FEBRUARY 2019

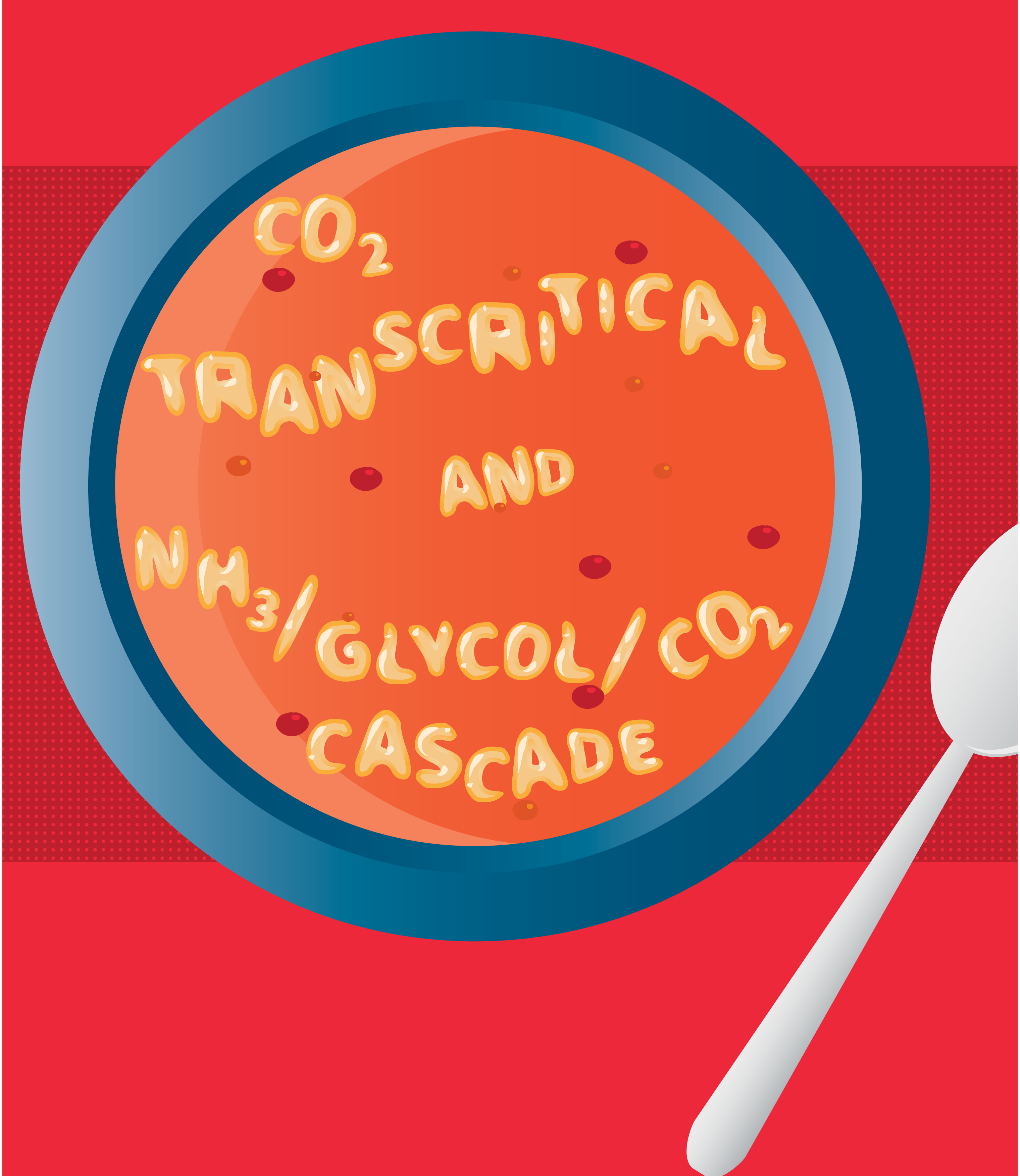
ACCELERATE

ADVANCING HVAC&R NATURALLY

AMERICA

Campbell's

NEW REFRIGERATION FLAVORS


CO_2
TRANSCRITICAL
AND
NH_3/GLYCOL/CO_2
CASCADE

Campbell's NEW REFRIGERATION FLAVORS

The food and beverage giant, which pioneered low-charge ammonia systems, has added cascade and transcritical CO_2 technology to the mix

– By Michael Garry

Like many consumer packaged goods companies, Campbell Soup Company offers numerous versions of its products, including dozens of soups and countless cookie options.

