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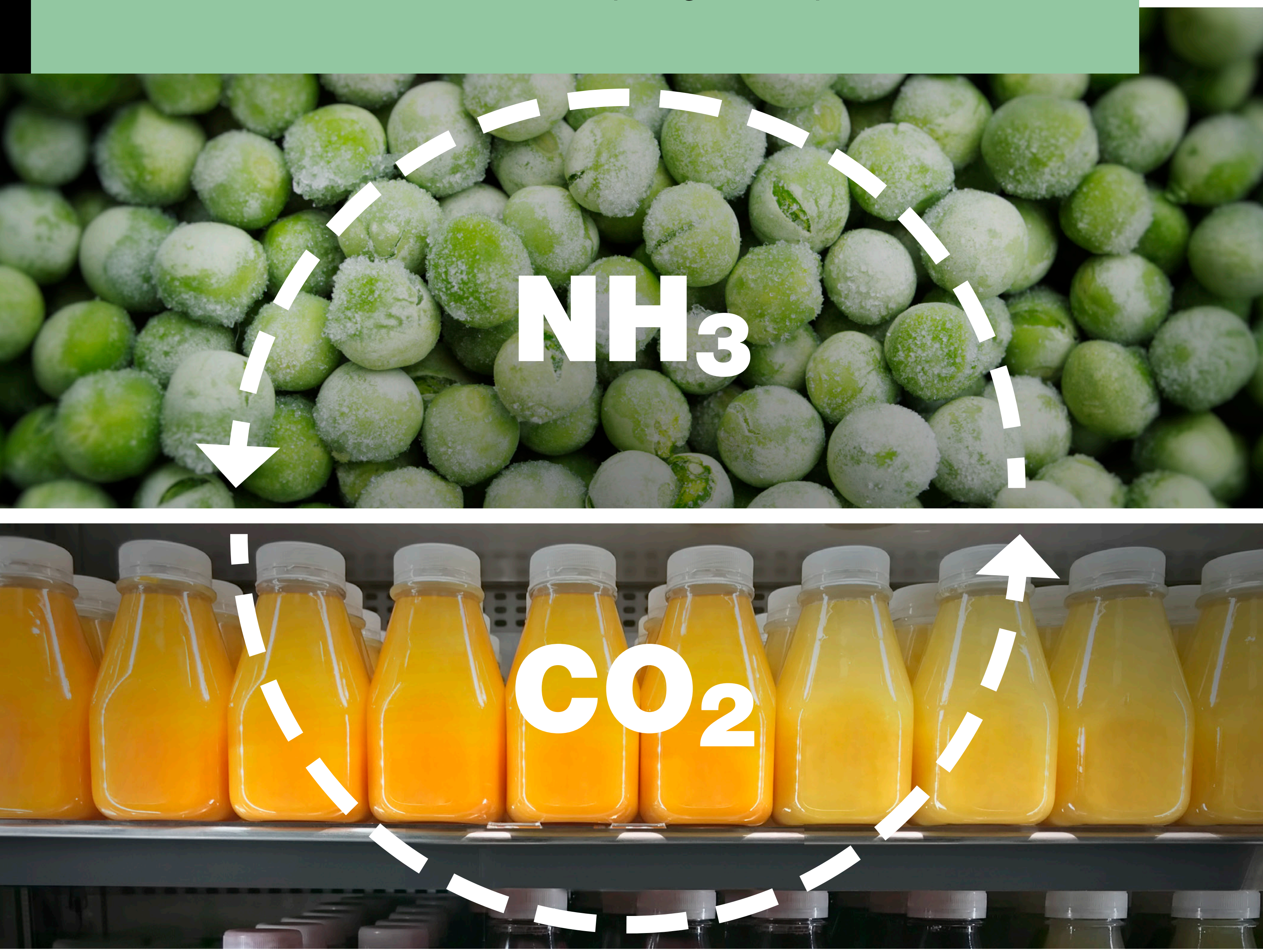
Trading places

CO_2 and ammonia cross over into competing market spaces.



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CO_2 and ammonia are two natural refrigerants that have historically played predictable roles in refrigeration Ammonia (aka NH_3 and refrigerant name R-717) has long been considered a highly efficient workhorse in low-temperature, industrial refrigeration. In recent decades, CO_2 (refrigerant name R-744) has emerged as a leading environmentally friendly alternative in commercial applications. But before we get too accustomed to these familiar roles, the tables are starting to turn.

Today, manufacturers are developing new refrigeration technologies that blur the lines between these traditional applications. Driven by sustainability objectives and regulatory compliance, these natural refrigerant technologies are converging into competing market spaces—where CO_2 is becoming a viable option in industrial applications and low-charge ammonia systems are making inroads into commercial applications.

Regulatory and market drivers

On the regulatory front, CO_2 has the global hydrofluorocarbon (HFC) refrigerant phase-down to thank for gaining a foothold in commercial refrigeration. As a natural alternative with near-zero global warming potential (GWP), it is one of the few ultra-low GWP refrigerants to be listed as acceptable by the Environmental Protection Agency's (EPA) Significant New Alternatives Policy (SNAP). CO_2 has minimal safety or toxicity barriers to adoption with respect to building/fire codes or local authorities having jurisdiction (AHJ). Be advised that in some regions, safety regulations are being developed to address piping best practices for managing CO_2's higher operating pressures.

