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TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS

Low-GWP Alternatives in Commercial Refrigeration: Propane, CO_2 and HFO Case Studies

CASE STUDY

Sobeys Commercial Refrigeration

Name of the Store/facility:
Sobeys, IGA Cookshire

Location:
35 rue Principale Est, Cookshire, Québec J0B1M0, Canada

Contact information:
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Type of Facility:
Supermarket, Store Area = 1,950 m^2, Grocery and Food Retailer, Store has LEED certification.

Refrigerant Used:
CO_2, transcritical refrigerant systems

Project Background:
Sobeys owns or franchises more than 1,300 stores all across Canada under different retail banners. In the province of Quebec, Sobeys operates under the IGA brand. In February 2010, the new IGA Cookshire store opened. The new supermarket is a state-of-the-art one, having been built to LEED (Leadership in Energy and Environmental Design) specification with environmental considerations throughout the building. Fig. 1 shows a photo of the Sobeys store. Amongst the environmental features of this 1,950 m^2 supermarket are improved air quality, such as low VOC (Volatile Organic Compound) finishes and natural ventilation. Moreover, the transcritical CO_2 refrigeration system reduced a large amount of greenhouse gas emissions relative to traditional systems used in other Sobeys stores.

The Carnot Refrigeration Company was retained by Sobeys in order to develop an alternative to the conventional refrigeration systems available on the market, which were less efficient, and incurred high maintenance costs. The goal was to provide a sustainable and reliable solution that would have lower initial (equipment and installation) and operating (energy, maintenance, gas replacement, insurance) costs. After many internal discussions, the management concluded that there were substantial benefits to eliminating HCFCs completely and focusing on a full transcritical CO_2 refrigeration system. Furthermore, in 2010, Sobeys endorsed the Consumer Goods Forum's natural refrigeration initiative (http://www.theconsumergoodsforum.com/sustainability.aspx), which encourages members to phase out HFC refrigerants in all new builds from 2015.

Fig. 1 Photo of the Sobeys, IGA Cookshirein Quebec, Canada

Sobeys' Quebec division piloted the approach to natural refrigerant systems. It had already installed low GWP transcritical CO_2 systems when in 2009 a national initiative was undertaken to review alternatives to traditional HCFC refrigerant systems, with a particular focus on various CO_2 systems. Several CO_2 options were considered, including the following:

- Secondary Loop Medium Temp (MT) Glycol and Low Temp (LT) CO_2 liquid
- Secondary Loop MT Glycol and LT Cascade CO_2
- Secondary Loop MT CO_2 liquid and LT CO_2
- Secondary Loop MT CO_2 liquid and LT Cascade CO_2
- Transcritical CO_2 DX.

"Sobeys' transcritical refrigeration system design is the solution for our climate here. It is meeting our entire vision." — **Simon Bérubé**, *senior director of engineering and commercial development, Sobeys Quebec.*

New System/Installation:

The transcritical CO_2 refrigerant system, which has become the new national standard for refrigerant systems at Sobeys, is a low GWP (Global Warming Potential) transcritical CO_2 system. It will be included in all new builds and will be considered for retrofits where feasible based on the store size and scope of the retrofit. Within these systems CO_2 levels are monitored for leakage; however, because CO_2 is a natural gas, these systems do not pose the same risk to the environment (due to leakage) as traditional HFC systems.

The average Sobeys supermarket refrigeration system contains 1,130-1,360 kg of HCFC refrigerant R-22. HCFC refrigerants have an ODP above zero and also significant GWPs of 1,810-4,657 and are therefore responsible for a significant portion of a typical supermarket's direct carbon footprint due to leakages. The common HFC replacement option for R-22 is R-507 or R-404A. Refrigerant R-507 has a GWP of 3,985, where a 1 kg leak of R-507 is equivalent to 3,985 kg of CO_2 emissions. Average rates of leakage of these refrigerants are between 10% and 30% per store each year, and almost 30% of Sobeys' stores' aggregate carbon footprint.

The transcritical CO_2 refrigerant system shown in Fig. 2 uses only CO_2, which has a GWP defined to be 1, as compared to the higher GWP of R-507. The CO_2 systems are energy efficient in comparison with traditional refrigeration systems, and especially with the combination of heat reclaim introduced with them, provide a net reduction in store energy consumption. The intensive reclaiming of waste heat from the refrigeration units can be used to cover almost all the heating needs of the supermarket. A pre-heating water loop is also installed in the supermarket to preheat hot water used within the store.

Fig. 3 is a schematic diagram and process explanation of the Carnot Refrigeration Transcritical CO_2 system used at Sobeys.

