

Case

Verdemar - The first supermarket in Latin America that uses CO₂ as a refrigerant



Front view of Verdemar supermarket: The first Latin American supermarket to use CO₂

An innovative project from Plotter & Racks, with the support of BITZER Brazil, guarantees the effective refrigeration of Verdemar supermarket with the use of the Carbon Dioxide - R744 (CO₂)

Sustainably: The mark of a new store.

Last April, the Verdemar supermarket chain inaugurated its fifth store in the suburb of Jardim Canada, Nova Lima - Minas Gerais, Brazil. This new store has been designed and constructed with consideration to the basic principles of economic-sustainability. Not only has the building been well planned, it's supermarket operation focuses on environmental and social awareness as well. Verdemar has literally created an environmentally friendly business, with the view of setting the benchmark of a modern-day business that contributes to the preservation of the environment.

Looking to the future, proprietors, Alexandre Poni and Hallison Moreira, plan to progressively take on the 'green' method. "The path to sustainability is something that we intend to follow in the company as a whole. When we talk about this, it is not just ecological issues that have to be taken into account, but economic and social issues as well", adds Alexandre, who envisions a 'greener' future. "This is the essence behind the creation of a Verdemar foundation."

In this report, we will present some of the sustainability features Verdemar has implemented.

Refrigeration System. It is the first Latin American supermarket that uses Carbon Dioxide (CO₂) as a refrigerant, as opposed to the current synthetic refrigerants HCFC/HFC, such as R22 and R404A. The result is a complete reduction of environmentally unfriendly emissions, since CO₂ does not deplete the Ozone Layer and it also has a global warming potential about 3.26 thousand times less than R404A.

Water savings. This store has a system of rain water tanks as well as a Water Treatment Station (WTS), in which the goal is to treat and recycle 80% of the liquid waste generated by the store. This treated water is then used to clean external and some internal areas, for the maintenance of gardens and for selected use in the bathrooms as well. The bathrooms have discharge valves with a drive for liquid residue and another one for solids, which also saves water.

Floor with heating system. As Jardim Canada is a cold region, the new store offers an extra comfort to the customers: a heated floor. This comes in the form of 1800 m² of radiating floor, under which piping for hot water circulation has been installed. The hot water is generated by the heat exchanger of the refrigeration system. The result is effective heating to warm staff and customers without an added energy cost.

Innovative floor. Parking areas and walkways of the new store also have the mark of ambient preservation: a resistant and ecological floor. The Pavieco floor is made from sedimentary rocks (formed by sediment left by water) which are collected at dam inlets from the region of Macacos (São Sebastião de Águas Clara's region).

Reusable shopping bags. Verdemar uses waterproof, ecological bags which are 100% recyclable. The bags also have advantages for customers who choose to use them. A 0.5% discount off the total value of any purchases over R\$20.00 is offered. This reduces the use of plastic bags, as well as inadvertently highlighting the importance of controlling this type of product as waste.

Recycling. Like other supermarket stores from Verdemar, the Jardim Canada store has a section for used oil collection and other recyclable residues and materials, such as batteries, aluminum cans, packaging, tetra pak, paper, cardboard, glass and metal. This store also has a section for hardware collection included.

Painting from iron ore. Another application of reprocessed mineral resources was demonstrated in the painting of the store. The external areas were painted with an ink type in which its base is made of reprocessed iron ore.

Biodiesel plant. A biodiesel production plant will be installed in this new Verdemar store. This plant is fuelled with used cooking oil from the store, and customers are encouraged to bring in their used oil as well. The idea is to prevent the disposal of used kitchen oil in nature, as well as building social awareness. The biodiesel produced will be used as a fuel and also an income source for social projects as well.

Reduction of electric energy. LED light bulbs that consume less energy are being used and other than being quite energy efficient, they also prevent food oxidation. It is forecasted that it will slash an approximate 25% off the consumption of energy in relation to the other Verdemar stores.



