

Innovation Key NaturaLINE

THE NATURAL ONE

For container shipping, CO₂ is the only refrigerant that meets all of the following criteria:

- **GWP of 1;**
- **Zero ozone depletion potential (ODP);**
- **Excellent heat transfer / heat reclaim properties;**
- **Non-flammable;**
- **Cost effective, available worldwide and requires no special disposal;**
- **Protected against phase-outs, taxes, and European F-gas regulations.**

Although it bears some resemblance to other refrigeration units in the Carrier Transicold family, closer inspection of the NaturaLINE™ design reveals some critical distinctions or, in deference to our container refrigeration engineers, we'll call them "transcritical" distinctions.

"Transcritical refers to a refrigeration cycle that is unique to CO₂ compared to conventional refrigerants," explained Program Manager Mike Griffin, who led the engineering and development of NaturaLINE technology.

Addressing the transcritical cycle and the special thermodynamic properties of CO₂ necessitated the development of an innovative refrigerant management system, including a new purpose-built multi-stage compressor, a "gas cooler" with a wrap-around coil design and a flash tank.

In spite of the differences, much of the NaturaLINE design remains the same as other Carrier units. The basic frame, the evaporator and evaporator fans, and the controller and control box are virtually identical to existing Carrier models. The control interface is the same, although there will be new alarm and function codes. Also, serviceability will be similar to existing Carrier products, and will be supported by a new comprehensive training program offered by Carrier.

NaturaLINE technology achieves goals for best-in-class efficiency, performance and serviceability, all within a compact design envelope. The adjacent illustration shows some of the new core components that distinguish a NaturaLINE refrigeration unit from anything that has come before.

Multi-Stage Compressor

The NaturaLINE design makes use of an exclusive new multi-stage compressor that maximizes capacity and minimizes power consumption. "Purpose built" for the NaturaLINE application, the patented reciprocating compressor was developed by Carrier's world-class Carlyle Compressor design center.

New to container refrigeration are the NaturaLINE system's two stages of compression, which improve the overall efficiency of the unit.

The compressor also features a unique cylinder unloading capability. If the compressor needs to shed capacity for light-load conditions, it can save energy by turning off one of its two cylinders, similar to how certain automobiles do to save fuel.

Variable-Speed Drive

A first for a Carrier container refrigeration unit, the electric motor that powers the compressor now runs at variable speeds. A custom-designed variable-speed drive electronically adjusts the compressor's speed, to provide the precise amount of cooling capacity to meet demand.

NaturaLINE™ is The One

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As a result of Carrier's multi-year development initiative, the NaturaLINE design includes a number of "firsts" for container refrigeration applications, some of which are patented.

Among them are:

- A purpose-built, multi-stage compressor with variable-speed drive;
- A new gas cooler in place of the traditional condenser;
- A flash tank;
- Multi-speed fans; and,
- An advanced software control system.

All work together as one to efficiently optimize fan speeds and compressor capacity to match cooling loads and temperature control.

Although natural refrigerant technology differs distinctly from Carrier's other container refrigeration systems, one point of commonality is the Micro-Link® 3 Control, which assures that NaturaLINE units will be as familiar to operate as any other Carrier container refrigeration unit.

Serviceability will also be very similar to standard practices on today's refrigeration units, and will be supported by Carrier's complete service training program and global service center network. The way that technicians interact with, troubleshoot and repair NaturaLINE units will be very similar to how it is done with today's units.

At the Intermodal Europe 2011 event, Carrier executives said that NaturaLINE units have completed extensive life-testing and are readying for sea trials, following successful trans-critical demonstrations with Hapag-Lloyd in 2010 and 2008.

to™ Technology

This saves considerable energy compared to conventional units in which a compressor has only one speed – maximum – and refrigeration capacity is controlled via mechanical means.

Gas Cooler

NaturaLINE technology replaces the condenser assembly found in conventional refrigeration units with a new heat exchanger called the gas cooler. The gas cooler's coil wraps around its fan, maximizing heat-transfer surface area for greater efficiency in a design that is both compact and lightweight.

The gas cooler makes the overall refrigeration system more versatile in responding to CO₂'s thermodynamic properties. It's really two heat exchangers in one to allow gas cooling after each compression stage. This results in better unit efficiencies.

Flash Tank

An entirely new component in a container refrigeration system is the flash tank, which manages the flow and phase

change of the refrigerant after leaving the gas cooler. For efficient cooling performance, the exclusive Carrier design enables final separation of CO₂ from its gas phase to the liquid state before entering the evaporator.

Two-Speed Fans

The NaturaLINE unit's evaporator and gas cooler use two-speed fans, offering greater versatility and energy-saving performance. The evaporator fans are the same as the ones used on the PrimeLINE® unit, and other Carrier models. The new gas cooler fan has an aerospace-inspired design that is larger than the traditional condenser fan, with blades tuned to provide greater airflow and efficiency.

Advanced Operating Software

The operating software has been reengineered to manage the unique NaturaLINE mechanical system while still providing an easy to use control interface that works virtually the same as every other contemporary Carrier container refrigeration unit.