That penchant for diversity has now extended into natural refrigeration. A pioneer of low-charge industrial ammonia systems, Campbell over the past year has added two new refrigeration flavors – CO_2 cascade and transcritical CO_2.

In doing so, Campbell has joined a small but growing group of industrial end users who are installing transcritical and cascade CO_2 systems to improve safety and avoid regulations in what has for decades been an ammonia-centric industry.

The CO_2 cascade installations, incorporating ammonia (NH_3) and glycol, have taken place at two of Campbell Pepperidge Farm bakeries – a replacement system in Lakeland, Fla., and a new system in Downingtown, Pa. (incorporating an unusual spiral freezer). Another replacement system is planned this year at a bakery in Denver, Pa.

The CO_2 cascade solutions have so far "worked out well for us," said Bing Cheng, Campbell's senior manager of utilities, environmental and sustainability programs, who also serves on the IIAR's CO_2 standard committee.

In addition, at its headquarters in Camden, N.J., Campbell has deployed its first CO_2-only transcritical system for a new ingredient cooler/freezer.

The CO_2 cascade systems use ammonia as the primary refrigerant, which in turn chills a glycol solution; the glycol, serving as an intermediary, chills CO_2. The CO_2 is then delivered to the evaporators serving freezer loads.

By incorporating glycol in its CO_2 cascade freezer systems, Campbell is leveraging the glycol already being used as a result of an earlier decision to replace ozone-layer-depleting R22 systems at five of its Pepperidge Farm plants (Downingtown, Lakeland and Denver, as well as plants in Richmond, Utah, and Willard, Ohio) with low-charge ammonia systems. (See "Campbell Low-Charge Recipe," *Accelerate America*, April 2016.)

The bakeries – which produce such iconic brands as Milano Cookies and Goldfish crackers – are now more than 90% R22-free, said Cheng, who has overseen the transition from R22 to natural refrigerants at Pepperidge Farm.

Campbell has deviated from using a direct ammonia/CO_2 cascade system (with no intermediary), an option increasingly utilized by industrial companies such as US Cold Storage and Mexican storage provider Frialsa. But in so doing, the soup company avoids having to deal with the possibility that ammonia and CO_2 would accidentally mix in the heat exchanger, producing system-clogging ammonium carbamate.

With its new CO_2 ventures, Campbell is adding another chapter to its pioneering career as a natural refrigerant innovator. That started in the early 1990s, when former longtime head of refrigeration Bob Czarnecki introduced one of the industry's first low-charge ammonia designs, followed in the late 1990s with low-charge packaged ammonia units. Most of Campbell thermal plants (which make soup, sauces, beverages and other products) emphasize low-charge ammonia chiller packages circulating glycol.

Starting in Lakeland

Campbell first CO_2 cascade project took place in 2017 at the Lakeland, Fla., Pepperidge Farm facility as it underwent its conversion from R22, which was replaced by ammonia/glycol for HVAC and chilled water applications.

"We included enough capacity in that new system for a CO_2 skid," which serves a small formerly R22 ingredient freezer, said Cheng. "CO_2 is better for low-temperature applications" than glycol, he added. The cascade system was provided by engineering firm CRT Design, Jacksonville, Fla.

The same approach will be followed in the early spring of 2019 at the Denver plant, though the CO_2 rack (from Zero Zone) will be located on the roof rather than in an engine room. "The load at Denver was remote enough [from the engine room] to put the CO_2 skid out there," said Cheng.

