SPECIAL EDITION: 2020

ACCELERATE

ADVANCING HVAC&R NATURALLY

CORPORATE

FUTURE-PROOFING HVAC&R: THE 'NATURAL' CHOICE.

About
ACCELERATE CORPORATE

Accelerate Corporate captures the efforts of market leaders in advancing the use of natural refrigerants across different applications, industry sectors and continents.

Each issue of the magazine is prepared in partnership with an influential corporation, organisation or group of entities striving to accelerate the uptake of climate-friendly, natural refrigerant-based technologies.

Accelerate Corporate seeks to showcase end users' experiences working with natural refrigerants and to highlight the underlying market, policy and technology trends driving their uptake.

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Sphere.

CO_2: A Natural Solution for a Sustainable Future

– Editor's Note by Ilana Koegelenberg

Climate-friendly HVAC&R technologies using natural refrigerants are being adopted faster than ever as the world wakes up to the urgency of the climate crisis. These systems are no longer being viewed as just a "nice-to-have" but rather the go-to solution for future-proofing HVAC&R systems.

Indeed, as measures to mitigate carbon emissions intensify, natural refrigerants are becoming an ever more attractive option – and not just in the applications for which they have been traditionally employed. Gone are the days of using only ammonia for industrial applications and only CO_2 in commercial installations. Today, there are multiple natural solutions for every HVAC&R application – even in the domestic market.

CO_2 in particular is showing its diversity as end users around the world recognize its potential. From just 140 transcritical CO_2 installations in Europe in 2008, the technology has spread rapidly with an estimated nearly 30,000 systems installed globally today. The sheccoBase market report on page 22 shares an in-depth look into the global CO_2 market, highlighting key trends and developments to watch. (sheccoBase is a service of shecco, publisher of this magazine.)

Innovation is key to increasing the uptake of natural refrigerant installations around the world, and OEMs are investing a great deal in R&D and production infrastructure. Even in countries considered "developing", companies are no longer confined by what was previously thought "impossible."

One such OEM pioneer is Sphere Cooling Solutions, a CO_2 refrigeration-system designer, manufacturer and installer in South Africa. Together with its CRS and Matador Refrigeration companies, the Sphere group has equipped more than 150 stores with transcritical CO_2 refrigeration systems over the past decade. Read more about the company in a letter from its CEO on page 5.

One of these transcritical systems was designed for the Evergreens food retailer in South Africa – the largest retail installation of transcritical in the Southern Hemisphere (page 14). Another was food retailer SPAR's first transcritical CO_2 installation in South Africa (read more on page 12).

Sphere's systems aren't confined to the African continent. The company has supplied nine transcritical CO_2 systems to Australia as well (read more on page 20). It has also supplied an impressive 4MW (1,137.38TR) system to Yosemite Meat Co in California, U.S. (page 16).

The key to Sphere's success has been keeping up with technology trends. Sphere COO Wynand Groenewald has travelled around the world to present at ATMOsphere conferences (organized by shecco) on this topic. Read about his predictions on global technology trends on page 29.

One of the biggest global trends right now is the Cooling as a Service (CaaS) business model, especially developed to overcome key market and financial barriers to the adoption of energy-efficient cooling technologies and climate-friendly refrigerants. Read more about this on page 28.

I would like to take the opportunity to thank Sphere, whose support made this special edition of Accelerate Corporate possible. Join Sphere and other South African natural refrigerant players at the inaugural ATMOsphere Cape Town event on March 10, 2020 (check out the back page). I hope to see you there.

As we look through the lens to see what the future of refrigeration looks like, the vision in the proverbial crystal ball is clearly natural – just like the cool, "Spherical" theme of this edition...

Happy reading!

Ilana Koegelenberg
sheccoBase

In this issue

shecco™
SUSTAINING OUR ATMOSPHERE

A Passion for CO_2

At Sphere Cooling Solutions, we believe that we have a responsibility to play a role in shaping the future and we are inspired by the certainty that even a small change can have a significant and lasting positive impact.

— By Marcel Steinberg and Wynand Groenewald

Marcel Steinberg
CEO, Sphere

Sphere was born out of the long history of serving the African continent's needs for sustainable refrigeration solutions. With over 100 years of combined experience, Sphere was born to serve our customers' needs and adapt to the global trend for more globally relevant, sustainable, and green cooling solutions.

