



CO₂ TRANSCRITICAL REFRIGERATION SYSTEM



KYSOR WARREN
eptarefrigeration

ABOUT KYSOR WARREN

Kysor Warren is a leading manufacturer of refrigerated display cases and refrigeration systems, partnering with customers to bring complete commercial refrigeration solutions to supermarkets, grocers and other retailers across North America.

Warren Refrigeration was founded in 1882, providing refrigeration solutions to food retailers. Warren Refrigeration later joined with Sherer Brothers Company which was the first to patent counters featuring glass panels in order to feature and display merchandise. They continued innovating by adding cold-air flow to the cases, so that perishable foods could be showcased in retailer shops. You can trust that our highly experienced personnel will provide you with the customer, engineering and technical support services that you need.

Our case and system solutions are known for their durability, efficiency, and quality in design. Our firsthand experience and knowledge of refrigeration system operations are unparalleled, getting you the exact results you are looking for.

Kysor Warren is an Epta Refrigeration company headquartered in Columbus, Georgia.

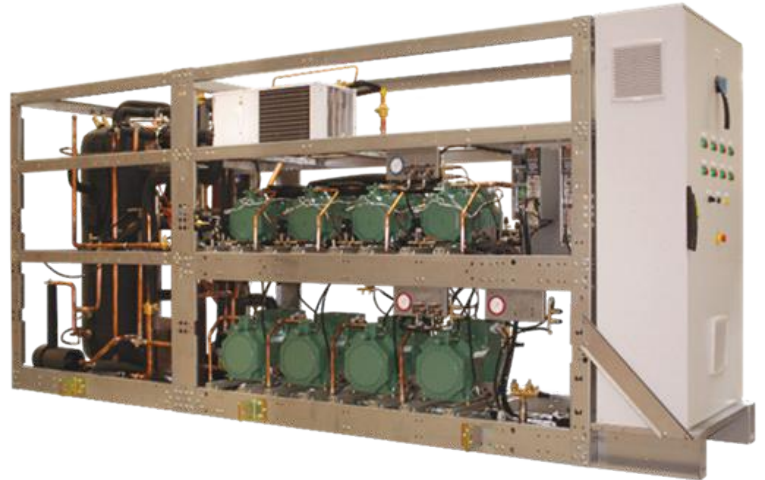


CO₂ TRANSCRITICAL REFRIGERATION SYSTEM

The Kysor Warren CO₂ Transcritical system provides the ultimate solution for sustainable refrigeration system design. This system provides an HFC-free supermarket refrigeration solution while providing significant lifecycle cost savings for retailers.

Benefits:

- **100% HFC-FREE, SINGLE REFRIGERANT SYSTEM** - Uses only one naturally occurring refrigerant: carbon dioxide. Low toxicity and non-flammable. Eliminating the need for multiple refrigerants – refrigerant cost is lower than for HFCs. Single refrigerant system benefits single molecule, no temperature glide in subcritical operations.
- **IMPROVED PERFORMANCE** - Has a significant reduction in pull down time when compared to HFC/DX systems. Reduction in pull-down time reduces the time the compressor is running to bring temperature down; thus increasing the shelf life of compressors and energy usage in running compressors longer to pull down as with HFC systems.
- **LIFE CYCLE COST ADVANTAGE** - This system eliminates the need for any secondary loops or cascades. There is no impending legislation phasing down or phasing out R744 so it can be viewed as a long-term refrigerant. Inexpensive to produce and widely available.
- **ENERGY EFFICIENT** - CO₂ is a climate neutral refrigerant that is highly favored primarily due to its high energy efficiency, ODP (Ozone Depletion Potential) = 0 and GWP (Global Warming Potential) = 1. Negligible GWP so that, in the event of a leak, the direct impact on climate change is very low. CO₂ also has significantly higher volumetric capacity than conventional refrigerants (ability of a given volume of a substance to store internal energy while undergoing a given temperature change, but without undergoing a phase transition).
- In the refrigeration industry, as a food retailer, you value more than just product features; you rely heavily on support, service, parts replacement network, and minimal downtime.