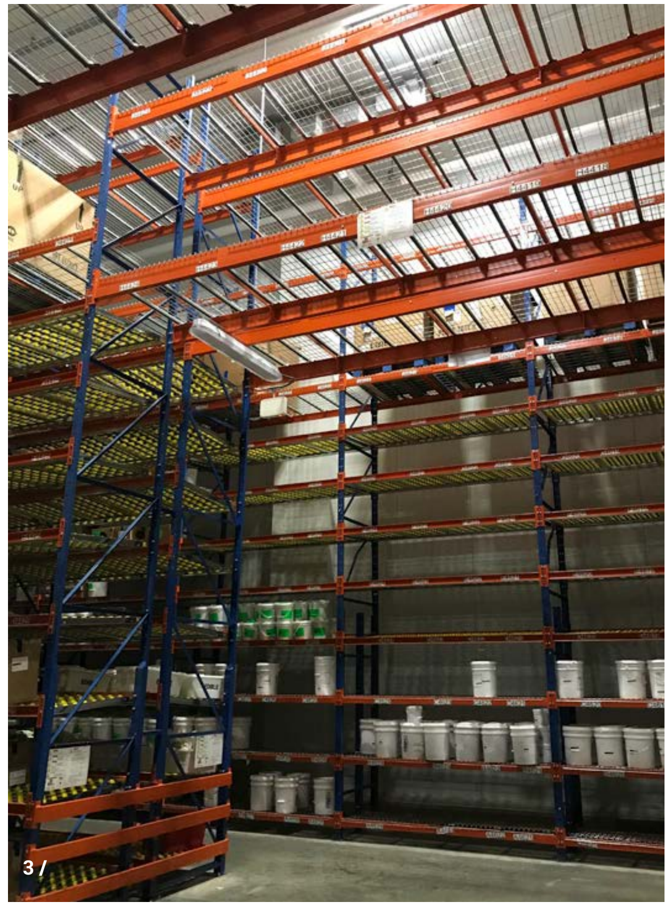
The cascade systems at both Lakeland and Denver serve small ingredient freezers (7.2 TR and 6 TR, respectively), with CO_2 evaporators in the rooms.

Because of ammonia's greater efficiency, Campbell normally uses it for freezers, but "it would not make economic sense to put in a low-temperature ammonia compressor and penthouse ammonia evaporator for that small a load," said Steve Parra, a senior engineer for Campbell based, like Cheng, at its Camden, N.J., headquarters.

Campbell does employ a direct ammonia system with a penthouse evaporator in freezers at its thermal plants and at a Pepperidge Farm facility in Richmond, Utah. "We use a slight overfeed on the coil because we're trying to reduce the amount of ammonia," explained Parra. "We build them in a penthouse and elevate the coils enough to drain freely to the engine room."

1 / HVAC NH_3/glycol chiller package, Richmond, Utah
2 / Campbell Soup headquarters, Camden, N.J.
3 / Freezer, Camden, N.J.
4 / Transcritical CO_2 rack, Camden, N.J.
5 / Transcritical CO_2 rack, Downingtown, Pa.
6/ Spiral CO_2 freezer, Downingtown, Pa.


2 /


3 /

4 /


5 /


6 /

Photo by Carla Tramullas

LEFT
Bing Cheng, Campbell Soup

RIGHT
Steve Parra, Campbell Soup

For safety reasons, he added, "we don't like flooded coils in the plant." This is also one of the advantages of using CO_2 in a freezer application rather than ammonia. "If you blow [a CO_2] evaporator unit in the freezer, there's not the potential for a dangerous situation," he said.

A lesson learned from the initial Lakeland cascade installation, which was delayed due to contractor issues, was the importance of hiring a contractor who is "familiar and comfortable with CO_2 systems," said Cheng. For its succeeding CO_2 projects, Campbell has employed Jax Refrigeration, Jacksonville, Fla.

For maintenance, Campbell uses its own technicians (such as in Downingtown) or a third party (Capital Refrigeration and Sodexo in Camden). Hillphoenix did initial training on its CO_2 technology at Downingtown and Camden.

For CO_2 racks in both transcritical and cascade systems, it's important to train the maintenance staff to remove all moisture from the system if the system is recharged with CO_2 and to use only "Coleman grade" CO_2 gas, noted Parra.