For over 10 years now, the Sphere group of companies has equipped more than 150 stores with transcritical CO_2 refrigeration, helping our clients save over 150,000MWh of energy, over 3,500,000 metric tons of CO_2e, and over 320,000Mℓ (84,535 Mgal) of water.

CRS, a Sphere company for over five years now, and celebrating 45 years of service to its customers, has been a pioneer for developing CO_2 technology in Africa. It designs and builds natural refrigeration plants capable of handling higher ambient conditions, which were traditionally considered "challenging" in terms of making efficient use of CO_2. In 2009, CRS built the first CO_2/R134a cascade system in Africa and the following year, the first transcritical CO_2 system on the continent.

In 2012, CRS designed and installed the first CO_2 transcritical booster system in Africa and in 2015, its list of Africa firsts included: first CO_2 booster system with parallel compression and ejectors; first CO_2 heat pump; and first CO_2 condensing unit.

> *"Sphere believes natural refrigeration is the future and wants to contribute to the industry in a positive way."*

In 2016, CRS was responsible for the continent's first CO_2 chiller and the first CO_2 training facility in Africa. In 2017, it designed the first CO_2 blast freezer in Africa and in 2018, the largest CO_2 trans-critical installation in the Southern Hemisphere: an impressive 2.75MW (782TR)! This is also the year that CRS went global with its first CO_2 transcritical installation in Melbourne, Australia and an impressive 4MW (1,137TR) transcritical installation in California, U.S.

Matador Refrigeration was founded in May 1958 and became part of the Sphere Group in 2017. Over the past 60 years, the company has grown into a national operation specializing in installation and servicing of supermarket refrigeration as well cold storage and industrial refrigeration. Having cemented long-standing relationships with large retailers for being innovators in engineering solutions, the Matador portfolio covers a full range of HVAC&R requirements.

In 2009, Matador built and installed its first CO_2 subcritical system in Chris Hani Mall in Johannesburg and in 2014, it installed its largest retail installation in Vanderbijlpark, boasting 1,300kW (370TR) medium temperature and 105.83kW (30.1TR) low temperature capacities. In 2017, it built its first transcritical CO_2 test plant, installing its first transcritical system for food retailer Pick 'n Pay the following year.

Together, Matador Refrigeration and CRS allow Sphere to offer end users a complete CO_2 solution – from design and manufacturing, to installation, servicing and even maintenance.

Sphere pioneers globally relevant, future-fit and insightful temperature control solutions for the built environment that also serve the long-term interests of broader society. We are passionate about creating a meaningful future, by not only ensuring we "do no harm" but also by consciously adding value through creativity, leadership and simplicity. That's why everything that we do is 'sustainable by design'.

SUSTAINABLE BY DESIGN

"Sustainable by design" isn't just what we do: expertly engineered solutions that are designed to be future-fit; it is also our approach to purposeful business, insight, partnerships, and people. We are passionate and focused, and we are conscious that every one of our actions must have a significant positive impact. We are mindful of the present and of the future, committed to practical idealism about the role we play in a changing world and the mindsets of all who live in it.

We design with a conscience. We create with foresight. We are "sustainable by design". Our systems are designed from first principle engineering methods with energy efficiency as the main driver.

An environmentally-friendly alternative, CO_2 is the world's number one choice of refrigerant. Global legislation, as well as the Kyoto and Montreal Protocols, which reviewed substances linked to ozone depletion and climate change, encourage its use. The Sphere team and entities has built up solid experience and a proven track-record in applying CO_2. We use it in all our ranges, bringing its advantages to customers and suppliers alike.

Our portfolio covers the full range of heating, ventilation and refrigeration (HVAC&R) requirements and includes the following: energy efficient CO_2 industrial and commercial refrigeration, CO_2 chillers, heat pumps and condensing units.

Sphere provides a 'green', technologically-advanced, customizable range of

solutions for our clients' cooling and heating needs. Harnessing our engineering, technical and design expertise, we can also design a unique product based on the size of the business, its requirements, and its goals.

We believe in a holistic approach to design and problem-solving where the goal is to make sure that no waste heat, cooling or water is disposed of but utilised within a system to ensure energy efficiency and sustainability.