DESIGN

STANDARD FEATURES	OPTIONS
■ Air-cooled gas cooler ■ Electronic oil management system ■ Case and unit cooler coils optimized for use with CO₂ ■ Electronic expansion valves	■ Evaporative assisted gas cooler ■ Heat reclaim ■ Warm climate solutions ■ Low capacity rack

TYPICAL PERFORMANCE VS. TRADITIONAL HFC SYSTEM

	TRADITIONAL HFC	CO ₂ TRANSCRITICAL
GLOBAL WARMING IMPACT	Baseline	↓ 98%
ENERGY COST	Baseline	↓ 6% - 10%
TOTAL COST OF OWNERSHIP	Baseline	↓ 5% - 10%

CO2 TRANSCRITICAL REFRIGERATION SYSTEM

As a COMPLETE SOLUTIONS PROVIDER Kysor Warren offers the following advantages:

- One point of contact OEM for cases, systems, condensers/gas coolers, controls - one stop shop for refrigeration
- Fully trained and experienced Technical Sales and Service team
- Qualified engineers available for customer requests - "PhDs that turn Wrenches"
- Over 40 patents filed to cover Alternative Systems applications and design methods
- Fully documented manuals and procedures for seamless startups
- Training program designed to take the guesswork out of installing, operating and servicing the systems
- Global Labs with UL Client Test Data Program Certification – the only OEM in the industry to do so
- Extensive testing capabilities for Alternative Systems:
 - Complete system testing - racks, cases, unit coolers, gas coolers, controllers
 - Vibration for operating conditions and shipping and packaging validation
- Rigorous component qualification process
 - Performance testing
 - Safety Testing
 - Accelerated Life Testing
 - Supplier Qualification process
 - Audit process

Design validation through extensive FEA, CFD and Solid Modeling.



Parts are labeled to assist personnel in easily identifying and locating key parts of the system.



For outdoor application, our weather enclosure machine house is used to house the rack.



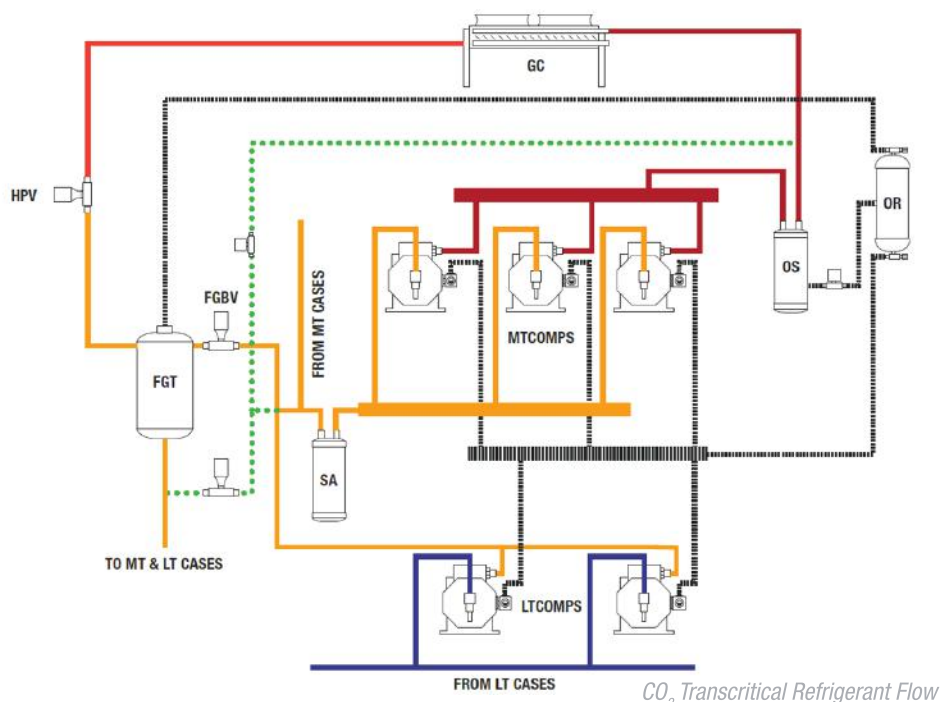
Our training program takes the guesswork out of installation, operation and servicing.

