Low-GWP Alternatives in Commercial Refrigeration: Propane, CO$_2$ and HFO Case Studies
Application of Climate-Friendly Commercial Refrigeration Technologies: H-E-B

Name of the Store/facility:
H-E-B at Mueller

Location:
Austin, Texas, United States

Contact information:
Charlie Wernette, wernette.charlie@heb.com

Type of Facility:
Supermarket, Store Area = 7,711 m²

Refrigerant Used:
Propane Self-Contained Cases

Project Background:
H-E-B has been incorporating sustainability measures into their stores for the past 15 years. As part of their environmental strategy for the H-E-B at Mueller sustainable design test store, H-E-B set a goal to reduce energy and potable water consumption by 50% relative to their 2010 baseline. In addition, H-E-B decided to trial the use of climate-friendly refrigerants.

Prior to the opening of their Mueller store, H-E-B had never used a non-fluorinated refrigerant. With the company’s stores located in Texas (United States), and Mexico, H-E-B made a decision not to use a carbon dioxide (CO₂)-based technology, which operates at much higher pressures and therefore is not ideal for use in warmer climates. Inspired by Waitrose—a U.K.-based supermarket chain that began using propane-based refrigeration systems in their stores in 2009—H-E-B approached several equipment manufacturers in the United States about the possibility of implementing a similar type of refrigeration system in their stores. H-E-B ultimately decided to work with Hussmann, and in 2011, the effort to develop self-contained propane units was officially underway. Fig. 1 shows a photo of the store.

New System/Installation:
In total, the H-E-B at Mueller store contains 70 refrigerated cases that have a total cooling capacity of 1,013 MBTUs¹. The majority of these cases are self-contained units that use propane (R-290) as the refrigerant. Each condensing unit contains a refrigerant charge size of no more than 150 g, as required by U.S. regulations, adding up to a total of 66.2 kg of propane within the store. The compressors, which pipe the refrigerant directly to the evaporator, are contained within each unit. The vast majority of the propane-refrigerated cases in the store have a door or sliding lid, which minimises energy consumption and allows the refrigerant charge to remain small.

In addition to the propane units, a small number of cases are cooled using a distributed direct expansion refrigeration system. This system, which uses R-404A as the refrigerant, is used to cool select produce cases that are not equipped with a door. These produce cases contain products that are kept wet with an automatic misting system, and therefore cannot be easily equipped with a door. Without a door, it would not have been feasible to keep the refrigerant charge of propane below 150 g; thus, H-E-B reverted to a more traditional refrigeration system to cool these cases.

All of the cases in the store are connected to a water-chilled condenser, which is used to remove heat from the refrigerant after it has removed heat from the refrigerated space. The water-chilled system, which is also used for space cooling and heating, contains 544.3 kg of HFC-134a. It is estimated that roughly 26% of the HFC-134a is used for refrigeration while the rest is used for cooling and heating.

¹ Million British Thermal Units
Fig. 1  H-E-B at Mueller, Austin, Texas, United States. Photo courtesy of H-E-B by photographer Ray Briggs.

Fig. 2  Deli Meat Cases  
Photo courtesy of H-E-B by photographer Ray Briggs.
Performance:
Although the store has only been operational for a few months, the refrigeration system so far is operating as expected. While performance data was not available at the time that this case study was developed, it is projected that the carbon footprint of the store will be reduced by 85% relative to a baseline store. Of the 85% reduction, 58% is attributable to reduced energy use while the remaining 27% is attributable to the direct emissions avoided by using propane as the refrigerant.

From a financial perspective, the store cost more upfront but is expected to save money over time. While capital costs were relatively high, the simple, self-contained design eliminated the need to pay a refrigeration contractor to install the system. Due to the simple design, maintenance costs are also expected to be relatively low. Furthermore, cost savings will be realised through a reduced energy bill. H-E-B anticipates a payback on its investment in energy reduction and advanced refrigeration technology design features.

Challenges and Lessons Learned:
H-E-B has identified a variety of benefits associated with its refrigeration system. First, using propane instead of a traditional HFC refrigerant offers enormous environmental benefits. Propane has a global warming potential (GWP) of three, which is significantly lower than the GWP of traditionally used HFC refrigerants, which can be over 3,000. In addition, the simple ‘plug-in’ design, similar to a home refrigerator, is a major benefit. The simple design allowed H-E-B to plug in the self-contained units and hook them up to the water-cooled condenser rather than having to purchase the display cases and refrigeration racks separately and hire a contractor to install the piping network, connect the system, and charge it with refrigerant and oil.

While H-E-B is very happy with the outcome of the store design, it did not come without some challenges. First, the United States Environmental Protection Agency restriction on charge size of 150 g of propane per unit required H-E-B, with the help of Hussmann, to develop a unique system design to accommodate the refrigerant. To compensate for the limited refrigerant charge, the resulting design uses significantly more compressors than a traditional system, which drives up costs. In addition, it was a challenge to overcome the stigma associated with using a flammable refrigerant. The store was required to install extra leak detection and alarm systems prior to receiving approval from the Austin Fire Department to operate.

Even with the challenges that H-E-B faced, they believe that the benefits of this store outweigh the costs; plans are underway to install the novel technology in other H-E-B stores.

Disclaimer
The information presented here is provided by H-E-B. The accuracy of the content and figures is the responsibility of the company and these have not been verified by the CCAC or UNEP.