With the lack of knowledge on how to handle natural refrigerants in high ambient temperatures, as well as the mentality of why change something that works, people have feared these new advances and have been put off by the supposed complexity of building new technology in Africa. That's where Spheres entities CRS and Matador come in with training facilities and programs.

Spheres entities have broken that barrier by constant R&D, working together with clients they have had for over 60 years, keeping them a "green" step ahead and becoming a forerunner in energy efficient cooling and heating systems.

GROWING A GLOBAL FOOTPRINT

It's not just in South Africa that Sphere has been making waves in the custom-built CO_2 rack market. In 2017, Sphere partnered with MB Refrigeration (part of the MB Group) to supply the Australia and New Zealand market.

In the U.S., Sphere partnered with Advanced Refrigeration (owned by Coolsys) through the collaboration on the world's largest transcritical CO_2 installation in California (4MW or 1,137TR). Sphere supplied the racks and Advanced Refrigeration acted as contractor and project manager.

Sphere is also driving natural cooling and heating solutions into the Asian market. Our regional collaboration brings over 50 years of design, manufacturing and installation experience within the HVAC&R sector. Headquartered in Singapore with an established partner network throughout the region, Sphere Asia is serving the market throughout the whole life-cycle from innovation to CO_2 training and after sales service.

THE FUTURE IS NATURAL

Sphere is always looking at improving and growing our products into different industries and sectors. Moving CO_2 into the industrial sector has been challenging but having done a few products for large food processing houses, as well as having the heat pumps go into the property development sector, Sphere is definitely looking to expand our reach in future.

From the success of all our global projects, we hope to carry on expanding our global footprint in the CO_2 market.

Our experience has laid the foundation to move our technology to the next level. Having overcome the initial hurdles of installing and operating a CO_2 system, Sphere is now looking to the future. The future holds constant innovation to make CO_2 fit for purpose and finding the optimum system to suit all the different sectors within the HVAC&R industry at the best cost and performance.

Sphere believes natural refrigeration is the future and wants to contribute to the industry in a positive way. Ensuring that natural refrigerants gets adopted faster into the market, Sphere will continue to partner with other entities, so we can spread the knowledge through training and ensure the right product enters the market. ■ MS & WG

An Ongoing Partnership to Help Australia Go Natural

We chat with Chris Paulson of Australian contracting company MB Group about how the working relationship with CRS/Sphere came about.

CRS/Sphere has been supplying transcritical CO_2 racks into the Australian market for two years now with the help of local contractor MB Refrigeration (part of the MB Group). We chat to Chris Paulson of MB Refrigeration about the uptake of CO_2 in Australia and the projects completed with CRS/Sphere's refrigeration racks.

HOW DID YOUR RELATIONSHIP WITH CRS/SPHERE START?

I first heard of CRS around 2010 from one of my then-employees who was from South Africa. He encouraged me to get in touch with CRS to discuss its CO_2 offering. Several years later in 2016, I finally connected with Dave Spence and Wynand Groenewald from CRS at an Air Conditioning Refrigeration Building Services (ARBS) event in Melbourne, Australia. We landed our first project in 2017 and we have been working together ever since.

HOW MANY PROJECTS HAVE YOU WORKED ON WITH SPHERE?

By December 2019, we will have completed eight transcritical CO_2 projects over the past 24 months with Sphere racks. Most of the projects have been retail projects, though we have also undertaken one light industrial/cold storage project (read more on page 20).

The projects have featured a range of componentry and design elements. All the projects thus far have used brazed plate heat exchangers (BPHE) for heat recovery for either space heating or underfloor heating. Additionally, most of the recent retail systems have also featured integrated chilled water for air-conditioning (via a chilled water BPHE).

There is a lot of local market interest in CO_2.

WHY WERE THESE PROJECTS SUITABLE FOR CO_2?

We've consistently found that CO_2 offers the best value proposition for a range of applications. Transcritical CO_2 systems can be slightly more expensive on the equipment side due to the requirement for high pressure componentry, but over the life of the asset, the total cost of ownership for the customer is lower. This is driven by various factors, but the main one is the mitigation of HFC refrigerant costs. Moving to CO_2 completely mitigates the price risk of the HFC phasedown for the customer.

Chris Paulsen, MB Group.

Additionally, the cost of CO_2 refrigerant is so low that it allows us to store spare refrigerant on site at minimal cost, which reduces both service costs and the risk of stock loss in the event of a system leak. When ownership costs are modelled over the life of the refrigeration system, these factors weigh in favor of a CO_2 solution.