The frozen products section of the new store: Low temperature islands with CO₂

Excellency in technology

Plotter & Racks has installed its new refrigeration system which uses CO₂ as a refrigerant, in the Verdemar supermarket situated in Nova Lima / Minas Gerais, Brazil. It is a patented system, which is ultra-efficient, and greatly reduces the emission of greenhouse gases into the environment. This system is based on a patented technological platform called SKYRACK BREEZE. Plotter & Racks is a Brazilian company that also acts in the development and commercialization of refrigeration systems for the supermarket and industrial sector. Over many years, the company has occupied a prominent position in the Brazilian market. Their capacity for innovation has enabled them to develop ecological refrigeration systems with high quality, high performance and reliability according to the varied necessities of their customers.

Features of the new SKYRACK BREEZE

The SKYRACK BREEZE is a refrigeration system in the cascade application that uses CO₂ in the low stage system with direct expansion linked to the island and freezing rooms. Propylene glycol supplies cold temperatures to the medium temperature cold rooms and display cases. In the high stage system, R134a is used with a much reduced refrigerant charge, which only acts in the cooling of both Propylene glycol and CO₂ condensation (see the simplified refrigeration circuit below). “Traditional refrigeration systems in supermarkets are responsible for significant emissions of greenhouse gases. The potential emissions of the new SKYRACK BREEZE system that uses CO₂, is approximately 6 times lower compared to other existing technologies in the market that use synthetic refrigerants, such as R404A, which has a very high global warming potential. Carbon dioxide is a climate-friendly refrigerant because it does not contribute to the depletion of the ozone layer and has a low direct global warming potential with the reference value of 1. Moreover, CO₂ refrigerant charge is very low due to its high volumetric cooling capacity that is 5 to 8 times higher than R22 or R404A, explains Marcelo Merolli – General Manager from Plotter & Racks.

Advantages of the SKYRACK BREEZE system utilizing CO₂ Vs traditional systems with R404A and R22:

- Carbon dioxide is a climate-friendly refrigerant; it does not contribute to the depletion of the ozone layer.
- Low direct global warming potential (GWP) with a reference value of 1.
- Less carbon taxes (CO₂)
- It has a low with the reference value of 1.
- Carbon dioxide is naturally occurring.
- Reduction of the electric energy consumption (approx 20 to 35%; depending on the condition of the application and thermo load profile of each refrigeration plant).
- Low compression ratio & increased life expectancy of the CO₂ compressor.
- High CO₂ density & high pressure in the low pressure stage.
- Reduction of CO₂ piping diameter sizes.
- Reduction of CO₂ refrigerant charge.
- Low purchase price of CO₂.
- High enthalpy & high degree of liquid sub-cooling & higher cooling capacity.
- Small volumetric displacement & smaller sized CO₂ compressors.
- Smaller refrigeration rack & compact installation & smaller compressor numbers.
- Smaller and more efficient evaporator coils.
- Reduced installation & maintenance costs.



The new SKYRACK BREEZE from Plotter & Racks; environmental-friendly and extremely efficient

Beyond the ecological benefits, Mr. Ricardo Sozzi - Electronic Engineer from Plotter & Racks, explains that the new SKYRACK BREEZE has other advantages and benefits that guarantees less consumption of electric energy.

- **The heat recovery system;** provides hot water to the entire store. The hot water circulating through the pipes is also used to heat the floor. This system uses the heat rejected from the high-pressure stage to heat the water with a zero energy cost. This process occurs in a heat exchanger which is installed on the compressors` discharge line.