Spiral CO_2 freezer

At its Downingtown, Pa., Pepperidge Farm frozen-food plant, Campbell installed a new 110-TR spiral production freezer (including evaporator coils) for bread products in January 2018. Cheng believes this is one of the first freezers in the U.S. bakery industry to use CO_2 in the freezing unit, said Cheng. (In Canada, Wholesome Harvest Baking has installed a Mayekawa NewTon NH_3/CO_2 packaged system that serves a spiral bread freezer; see "A Canadian First," *Accelerate America*, February 2017.)

The CO_2 spiral freezer is connected to a CO_2 rack (from Hillphoenix), which is in turn linked to an existing ammonia/glycol system to create the cascade system. "There was extra glycol capacity that we tapped into for the CO_2," said Cheng.

Utilizing already existing ammonia/glycol equipment at the Downingtown plant again made the cascade system "a very low-cost option" compared to adding an penthouse ammonia evaporator, Cheng noted. For its Pepperidge Farm freezers, "we could have used penthouse ammonia or HFCs, but we thought [cascade CO_2] was the best balance between natural refrigerants and cost."

Campbell may install another CO_2 cascade system at a Pepperidge Farm facility in Downers Grove, Ill., that was converted in 2004 from R22 to mostly R507. "It sits in the middle of a residential neighborhood, so we can't have ammonia there," said Parra. The cascade system using secondary glycol would replace the remaining few R22 compressors.

Parra said he was pleased thus far with the performance of the CO_2 cascade systems. "We would use it again," he said. "It's a perfect fit for smaller loads where we don't have low-temperature ammonia systems."

After start-up, Campbell has not experienced CO_2 leaks in the cascade system, noted Parra. The efficiency of the cascade system takes a "little hit" compared to a direct ammonia system, noted Parra, but he did not consider it significant for "relatively small loads."

At its Pepperidge Farm facilities in Richmond, Utah, and Willard, Ohio, Campbell has transitioned to ammonia/glycol but has not yet installed CO_2.

CGF'S REFRIGERATION GOALS

Campbell Soup Company is a member of the Consumer Goods Forum (CGF), a consortium of consumer foods manufacturers and retailers that has pledged to meet environmental goals, including one related to refrigeration.

Its initial refrigeration "resolution and commitment," published in December 2010, declared that the group would mobilize its businesses to "begin phasing out HFC refrigerants as of 2015 and replace them with non-HFC refrigerants (natural refrigerant alternatives) where these are legally allowed and available for new purchases of point-of-sale unit and large refrigeration installations."

That statement was replaced with another in October 2016, which reads in part as follows.

"We … as individual companies, commit to the following in all commercial and industrial refrigeration equipment under our control along the food & beverage supply chain:

- In markets where viable, to install new equipment that utilizes only natural refrigerants or alternative ultra-low (under 150) GWP refrigerants, effective immediately.
- In markets where barriers to deployment exist, to engage with our suppliers, civil society, business partners and governments to overcome remaining technical, regulatory and other barriers in certain geographies and sectors, to enable the purchase if new equipment that utilize only natural refrigerants or alternative ultra-low GWP refrigerants as soon as possible but no later than 2025.
- Work to reduce the total equivalent environmental warming impact of our existing and new refrigeration systems, including (but not limited to) improving energy efficiency, optimizing refrigerant charge sizes and minimizing refrigerant leaks."

First transcritical

In Camden, N.J., at its world headquarters, Campbell installed its first transcritical CO_2 system (from Hillphoenix) in the first quarter of 2018 for a new 30-TR soup-ingredient cooler/freezer.

Camden is largely a research-and-development facility that occasionally does small manufacturing runs for test markets. In 2017, Campbell installed a 4.4- megawatt solar array at its headquarters, the largest in Camden, N.J. It was designed to generate the equivalent of 20% of the headquarters' electricity demand.

Campbell does not use ammonia in New Jersey due to the onerous regulations the state places on industrial users of the gas, said Parra, adding that the company does not want to use ammonia in any event at its headquarters. An R410A glycol chiller in Camden was too small to serve the new freezer, he said.