On the other hand, ammonia has been the subject of increasing regulatory activity to address its potential toxicity concerns. The Occupational Safety and Health Administration (OSHA) requires operators to provide necessary documentation for systems charged with 10,000 pounds of ammonia or more, according to its Process Safety Management of Highly Hazardous Chemicals standard.

Operators must always be prepared for rigorous inspections enforced by OSHA's National Emphasis Program (NEP) on process safety management industries, which includes ammonia-based refrigeration facilities. Since owners of large-charge ammonia systems have now incurred the added responsibility and expense of continuous record keeping, many operators are starting to reevaluate traditional ammonia refrigeration architectures.

To avoid possible regulatory entanglements and alleviate potential safety concerns, a new trend is emerging that favors lower-charge ammonia systems and moving the natural refrigerant out of occupied spaces. But even with these considerations, operators may still need the approval of local AHJs or secure the necessary permission to install ammonia systems.

Regardless of potential installation caveats, end users seeking to leave a smaller carbon footprint are formalizing sustainability strategies that include the following objectives:

- Deploying low-GWP, future-proof refrigerants
- Designing high energy-efficiency systems
- Constructing "green" facilities

Natural refrigerants like CO_2 and ammonia are helping businesses achieve these objectives.

The tale of the tape
(comparing CO_2 and NH_3)

CO_2 and ammonia are among the most eco-friendly, natural refrigerant alternatives available. OEMs continue to seek ways to exploit their efficiencies and mitigate their risks.

Ammonia

- 0 GWP and 0 ODP
- Toxic and slightly flammable
- Workhorse in cold storage, industrial refrigeration
- Architectures now evolving to utilize lower charges used, preferably removed from occupied spaces
- Extremely efficient in a wide range of temperatures

CO_2

- 1 GWP and 0 ODP
- High-pressure, low critical temperature, high triple point
- Non-toxic, non-flammable; very minor leak threat
- Foothold in commercial refrigeration as alternative to HFCs
- Effectiveness in low temperatures making inroads in industrial applications

 

Emerging and converging technologies

Market dynamics are prompting both commercial and industrial operators to ask original equipment manufacturers (OEMs) which natural refrigerant options are available. In turn, OEMs are responding with new innovations and system technologies that borrow from traditional architectures and cross over into competing market spaces. Let's look at some innovations that are indicative of this convergence.

NH_3/CO_2 cascade—ammonia in commercial refrigeration

Owners of large (+100-ton) commercial HFC systems are evaluating smaller, lower-charge NH_3/CO_2 cascade systems. Some industrial OEMs are expanding their product portfolios to target this emerging niche for natural, energy-efficient systems. These NH_3/CO_2 cascade systems are designed to operate with very low charges of ammonia (100 pounds or less) on the high side of the refrigeration cycle (in a remote location, e.g., the roof) to chill the CO_2. Chilled CO_2 is then pumped into heat exchangers and sent to direct-expansion, low-temperature evaporators and CO_2-rated compressors.

CO_2 transcritical booster—CO_2 in industrial refrigeration

CO_2 represents a documentation-free refrigeration alternative to long-time owner/operators of large-charge ammonia systems; these operators are turning to commercial OEMs with CO_2 expertise. CO_2 transcritical booster systems have proved viable in cooler regions, relying on an architecture that utilizes several compressors in parallel to meet the desired cooling requirement. CO_2 blast freezers are also effective in low temperatures, especially below -40 °F.

Smaller platform applications for ammonia

Both commercial and industrial operators with smaller facilities have many low-charge ammonia options to meet their cooling requirements and sustainability goals. Let's look at a few of these systems:

- ***NH_3 low-charge centralized***—this remote, distributed architecture is designed to reduce the liquid line length and subsequent refrigerant charge. The system utilizes a compressor skid in a smaller engine room and a liquid receiver located on the roof directly above the evaporators (liquid overfeed).

- ***NH_3 direct expansion***—available in distributed or remote varieties, this system requires the circulation of much less refrigerant compared to the liquid overfeed method.

- ***NH_3 chiller with pumped CO_2 secondary***—here ammonia is used to chill CO_2 (volatile brine), which is then pumped into the refrigerated areas.

- ***NH_3 chiller with pumped CO_2 secondary, plus CO_2 cascade***—this system combines an NH_3 chiller that provides the medium-temperature load via a CO_2 secondary design, plus a CO_2 cascade system for the low-temperature side.

It's important to note that contracting companies are also being affected by this market convergence. Just as commercial operators are turning to industrial service technicians with ammonia expertise, industrial customers are calling on commercial mechanics to assist with their emerging CO_2 applications.

Market intersection provides more options for end users

Owner/operators of commercial and industrial facilities have much in common. Both must attempt to balance capital expenditures, total cost of ownership and sustainability objectives in their selection of refrigeration systems. But the blurring of lines between CO_2 and ammonia technologies in these markets is ultimately beneficial to all involved.

While many of the options discussed herein are currently being "trialed" by some of the most forward-thinking companies, the fact remains that end users now have access to more environmentally friendly options than ever before. This ongoing evolution will continue to drive OEM innovation to develop a greater diversity of options to meet end users' specific requirements.

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