We have also identified two applications in which CO_2 offers a clear capital expenditure (CAPEX) advantage for customers, namely 1) large industrial systems and 2) integrated refrigerated-mechanical systems.

In the former case (large industrial systems), it is because CO_2 scales very economically. We have found that the marginal cost of increasing pack capacity is quite low once you are past approximately 250kW (71.1TR) on a pack. At the system level the volumetric efficiency of CO_2 also comes into play, allowing for compact componentry, reduced pipe diameters, reduced equipment mass etc. These design elements all help reduce the turnkey system price. The gas coolers for these applications are also compact, economical, and technically simplistic relative to most incumbent industrial system designs for condensers, dry-coolers, cooling towers or other types of evaporative coolers.

In the latter case (integrated refrigerated-mechanical systems), the CAPEX savings arises due to the modest marginal cost to upgrade the parallel suction group into an integrated chiller to accommodate space cooling requirements. The ancillary equipment needed to operate the suction group as a chiller is already in place (electrical, controls, piping, framing, etc.). So, for a modest cost increase, it is possible to build an integrated CO_2 chiller directly into the pack. When coupled with an ejector, an integrated chiller offers a coefficient of performance (COP) that is comparable to most standard commercial HVAC cooling systems. When viewed as a combined heating and cooling system, the Seasonal COP (SCOP) over the course of a year on an integrated pack is extremely compelling, since the heating is essentially free.

WHY DID IT MAKE SENSE TO USE A SOUTH AFRICAN SUPPLIER AS OPPOSED TO A LOCAL ONE?

The key advantages with CRS/Sphere were the extensive high ambient experience, the engineering support, and the design ethos. Sphere has over 10 years of transcritical CO_2 experience in high ambient conditions. There was no other supplier with this unique background.

> *"Ultimately, CO_2 adoption in Australia will be driven by the large retailers."*
>
> - Chris Paulson, MB Group

Sphere has also designed its equipment from the ground up using in-house engineering expertise while pursuing a design that has been heavily influenced by direct feedback from service technicians in the field. This has resulted in a solution that is both well-designed for high ambient conditions and is also highly serviceable. It was important to us to work with a supplier who had firm control of their product design and could engineer bespoke solutions as needed, who had proven experience in high ambient conditions and who had experience with retail service requirements. Sphere met all three requirements.

HOW HAS THE UPTAKE OF CO_2 TRANSCRITICAL SYSTEMS BEEN IN AUSTRALIA IN GENERAL?

It is accelerating slowly. In our case, 80% of our projects over the past two years have been transcritical CO_2, but we are a relatively small contractor in the national market. Ultimately, CO_2 adoption in Australia will be driven by the large retailers. There are enough contractors, equipment suppliers and wholesalers in place to support widescale transcritical CO_2 adoption in the Australian market. In my view, the supply-side market constraints on CO_2 adoption have almost completely lifted over the past few years, and from 2020 onwards the pace of adoption will be dictated exclusively by the retailers.

WHY ARE MORE CLIENTS NOT INSTALLING TRANSCRITICAL CO_2 SYSTEMS IN AUSTRALIA?

There are some perceived challenges around high ambient locations (e.g. Queensland), but I think that mental barrier will be broken in the next 12 months, if not sooner. We are currently pursuing CO_2 projects in Queensland, and if it's not MB Group it will be someone else who completes a project there (if they haven't already).

At this point, there are thousands of transcritical CO_2 systems installed globally. The technology risk is minimal, so from a contractor standpoint there are no more barriers. Anyone willing to learn about transcritical CO_2 systems can do so, with excellent support from a variety of global suppliers in the local Australian market. At this point, I think the larger end-users are simply proceeding slowly out of an abundance of caution.

HOW DO YOU SEE THE FUTURE OF CO_2 INSTALLATIONS IN AUSTRALIA?

I think it will accelerate very quickly from here. Once the large retailers have locked in their preferred solutions and suppliers, it will scale up very quickly. ■ IK

Sphere CO_2 installations around the world

Types of CO_2 applications

Firmino Patricio of SPAR (left) and Grant Ford of Matador Refrigeration.

SPAR Opens First Transcritial CO_2 Store in South Africa

The food retailer scrapped its existing premises and R22/R404A refrigeration system to invest in a more future-proof, energy efficient solution for its Middelburg store.