SYSTEM OPERATION

The Kysor Warren CO₂ Transcritical refrigeration system is a completely HFC-free refrigeration system designed to provide superior performance for food retail applications.

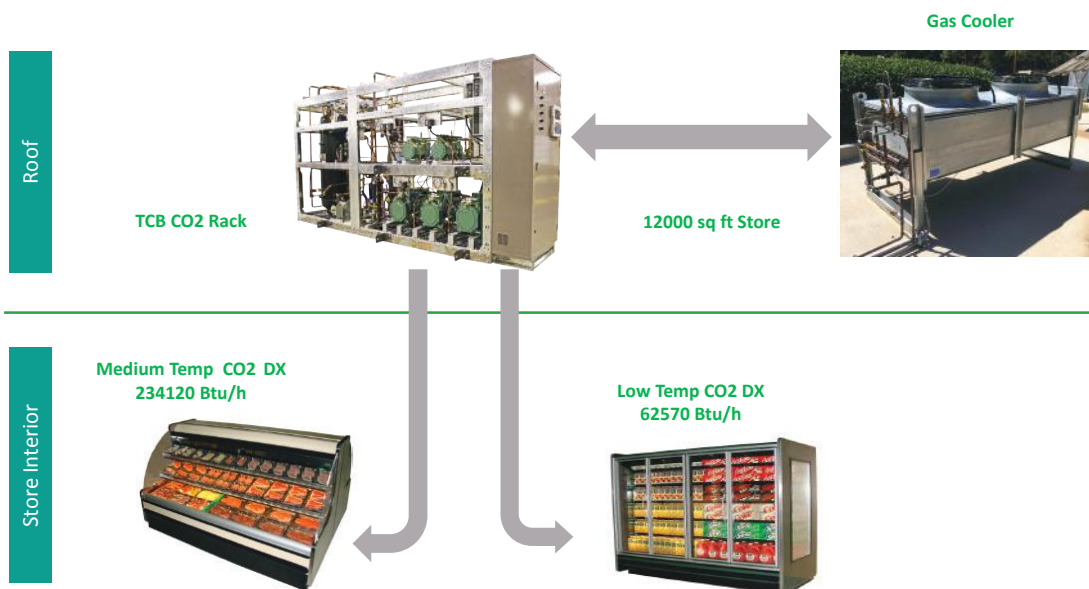
In this system, liquid carbon dioxide is distributed throughout the store to provide cooling for each refrigerated case or walk-in box. Electronic expansion devices control temperatures by metering refrigerant flow into case coils optimized specifically for use in CO₂ applications.

Suction gas from the low temperature cases returns to the low temperature compressors on the CO₂ booster rack. The gas is compressed to the same pressure as the suction line coming from the medium temperature cases. It is then combined with the medium temperature suction gas and any flash gas coming from the flash tank. This mixture then enters the medium temperature compressors before being routed to the gas cooler for heat rejection (gas cooling or condensation).



Upon exiting the gas cooler, the refrigerant passes through a high pressure electronic expansion valve (EEV) into the flash tank where it is being separated as gas is sent to medium temperature suction and liquid into the store (which completes the refrigerant cycle).