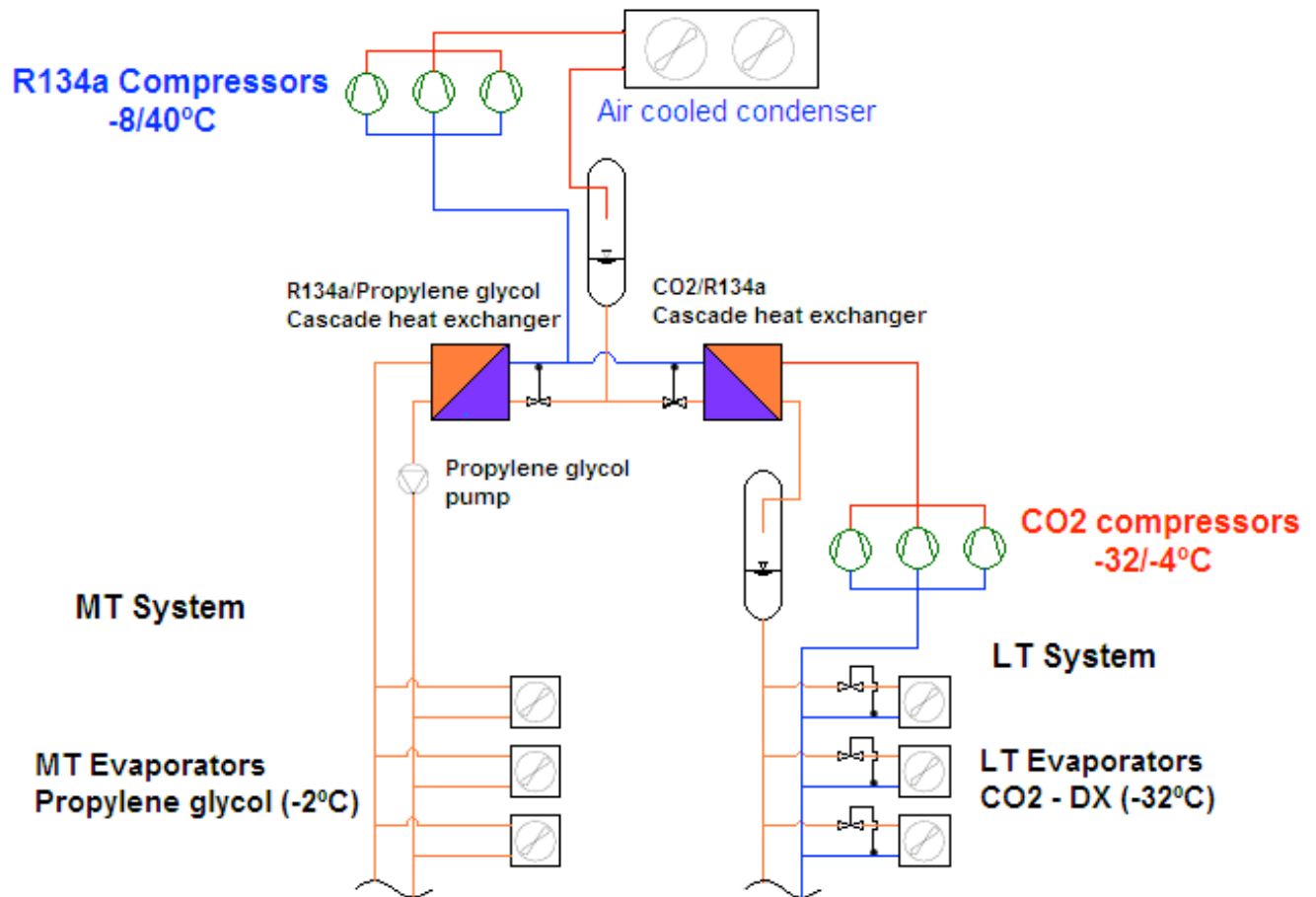
- **Condensing temperature reduction system.** (Patented and called “Breeze”) Before entering the condenser coil, air first passes through a “panel” which flows with water, diminishing the inlet air temperature and, as a result the condensing temperature as well. With this, the system COP (coefficient of performance) is raised significantly, increasing the cooling capacity of the compressors with lower energy cost.

- **Condenser fans with direct-current and variable speed.** These are more efficient and provide higher stability of the condensing temperature. As a result, energy consumption is lower and the life expectancy of the compressors is increased.

- **Electronic expansion valves** are used in both CO₂ and Propylene glycol heat exchangers. These provide better stability of the evaporating temperature in the high-pressure stage and bigger energy savings.

- **Variable frequency driver Compressors.** These compressors allow for a more stabilized evaporating temperature, a better adjustment to the instantaneous cooling capacity required, and as a result provides bigger energy savings.

- **Electronic controllers** that guarantees safe and efficient operation of the entire system. It allows local or remote access via the Internet, which sends notifications of any alarms via SMS. They are also important tools for the thorough, preventive maintenance of the entire system, thus greatly reducing the risk of operational failure.