"With the advancements in transcritical CO_2 refrigeration, we were confident that our retailers would eventually be able to combat not only the environmental issues surrounding HFCs, but also be able to surpass the energy efficiencies of HFC plants."

- Wayne Dedekind, SPAR South Africa

In a total refurbishment, SuperSPAR Wonderpark in Middelburg not only completely rebuilt its premises from scratch, but replaced its existing R22/R404A refrigeration system with a transcritical CO_2 system built by Sphere's Matador Refrigeration contracting division. This is the first Spar in South Africa to install a natural refrigeration system and the end user is very happy with the result.

The 3,700m² (39,827ft²) SPAR Wonderpark project commenced late 2018 and was completed on time by September 25, 2019. The store belongs to the Patricio Group, who owns five Spar stores across the Limpopo and Mpumalanga provinces in South Africa. It has worked with Matador Refrigeration before on various other projects and the two companies have a good working relationship. As such, upon deciding to go the CO_2 route, Matador was a natural choice for Patricio.

Grant Ford, Sales Director of Matador, then pitched the idea of a transcritical CO_2 system to the client, explaining the various benefits such as future-proofing the installation. "We were aware of the fast-growing increase in the price of synthetic refrigerants," explained Firmino Patricio, Owner of SuperSPAR Wonderpark. "And by installing a CO_2 system, it would help us negate this future problem."

Matador then supplied and installed a CO_2 booster system with parallel compression, including evaporator coils and expansion valves. Carel electronic controls and a monitoring system was also installed with dial-in facilities. It was designed to operate at 36°C (96.8°F) ambient conditions, 1,371m (4,498ft) above sea level.

The system's capacity is 265kW (75.35TR) at -6.5°C (20.3°F) on the medium temperature (MT) side with low temperature (LT) on: 23kW (6.54TR) at -35°C (9°F), which offers a greater capacity than the previous refrigeration system. It is used for the cooling of all cabinets, cold rooms, and freezer rooms. A custom biltong (local dried meat) drying room was also installed on site. There are 27 cabinets and nine rooms operating on the MT side, with four LT rooms as well.

The system was designed complete with hot water reclaim, heating 500L (132 gal) of water from 20°C to 55°C (68°F to 131°F). An Adiabatic gas cooler was also installed to maintain a 28°C (82.4°F) gas cooler outlet temperature for maximum energy savings. All cabinets are fitted with acrylic doors to further improve energy efficiency.

There were no challenges on this project and things ran according to plan. This was because of great planning and coordination between client and contractor, explained Ford. The client reported that they are happy with how the plant is running. "The installation and running of the plant have been seamless," according to Patricio.

Although it's too early to tell exactly how much the new refrigeration is saving SPAR, it is performing as it should. "Through careful commissioning and monitoring, it's apparent that the system is running optimally and efficiently," confirmed Ford.

"We have been monitoring the development of CO_2 refrigeration systems for some time, however prior to transcritical systems, the South African climate had a significant impact on the efficiencies of these systems," Wayne Dedekind, Group Development Manager for SPAR South Africa stated. "With the advancements in transcritical CO_2 refrigeration, we were confident that our retailers would eventually be able to combat not only the environmental issues surrounding HFCs, but also be able to surpass the energy efficiencies of HFC plants."

"Mr. Patricio was the first of our independent retailers to acknowledge the inevitable future of refrigeration for The SPAR Group South Africa, and we have since opened a second CO_2 site, with the objective to open another 10 sites for 2020," said Dedekind. ■ IK

PROJECT TEAM AND SUPPLIERS

- ***Owner/Developer***: Patricio & Sons Properties
- ***Architect/Designer***: AW Austin Architects
- ***Project manager***: Seome Quantity Surveyors
- ***Main contractor***: LLG Projects
- ***Health and safety***: Safety Solutions
- ***Refrigeration contractor***: Matador Refrigeration (Sphere)
- ***Compressors***: Bitzer
- ***Controls***: Carel
- ***Switch gear***: Hager and Laevato
- ***Oil management***: Emerson
- ***Brace plates heat exchange***: Swep
- ***Cabinets***: ColCab

DATA EXTRACTED AFTER FIRST MONTH OF OPERATION (OCTOBER 2019)

- ***Average Amps***: 109.04
- ***Average Kva***: 74.5
- ***Average kW***: 68.32

1.9MW of CO_2 for South African Produce Market

Evergreens, the largest independent fresh produce retail/warehouse store in the Southern Hemisphere chooses industrial-scale transcritical CO_2 to feed its 167 refrigeration points.