In terms of efficiency, the transcritical system offers the advantage of using a single refrigerant and not having to pump secondary glycol or use heat exchangers between refrigerants, as in the cascade systems. On the other hand, transcritical loses efficiency while operating in warmer ambient temperatures. Campbell did not choose to use an adiabatic condenser or other add-ons to improve efficiency.

Overall, though, Cheng has been satisfied with the energy performance of the transcritical system over its first year of operation. "We definitely didn't see a large spike in energy use" after adding the system, he said. For the capacity being served, the energy penalty for the transcritical system was small, added Parra. "It did not make a big difference in our decision."

As a company, Campbell said in its 2018 Corporate Responsibility Report that it believes the use of natural refrigerants "significantly improves energy efficiency, lowers energy costs and reduces GHG emissions."

For Parra, transcritical was "the best way from an economic standpoint, both capital and installation. And it runs nice."

Cheng concurs that the transcritical system is reliable and "maintenance- and operations-wise, it functions pretty well." After some initial tweaking in the first month, the system has not experienced a leak, he said.

Challenge of remote units

While most of the R22 HVAC units at Pepperidge Farm plants have been replaced by ammonia/glycol chillers, there were some small remote units, roughly 20-30 TR in capacity, for which "it did not make economic sense to run glycol across the roof from a central system," said Parra. They have so far been replaced with R410A units.

"Eventually the R410A units will get replaced," said Cheng. "We're trying to figure out if it's worth expanding the existing [ammonia/glycol] system to cover it."

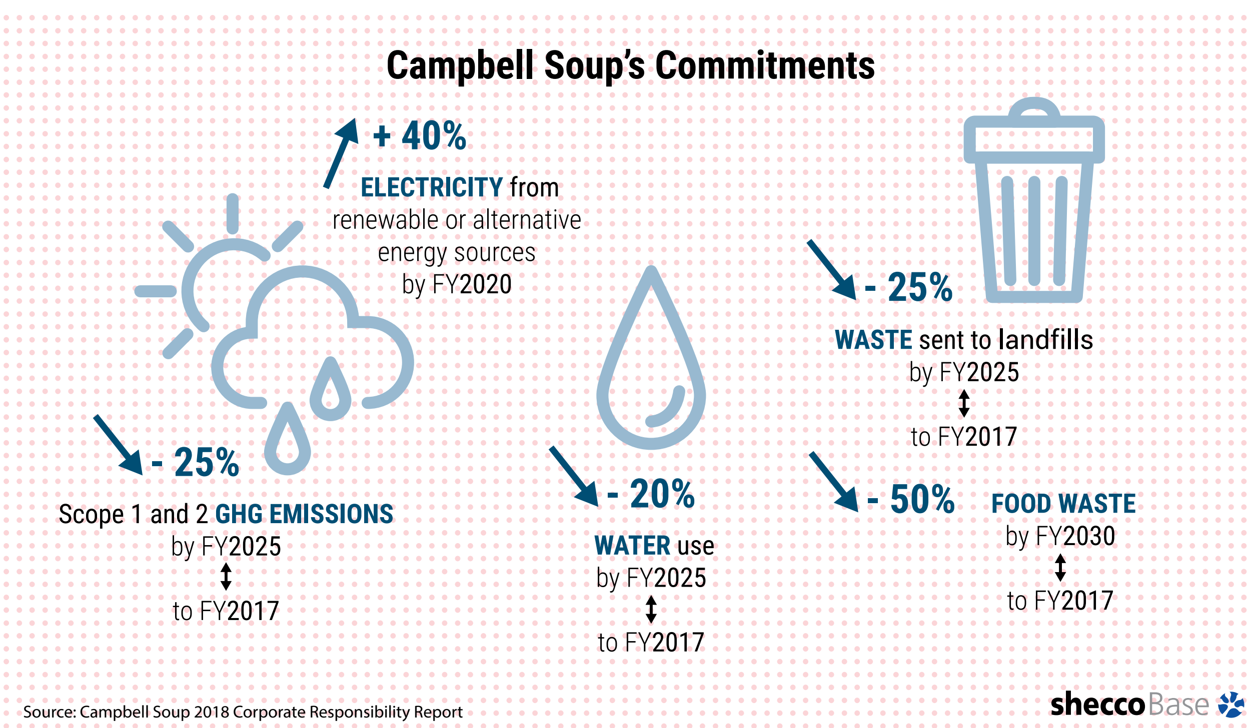
However, for a much larger (300-TR) load at a thermal plant in Napoleon, Ohio, Campbell installed a air-cooled ammonia chiller from Azane that produces cold glycol used by an air handler to generate air conditioning. "There was nothing else on that side of the plant," said Parra. "So we put the Azane unit there." (See "NatRefs for AC," *Accelerate America*, October 2017.)