Simplified refrigeration circuit of the SKYRACK BREEZE with CO₂ which is installed in Verdemar

“In the subcritical application (cascade), CO₂ is advantageous in relation to simple stage systems. Its high suction vapor density results in a very efficient heat exchange between the CO₂ suction line and the R134a liquid line of the high-pressure system. Consequently, beyond increasing performance of the high-pressure system, it also guarantees steady control of the superheating of the suction vapor of the CO₂ compressors, preventing the oil dilution in the refrigerant”, explains Mr. Fernando Machioro – Designer from Plotter - Racks.

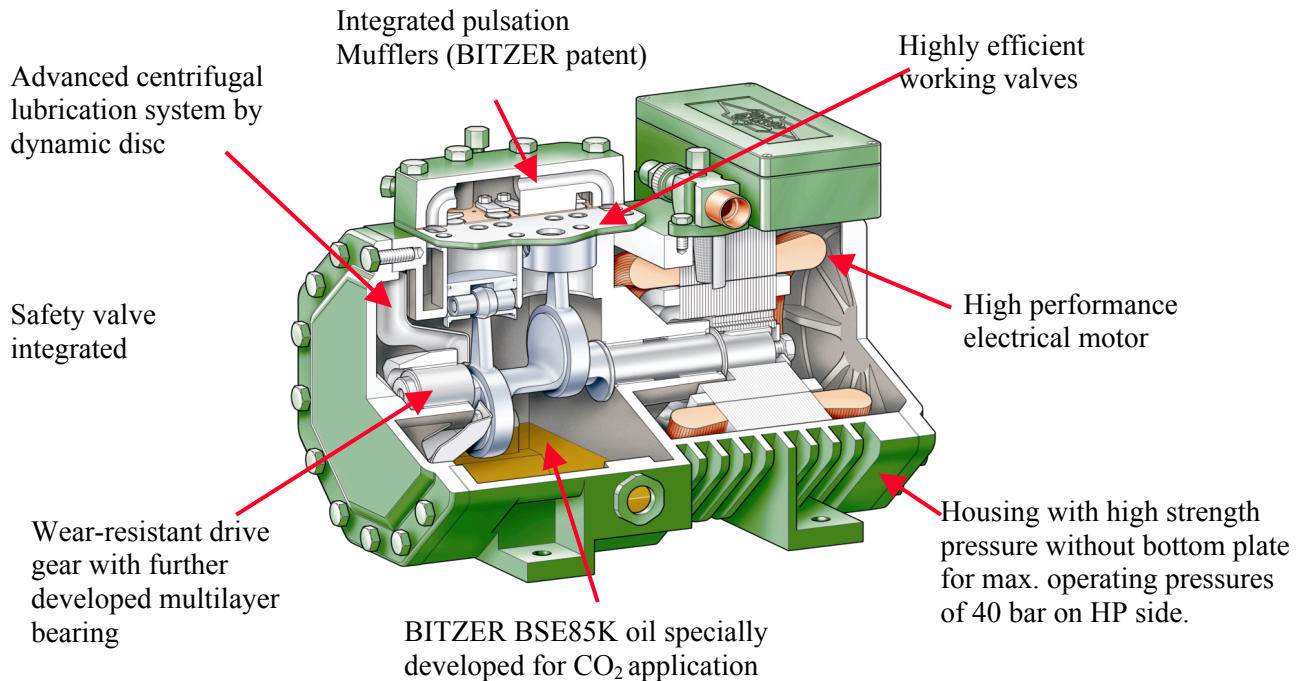
Sustainable Solutions

Nature demanded and BITZER complied with a wide program of developments and global standardization, utilizing new technologies with natural alternative refrigerants such as Carbon Dioxide - CO₂, thus preventing the problems caused by (H) CFC's and HFC's in the Ozone Layer and Global Warming (the greenhouse effect).

“All the existing refrigeration systems using our compressors with CO₂ have so far had a superior performance over the traditional synthetic refrigerants used in commercial supermarket refrigeration systems such as R22 and R404A, mainly in regards to energy issues. In 2008, we installed a CO₂ technology & Training Center in BITZER's plant in Sao Paulo, Brazil, to prove the high superiority of CO₂ in relation to these traditional synthetic fluids. The focus of this center is to promote the technical improvement, in a simple and objective way, of Carbon Dioxide application technology. During the CO₂ training courses, safety issues, design features, installation, commissioning, servicing and maintenance procedures will be discussed with practical and theoretical classes. Moreover, energy efficiency comparisons will be carried out between the CO₂ system and the direct expansion conventional systems using the R404A and R22”, explains Alessandro da Silva - Application Engineer at BITZER Brazil.