When it comes to its food offerings, South African retail/wholesale outlet Evergreens is very hands-on, visiting every farm and factory before taking in their products. Similarly, company executives visited refrigeration manufacturer CRS's workshop to make sure they were happy with the operation before agreeing to let the OEM build their new transcritical CO_2 refrigeration system.

South Africa-Based CRS (a subsidiary of holding company Sphere), then custom-designed, built, and manufactured the system, and installed it at Evergreens' brand new 22,000m² (236, 806ft²) store in Johannesburg, South Africa, which opened in August. Evergreens' other store, in Pretoria, employs an HFC-based refrigeration system.

The new store boasts the largest transcritical CO_2 installation in the South African commercial sector – and one of the largest commercial systems in the world – with a refrigeration capacity of 1.9MW (540TR) serving 167 loads, says CRS.

"With the rise in prices of synthetic refrigerants and the plan to phase them down, it was only a natural choice to choose a CO_2 refrigeration system," said David Lopes, Senior Buyer and Project Manager for New Business. "Not only do we at Evergreen place ourselves in a position to reduce future costs but also reduce our carbon footprint by using a natural gas."

CRS, the primary supplier of CO_2 systems in South Africa, has installed more than 100 transcritical CO_2 systems in the country (and beyond). Evergreens, however, is their largest commercial installation to date with a capacity more akin to an industrial system. Transcritical CO_2 is, in fact, being adopted by a growing number of cold-storage plants around the world.

Established 35 years ago, Evergreens is a one-stop shop that supplies fresh produce, groceries and frozen goods for both retail and

1 / Evergreens in Johannesburg, South Africa.

> *"Not only do we at Evergreen place ourselves in a position to reduce future costs but also reduce our carbon footprint by using a natural gas."*
>
> - David Lopes, Evergreens

bulk shoppers, including everything from restaurants and schools to hotels and nursing homes. It includes a butchery, a bakery and a hot-foods section that the company is looking to expand. There is even an onsite packaging and processing facility to deal with produce as it comes into the receiving side.

The business commands high food-safety standards in all practices, with multi-temperature refrigerated trucks to ensure the products last as long as possible. It employs its own buyers who source produce directly from farms daily via nearly 500 suppliers.

"Being passionate about fresh produce and ensuring our clients receive the highest quality produce is what has made Evergreen successful and by using a CO_2 refrigeration system, we have given back to the earth by reducing the carbon footprint by being as sustainable as possible," said Lopes.

KIGALI'S IMPACT

Although CO_2 seems like an unconventional choice for this type of installation, there has been a big push for South African retailers to go green and opt for natural refrigerants to bring local stores in line with global policy. The Kigali Amendment to the Montreal Protocol – ratified by South Africa on August 1 – continues to have a great impact on the future of refrigerants around the world, adding pressure to phase down towards more environmentally friendly refrigeration systems.

CRS pitched the CO_2 option to Evergreens as the size of the project meant that it fell into a gap where it is large enough for it to be cheaper than a synthetic-refrigerant solution and small enough to be cheaper than ammonia. Not only was the capital expenditure less than the alternatives, but CO_2 provided the benefit of being more energy efficient.

"The client was looking for a future-proof solution and after considering the environmental impact of different refrigerants and the phase out and phase down of greenhouse gases, they decided that CO_2 was the better option," said Maurice Robinson, director of sales and marketing at Sphere.

In addition to two transcritical racks, CRS supplied the evaporators, as well as a monitoring system. The refrigeration racks were all custom-built and locally manufactured at the CRS premises in Johannesburg.

The main distribution board manages the racks as well as the evaporator coils. The racks, each with medium-temperature and low-temperature circuits, cool about 167 points, including various cold and freezer rooms, freezer and cold cabinets, and chillers.

Loads range in temperature depending on the product, with the freezer rooms being kept at -20°C (-4°F), the citrus at 2°C to 5°C (35.6°F to 41°F), and the avocados and bananas at 14°C (57.2°F). This is because if it is too hot, it will ripen fruit too fast, and if too cold, will make the fruit go black.