Fig. 2 Photos of the transcritical CO_2 system at Sobeys designed by Carnot Refrigeration.

Challenges

One of the initial challenges and concerns when installing these systems was that of contractor training and timely access to new components. It was unclear if contractors would be familiar enough to service and work with these systems. This was a particular concern as Sobeys considered scaling up and extending new builds into stores far from the Quebec location of the CO_2 system manufacturer where direct support from the system manufacturer would be much less readily available than during the Quebec pilot phase. However contractors were found to be increasingly embracing this technology and investing in servicing and installation training as these systems become more common. Another challenge was building the company's plan for the transition to transcritical CO_2 because of the differences in geographical and infrastructural constraints between stores. Furthermore, there are also financial challenges. At this stage, as early adopters, the Sobeys systems are still fairly expensive in capital cost terms compared to future projections, thus the return on investment (ROI) is dependent on the size and nature of the store, whether heat reclaim is already in place, and sometimes whether

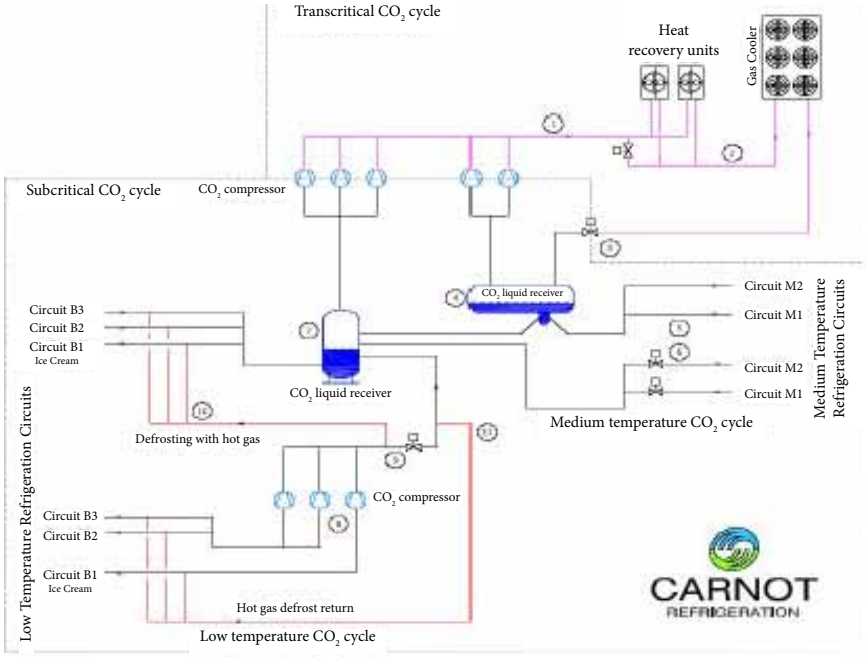

Fig. 3 Diagram explanation of the Carnot Refrigeration Transcritical CO_2 system

government incentives exist. These systems at Sobeys have a 3-4 year average return on investment. However, as mentioned above, the company expects costs to decrease and installation and infrastructural support to become easier as these systems become more prevalent and efficient. This presents the opportunity to reduce the cost curve.

Emerging out of these challenges and the commitment to this system, many lessons have been learned. For example, in order for the company's contractors and suppliers to provide the services needed for a new system, they need to be engaged early in the overall process from designing the system through the procurement and installation stages. They need to also understand the advantage of such a system in order for them to develop expertise on these new refrigeration systems, as it does require investment in training and adds complexity to their businesses. It is also important to look ahead, when conducting a business case study on return on investment (ROI), because what may not be feasible today may very well be feasible in the near future as regulations and industry initiatives drive adoption of these systems. Cost forecasts for refrigerant re-charges and energy savings are important considerations in such cases.

Performance:

Sobeys has made a commitment to alternative CO_2 refrigeration technology and is very pleased with the results. The installation of these transcritical CO_2 refrigerant systems with heat reclamation has not only made financial sense, but clearly makes environmental sense and is in line with Sobeys' commitment to reducing its CO_2 footprint and impact. The approach taken to come up with performance indicators was applied equally to all stores of identical nature. Therefore, the results will be reported per store. The following are the calculated reductions in comparison to a traditional HCFC refrigerant system:

- Carbon dioxide emissions reduced by 62% = 861,920 kg CO_2-equivalent per year, per store
- Energy consumption reduced per year by 15% -18%
- Natural gas (heating) consumption reduced per year by 75% - 85%