and energy efficient, and using

CO_2 as a refrigerant, is less costly in terms of maintenance and less likely to leak refrigerant, while also providing a high level of reliability.

The system designed for the Atwater supermarket was divided into three equipment parts: the transcritical part, the subcritical part and a gas cooler. The transcritical part consists of eight semi-hermetic reciprocal compressors and integrated control. The subcritical part consists of two tanks and three semi-hermetic reciprocal compressors and integrated control. The gas cooler has eight very quiet fans, producing barely 48 DBA at 10 meters, which meets the strict criteria of the City of Westmount. The system incorporates two direct heat recovery circuits and a heat recovery system for domestic hot water.

One of the biggest challenges of this project was in the logistics of the installation and start-up of the system. In order to bring the system up to the mechanical room, it had to be brought through the Alexis Nihon Plaza. Since the floor of this facility was not strong enough, the system had to be delivered without its compressors, which were installed on-site by plant technicians from Carnot Refrigeration.

The elements composing the refrigeration system are located on three different levels. The gas cooler is four levels above compressors racks, and the cold rooms are two floors below compressors racks. The Carnot engineering team had to think long to ensure that such a layout would not cause problems to the system, both in terms of refrigerant circulation and oil management. In addition, there is only one door separating the grocery-shopping customers and the refrigeration system, which required that the system be as quiet as possible to avoid disturbing the customers.

RESULTS

The site of Alexis Nihon Plaza has been operating for nearly a year. Preliminary numbers show that, conservatively, this type of equipment could bring savings of around 10% per year in electricity usage alone. Maintaining the counter temperatures is done in a very accurate way. Defrosts are very effective and allow products to last longer, especially during accelerated passive defrost. Heat recovery from the compressors is used to heat the store, further reducing costs. In addition to eliminating HCFCs, a natural refrigerant system brings concrete monetary savings and refrigeration efficiency. There is no reason not to switch to natural refrigerant because it is possible to change a system, regardless of its configuration, situation or location.

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Carnot Refrigeration at the heart of arenas

INTRODUCTION

The world of refrigeration is currently undergoing major changes. Refrigerants that have a detrimental impact on global warming and the ozone are being replaced with natural refrigerants, and the systems replaced with more energy-efficient ones. Carnot Refrigeration, a pioneer in natural refrigerant refrigeration technology, has developed a CO_2 transcritical energy-efficient system designed for arenas. While many arenas choose to go to ammonia, this highly efficient refrigerant is not the best solution for all projects. Therefore, more are choosing to use CO_2 transcritical refrigeration. The advantages of this option are numerous, including the possibility of direct heat recovery, maintenance simplicity, water tower not required, and so on. For these reasons, the City of Longueuil has chosen Carnot Refrigeration to provide a CO_2 transcritical system to upgrade its Cynthia-Coull arena.

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ABOUT THE SYSTEM

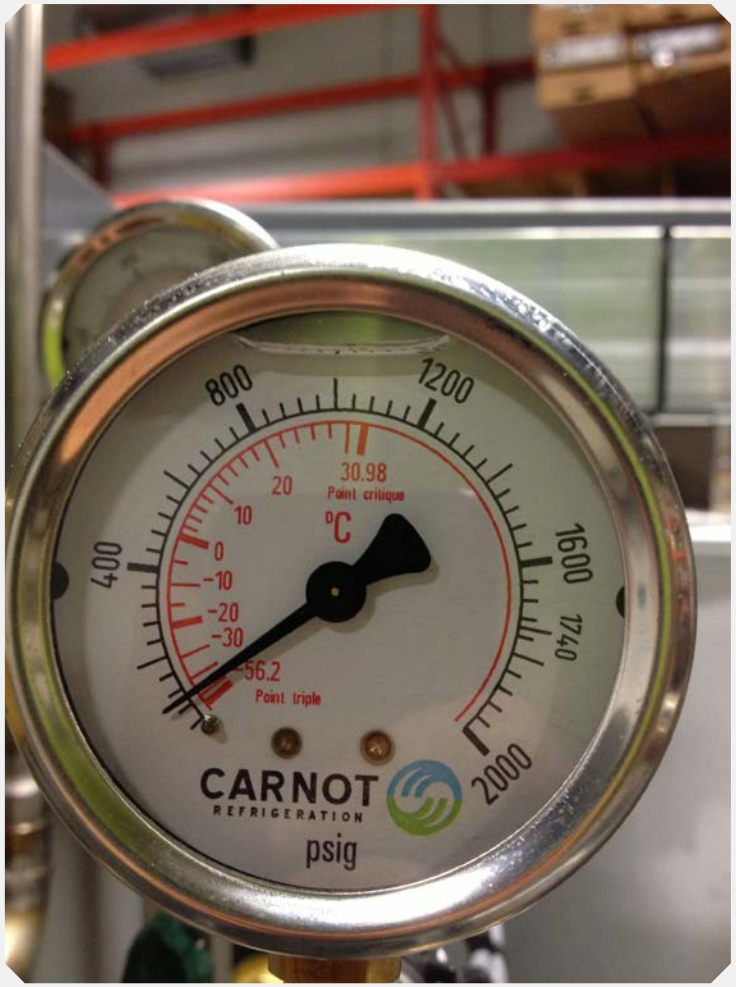
The Cynthia-Coull arena wanted to upgrade its R22 refrigeration system, which had an impact on the ozone layer and global warming, with a CO_2 transcritical system with a 281 kW capacity. The piping of the brine slab was still in good condition, so it was not replaced. The arena has only one ice rink, which operates nine months per year, so work had to be done during the three-month shutdown. Several heat reclaims were included in the project: five heat reclaims for direct recovery, a CO_2/water exchanger to preheat domestic water, and a CO_2/glycol exchanger for a snow pit. One of the direct heat recovery reclaims was used to regenerate the desiccant wheel of the dehumidification station.