There are night blinds on all cabinets and freezers on the shop floor to ensure no energy is wasted because of unnecessary refrigeration. (No doors are used.)

The large vegetable rooms can fit 1,500 pallets and employs 12m (39.4ft) insulated panels from Dalucon – the largest single-mold injected panels available locally. The rooms are also equipped with Storax mobile racking from Barpro Storage that can move within just 2mm (0.8in) from one another before a sensor automatically stops them.

The estimated heat rejection is around 384kW (109TR), and this is used to heat water from 20°C to 55°C (68°F to 131°F). Hot gas defrost has been included instead of the normal element heater that uses a lot of electricity.

"Using heat reclaim and hot-gas defrost minimizes the need for electrical elements within the store set up, reducing the overall energy consumption of the fresh market," said Robinson.

HAPPY SO FAR

So far, Evergreens is very happy with the refrigeration installation and how it is running, confirmed Lopes.

"The site is relatively new and therefore the plant has run for only a few months and while the initial indicators currently show good performance levels, we will continue to monitor the consumption," said Robinson.

The system was sized for future expansion, with an extra 24 refrigeration points available for new cabinets.

Future plans include adding a coffee shop above the shop floor and a 1,200m² (12,916ft²) liquor store (which should be open by the end of the year). ■ IK

Colossal Industrial Transcritical CO_2 System Custom-Made for Yosemite

Commercial Refrigeration Services (CRS)/Sphere supplied an impressive 4MW (1,137.38TR) system to Yosemite Meat Co in California, U.S.

In 2018, CRS/Sphere designed, manufactured and shipped five refrigeration racks amounting to 4MW (1,137TR) of cooling to Yosemite Meat Co., a meat processing facility in California, U.S. The project was handled by California (U.S.)-based contractor, Coolsys, and at the time, it was the largest installation of this kind in the world.

In 2017, Michael Lau and his team at Yosemite Meat Co. had a vision of expanding this family-owned pork processing plant into a larger, state-of-the-art facility, allowing space for business growth, improved efficiency and the ability to have future capacity available. As such, an abandoned facility in Stockton, California, U.S. was chosen as the location.

CHOOSING CO_2 AS REFRIGERANT

Once the location was sorted, the next step was to determine what the best way was to refrigerate this new operation. The old facility had an ammonia 1970s semi-disconnected plant that could no longer keep up with the ever-growing refrigeration demand.

When it came to selecting the refrigeration system, the client brief required the following:

- The final solution had to be environmentally best in class;
- Safety was of critical importance;
- Using a non-corrosive substance as the refrigerant;
- Eliminating as many emergency and life safety issues as possible;
- Ability to generate a significant amount of reclaimed heat;
- And whatever the choice, it must be cost effective on both first cost and operating costs.

A CO_2 system ticks all these boxes and thus became the refrigerant of choice after an exhaustive study.

"We researched all different refrigerant systems and decided on CO_2 based on the evaluation of many factors," explained Lau, Owner of Yosemite. "Our company saw benefits in choosing CO_2 with the tightening regulatory environment in California. Additionally, CO_2 provides a story to incorporate into our future path as a leader among energy efficiency and as a low GHG food processing facility."

After the consultants on the project met CRS at one of the ATMOsphere America conferences, they contacted the team to quote on the manufacture, supply and commission of five refrigeration racks to handle the large 4MW (1,137RT) capacity.

"Although CO_2 is often more expensive than conventional synthetic refrigerant systems on smaller scales, the CO_2 solution becomes financially acceptable when implemented on larger scales, as in this case," explained Shaun Hadfield, CRS Managing Director.

The refrigeration racks were all manufactured in South Africa.

A total of five R744 racks were needed to cool Yosemite.

Another benefit of CO_2 over other natural refrigerants is that it is a non-toxic substance that is safe for use in the food industry, thus an intermediate glycol system is not required between the CO_2 and the refrigeration coils, explained Hadfield. "The other added saving, to the client for this project was the reduction of space required for the refrigeration racks, the plant room area was made smaller enabling the client to maximize on his production area," he said.

STATE-OF-THE ART REFRIGERATION

The entire facility is 199,993.46ft² (18,580m²) in size, of which 110,000ft² (10,219.3m²) comprises refrigerated space. These are divided up in many different dedicated areas as a production plant dictates and includes processing areas, cold-rooms, freezer rooms, and snap chills.