Innovative characteristics that guarantee a safe operation with low energy consumption

The Octagon® compressors for the CO₂ subcritical application are designed with an advanced centrifugal lubrication system by dynamic disc that guarantees excellent lubrication in the moving parts and promotes a longer life expectancy of the compressor. The compressor valve plates are designed to handle very high mass flow rates along with minimum pressure drops. The bearings are nylon impregnated (PTFE) to cope with oil retention in the bearing surfaces and offers better lubrication at high operating pressures and bearing loads which are experienced when using CO₂. Motors fitted to the CO₂ semi-hermetic compressors are comparatively large because of their increased volumetric cooling capacity, that's about 7 to 8 times higher when compared to operations on R22 and R404A systems. However they have a high COP (coefficient of performance) even in severe conditions of application. The lubricant for CO₂, a special POE oil type developed by BITZER called BSE85K, is used to enhance operation and protection of the equipment which suffers under the raised load requests provoked by the high pressures of CO₂ in the moving parts of the compressor.



Compressor Octagon® aplicado com Dióxido de Carbono – CO₂

To take advantage of the resources that the CO₂ systems offer, BITZER's application engineer Alessandro da Silva, points out some important items that should be taken in consideration when dealing with these systems:

- 1- It is crucial that all technical teams (O&M, installer, end customer, etc.), be previously trained with CO₂ technology before attempting to install, operate and perform maintenance of the CO₂ refrigeration equipments.
- 2- The CO₂ subcritical system is in some sense very simple and mechanically quite straightforward, but in other areas it can be extremely complicated and requires an extensive understanding of how the system will behave under the changing conditions. Understanding how the system will react in the event of a power failure or a failure in the high stage that removes the cooling from the inter-stage heat exchanger, are the most important issues that need to be addressed.
- 3- It is imperative that every possible scenario is run through long before the equipment is even delivered to a site, so that the commissioning team knows exactly how the system will react, and how the staff who are responsible for the system, should in turn react. Only then can the system be installed and operated in a safe and reliable manner, to the satisfaction and safety of all.
- 4- Service personnel need an intimate knowledge of the inter-relationships between the high and low stage control systems, as well as each stage's individual control systems, to be effective at maintaining and servicing these systems. They must familiarize themselves with all aspects of the plants' operation, control and safety issues to ensure that the system will operate in a safe and efficient manner over its operational working life.

“The CO₂ system project at the new Verdemar supermarket, brought together engineers and installers from Racks-Plotter, along with the maintenance technicians from end customer who had been trained at BITZER’s CO₂ Center in Brazil. With every step of the installation being crucial to a successful operation, the utmost care had been taken so that the system would be installed and therefore operate in a safe and efficient manner”, explains Alessandro.

“The established requirements set by the Montreal Protocol, which calls for the elimination and reduction of HCFC’s from 2013, has affected the commercial refrigeration sector directly, as it significantly reduces the availability of R22 in the market. As a result, many supermarkets are looking for a “green” solution with the use of natural refrigerants such as Carbon Dioxide - CO₂, which is environmentally friendly in all aspects and which also reduces energy consumption of the refrigeration plant”, concluded Alessandro.

Plant’s technical data

Plant: Verdemar supermarket. Installed in an area of 6,000m² in Nova Lima city Minas Gerais, Brazil

Project and installation of the refrigeration system: Plotter & Racks

Compressors & Technical Support & Training: BITZER Brazil

Cooling capacity of MT system: 200 KW (at - 2°C with Propylene Glycol pumped)

Cooling capacity of LT system: 36 KW (at- 32°C direct expansion with Carbon Dioxide - CO₂)

Display cases: Arneg Brazil

Evaporators of the islands: Mipal Brazil

Evaporators of the deep-freeze room: Thermofin Germany

Carbon dioxide (CO₂): Air Liquid - Belo Horizonte city / MG; Brazil