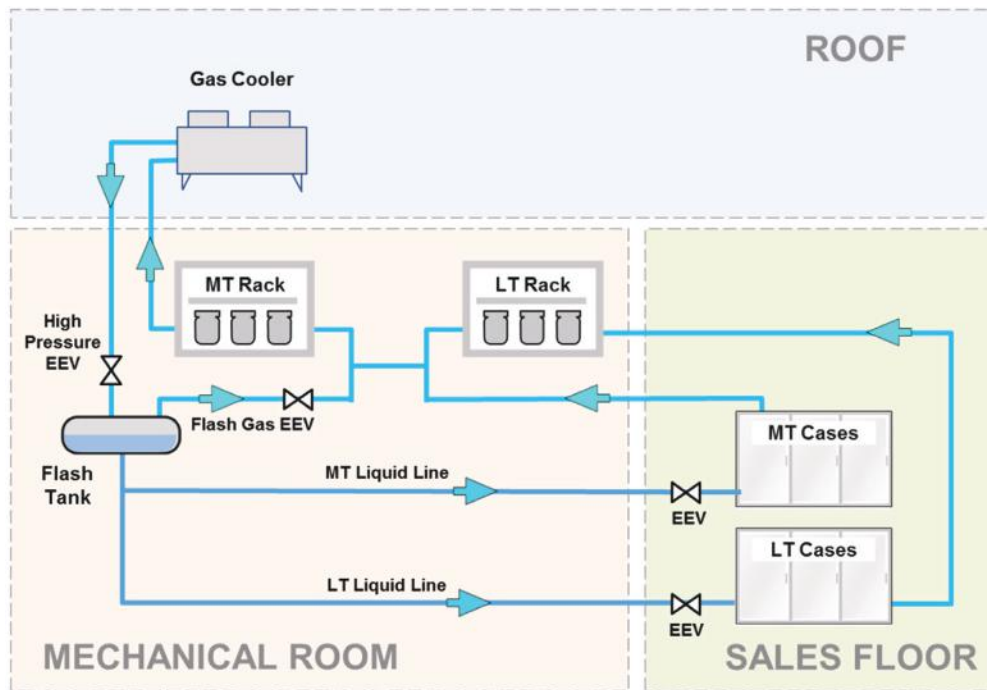
NOTE: The low temperature and medium temperature compressors are typically combined on one rack frame. (They are shown separately in the above graphic for illustrative purposes.)



Typical Grocery Store Configuration

CO2 TRANSCRITICAL

STANDARD OPERATION

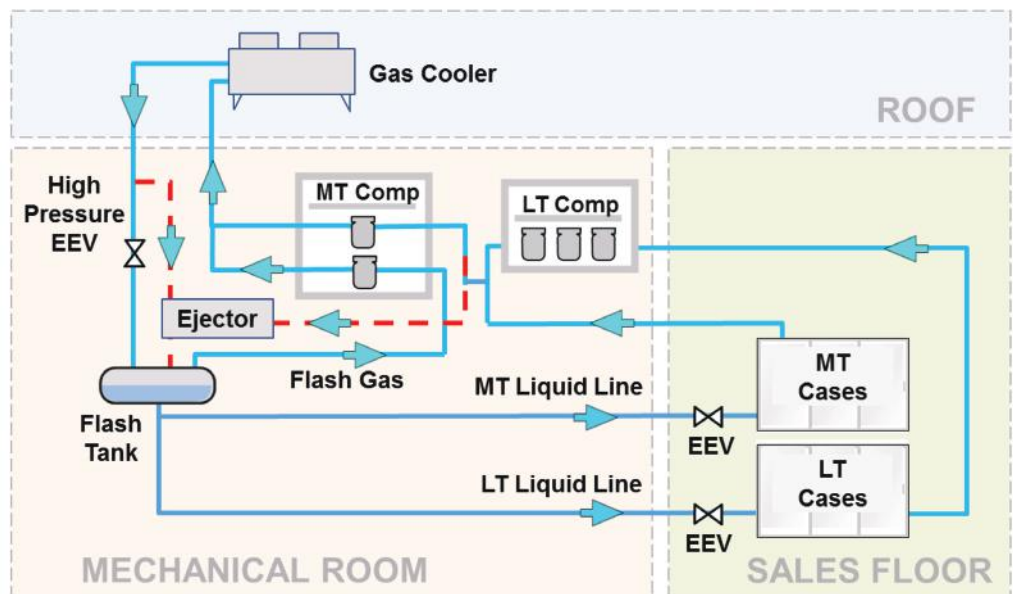


CO2 TRANSCRITICAL

WARM CLIMATE SOLUTIONS EJECTOR CYCLE

The ejector is an expansion device with virtually no moving parts that further enhances the efficiency of transcritical CO₂ booster systems in warm climates. It works by converting internal energy and high pressure related flow work held in the gas cooler outlet stream into kinetic energy to entrain and effectively pump the refrigerant from the medium temperature suction into the flash tank. This allows the medium temperature compressors to be unloaded and transfer such load to the parallel