"It made more sense to drop [the Azane unit] in," said Cheng. "It's working fine."

In general, Campbell's operating guidance is "to remove HFC whenever possible," said Parra. (Campbell has to date not used HFO blends.) That guidance stems from Campbell participation in the Consumer Goods Forum, which has pledged as a group to phase out HFCs and transition to climate-friendly refrigerants. (See page 47.)

"We're still committed to our Consumer Goods Forum's commitments," said Cheng.

And Cheng, who last year added management of environmental and sustainability programs to his title, is committed to achieving sustainability goals established by Campbell, not only in refrigeration but also water usage, overall greenhouse gas emissions and waste reduction. "It's a passion of mine," he said. ■ MG



CAMPBELL CO_2 SYSTEM SPECS

LAKELAND, FLA. CASCADE INGREDIENT FREEZER (2017)

- Capacity: 7.2 TR
- Size of freezer area (sq ft): 647
- Temperature of freezer : -10°F
- Charge of CO_2: 200 lbs
- Supplier CO_2 rack: CRT Engineering
- Supplier of glycol/CO_2 heat exchanger: Vahterus
- Supplier of CO_2 evaporator: Bohn
- Supplier of two CO_2 compressors: Copeland
- Supplier of CO_2 detection system: Calibration Technologies, Inc.
- Supplier of CO_2 rack controller: Allen Bradley
- Supplier of CO_2 valves: Danfoss
- Type of CO_2 piping: Copper

DOWNINGTOWN, PA. CASCADE SPIRAL PRODUCTION FREEZER (2018)

- Capacity: 110 TR
- Temperature of freezer : -30°F
- Supplier CO_2 rack: Hillphoenix
- Supplier of CO_2 evaporator: Evapco
- Supplier of CO_2 detection system: Calibration Technologies, Inc.
- Supplier of CO_2 rack controller: Micro Thermo
- Supplier of CO_2 valves: Sporlan
- Type of CO_2 piping: XHP Copper

DENVER, PA. CASCADE FREEZER (2019)

- Capacity: 6 TR
- Size of freezer area (sq ft): 800
- Temperature of freezer: -10°F
- Charge of CO_2: 40 lbs
- Supplier rooftop CO_2 rack: Zero Zone
- Supplier of glycol/CO_2 heat exchanger: SWEP
- Supplier of two CO_2 compressors: Bitzer
- Supplier of CO_2 detection system: Calibration Technologies Inc.
- Supplier of CO_2 rack controller: Allen Bradley
- Type of CO_2 piping: XHP Copper

CAMDEN, N.J. TRANSCRITICAL INGREDIENT COOLER & FREEZER (2018)

- **Capacity: 30 TR**
- **Size of freezer room (sq ft): 3,025**
- **Size of cooler room (sq ft): 1,144**
- **Temperature of freezer: 0°F**
- **Temperature of cooler: 35°F**
- **Supplier of CO_2 rack: Hillphoenix**
- **Supplier of gas cooler/condenser: Luvata**
- **Supplier of CO_2 evaporator: Bohn**
- **Supplier of CO_2 detection system: Calibration Technologies, Inc.**
- **Supplier of CO_2 rack controller: Allen Bradley**
- **Supplier of CO_2 valves: Danfoss**
- **Type of CO_2 piping: Copper**