Carnot Refrigeration designed an ideal chiller for this type of project: a very compact rack of 4.9m by 1.7m, with a height of 1.9m. This system incorporates seven compressors, a pump for brine, a CO_2/brine exchanger, electrical panels and all the tanks and piping required for proper operation.

The installation is very simple as it consists of connecting six pipes: two for the brine, two for the CO_2 that goes and returns to the gas cooler (condenser), and the two circuits for the relief valves. In the case of Cynthia-Coull arena, ten more connecting pipes are required for the five heat reclaims. A gas cooler (condenser) was also installed to the roof, and no water tower is necessary. The piping of the system is made entirely out of steel; it can contain a pressure of 79 bar on the low-pressure side and 120 bar on the high-pressure side. During prolonged shut-downs of the system, it can keep its refrigerant charge without any other system to reduce the pressure. This feature was essential for the project, as the rink is closed for three months per year. The installation of the system was done in the allotted time, the construction of the rink was made on time, and the citizens of Longueuil were able to enjoy their ice rink as if nothing had happened.

RESULTS

Following the start-up and adjustments of the system, the manager of the arena said he had never had such high quality of ice because the ice had never been so cold and that arena had never been so warm. The temperature of the ice is stably maintained at -8°C. and the room temperature is 14°C. Energy consumption of the building was compared for the months of February and March, revealing a decrease in electrical consumption of around 23%, which represents 91,370 kWh for this specific arena, resulting in yearly savings of several thousand dollars.



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CO_2 transcritical system at Les Atokas Bieler's refrigeration warehouse

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INTRODUCTION

In light of the major changes the refrigeration industry has undergone in recent years, many businesses working within the field of refrigeration are forced to review their approach to refrigeration. Les Atokas Bieler, in collaboration with Carnot Refrigeration, opted for a CO_2 transcritical technology to cool its cranberries at its new refrigeration warehouse located in Saint-Louis-de-Blandford. Carnot Refrigeration, a well-established manufacturer in the field of refrigeration systems utilizing natural refrigerants, was asked to install the system, and the company managed the complete process from design to manufacturing of the system, including the installation.

ABOUT THE SYSTEM

The cranberries come directly from a flooded field to the cleaning room, and from there, go directly to the warehouse without passing through a freezing tunnel. In addition, berries enter the warehouse only once a year from late September to late October. This type of operation poses a particular challenge for system designers who must anticipate a large charge that occurs only once a year. The rest of the year, the system is used to maintain temperatures. Another particularity of this project is that the berries are very humid, which requires special evaporators and a high-performance defrosting system.

The system installed in the new berry warehouse has a capacity of 690 kW. The system is divided into three parts: the medium temperature part that includes nine semi-hermetic reciprocal compressors and two tanks; the low temperature

part that includes ten semi-hermetic reciprocal compressors and two tanks; and two gas coolers including twelve fans. They system can contain 80 bar on the low pressure side and 120 bar on the high pressure side, allowing it to maintain its CO_2 refrigerant charge even if it is completely stopped.

All piping is stainless steel welded with an orbital welder. Twelve evaporators were necessary for the project, in which each coil is stainless steel designed for pressures up to 80 bar and able to handle a large quantity of water. Waste heat recovered from the system is used for hot gas defrost and sub-slab heating. For the sub-slab heating, a CO_2/glycol exchanger is installed on the system.

Carnot managed the complete installation of the refrigeration equipment for the project, from unloading equipment to welding the evaporators, and through to the positioning of the refrigeration racks. It was also required to obtain all permits and accreditations for compliance of the installation and equipment.

RESULTS

Following the start-up of the project, Carnot continues to monitor the effectiveness of its sites and to refine its remote settings. This service is highly appreciated by many customers, starting with the client who can control the temperature of its room with a simple phone call. The technician in charge of maintaining the system can also obtain important information via this service. Carnot Refrigeration has also had the chance to collect a lot of information that will be helpful for future designs.

PERFORMANCE

Although start-up of the system is recent, system performance is such that the client has acquired a second Carnot system for the expansion of its warehouse. It is certain that the effectiveness of hot gas defrost, combined with savings generated by heat recovery especially for sub-slab heating, and the quality of the installation were definitely great advantages. In addition, our customer found that he had never had such a good quality of frozen cranberries.

The implementation of the transcritical system in St-Louis-de-Blandford was a great success. Building operators are very happy and satisfied to work with this equipment. In addition to having to make a second-phase expansion of this same warehouse, we are hearing from other cranberry growers interested in acquiring such a system. We are currently experiencing the beginning of 100% transcritical refrigeration in refrigerated warehouses.

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Get in touch with shecco's Market Development team to learn more about the market for natural refrigerants in North America or find out how we can help you in gathering market intelligence and proactively building your business with our tailored market development services, to get your technology faster to market.

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