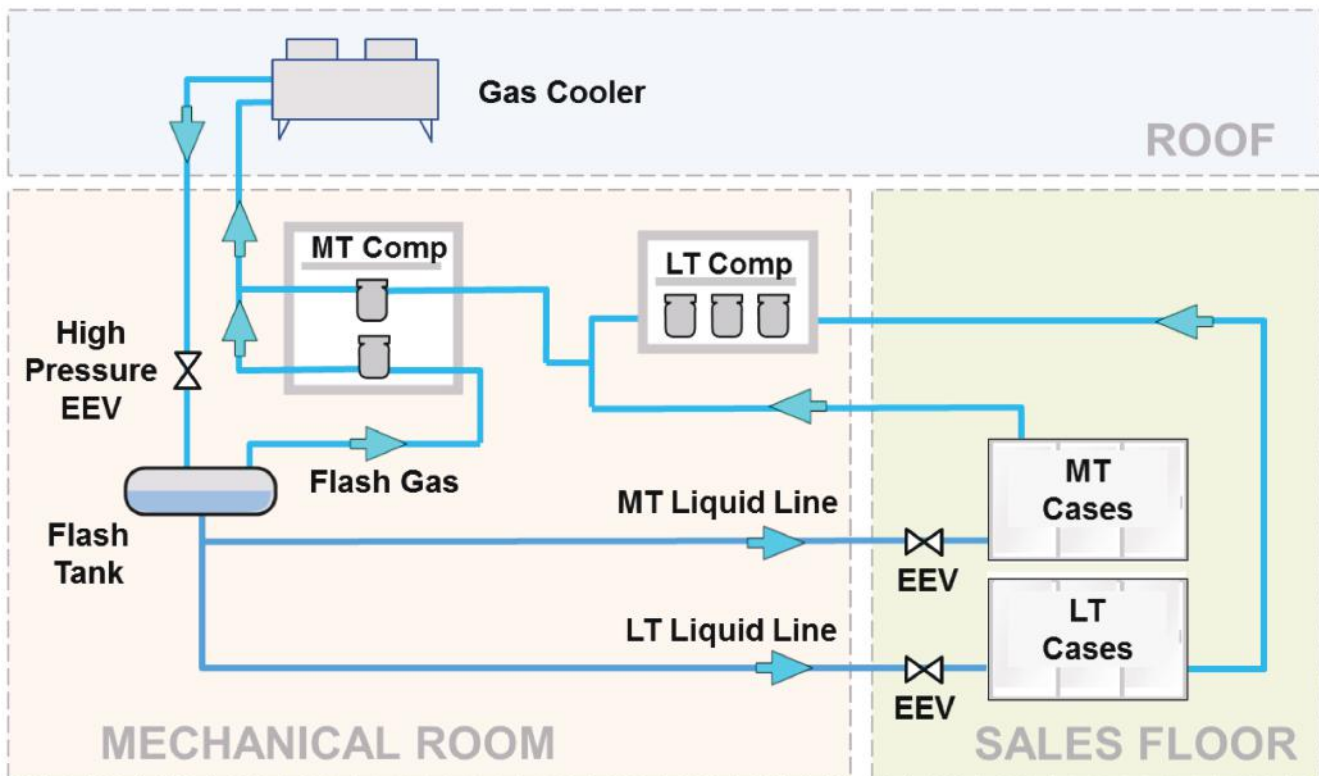
compression group that operates at higher suction pressure and therefore uses less energy to pump the refrigerant around the system. It provides 5-10% energy benefit when compared to parallel compression by itself.



CO₂ TRANSCRITICAL

WARM CLIMATE SOLUTIONS PARALLEL COMPRESSION

In traditional transcritical CO₂ booster systems, flash gas is generated through the high pressure valve (HPV) and removed from the tank through a flash gas bypass valve (FGBV) to the medium temperature compressor suction. This process is inefficient in warm climates due to the large amounts of flash gas generated and the pressure drop across the FGBV. To mitigate this effect, a compressor is connected to the top of the flash tank so the flash gas is removed at a higher suction pressure causing an increase in the energy efficiency of the system. It provides 5-10% energy benefit when compared to a standard transcritical CO₂ booster system.





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