The heart of the system consists of five CRS/Sphere parallel compressor rack systems, each with 13 semi-hermetic compressors. Each rack is split up into three separate suction groups; one designed at -13°F (-25°C) for freezer space and chill tunnels; one at 20°F (-6.7°C) for processing spaces, cooler storage and shipping and receiving; and one at 38F (3.3°C) for parallel compression, required during transcritical operation. Each rack operates independently from the others, and loads are dispersed between the racks so that each space has redundancy in mind.

To efficiently operate a system such as this, key elements of consideration were the use of electronic expansion valves for each evaporator (required in a CO_2 system), distributed controls allowing plant operators visual indication of system operation features (refrigeration, defrost, alarm, cleaning, etc.), and distributed smart controls which enabled "zone like" control strategies for temperature monitoring, leak detection, defrost and refrigeration control, as well as electronic valve control.

Remote defrost panels were located near the evaporator loads, minimizing wiring requirements for high and low voltage needs. Variable speed evaporator fan controls were included, following California's Title 24 requirements for a refrigerated warehouse such as this.

Controls allow the fan speed to vary during certain times, minimizing fan input kW (TR), and saving energy. A Danfoss control system was selected as the controls of choice, allowing central oversight, but "smart" local independent controllers not requiring a host central processor.

"In selecting CO_2 as the refrigerant of choice, this enabled the design to take in a more 'commercial' approach in an 'industrial' setting," explained Bryan Beitler, Vice President Special Projects, CoolSys.

All piping was copper, either type K, or new "iron copper", where pressure considerations were taking into account in the design. Main lines are loop piped to the plant, allowing one main piping system from each rack to collect branch circuits from the refrigerated spaces. Localized isolation valves and controls allow independent localized control and access. Hot gas piping was distributed similarly, using a main hot gas supply and return line serving all positive defrost evaporators on each rack. Compressors used were Bitzer semi-hermetic design, equipped with variable speed drives on the lead compressors and standard components rated for higher pressure operation.

The inclusion of hybrid gas coolers on this system enables the system to function in transcritical mode, in a high ambient environment. The dry bulb design for the plant is 103°F (39.44°C), and with the addition of a wetted pad upstream of the gas cooler coils, ambient temperatures are dropped to a significantly lower level, facilitating as efficient as transcritical operation as possible. When ambient temperatures are low enough, the system will automatically shift to sub-critical mode, disabling the parallel compressor function. The booster system design is built to take full advantage of every possible opportunity to run as efficiently as possible.

"With CO_2 operating in transcritical conditions it is possible to make use of up to 80% of the total heat rejection, which is not achievable with other refrigerants," explained Hadfield. This heat comes at no additional operating cost to the refrigeration system and can be used to heat domestic hot water, defrosting, and space heating to just name a few. Should a lot of heat be required, it is possible to manipulate the system to operate under transcritical conditions to supply the required heat without a high penalty in operating cost making it more efficient than any additional heating equipment on the market. This technology is suitable to any system and under any conditions.

Defrosting for lower temperature evaporators is accomplished with hot gas. Unlike the traditional CO_2 hot gas defrost solution, which uses the low temperature discharge gas, CRS decided to use the medium temperature discharge gas to gain as much sensible heat to reduce the defrosting period. A four-pipe system is used, with controls on the rack to supply gas volume to the system, and localized suction stop/hot gas solenoid/bypass check valve assemblies installed at each coil. Using hot gas allows further use of the system's waste heat, minimizing electrical resistant heat needs with alternative defrost types. In addition to the use of heat for defrosting, it is also used for warming under slab glycol for heating systems, and for hot water used for wash-down. Each rack is equipped with high side plate heat exchangers for extracting the majority of heat used for the system's hot water needs.

Adiabatic condensers were added to the gas cooler to bring the ambient temperature down to the wet bulb temperature, reducing the discharge pressure of the refrigeration system and making it more efficient. This ensured that minimum potable water is used and where possible, that reclaimed water is used so as to still have a water neutral installation. This technology works best in high ambient with low relative humidity. "There is an additional cost to adding adiabatic but using the water when required saves energy," said Hadfield. "Making use of adiabatic gas coolers can lead up to approximately 20% of energy savings compared to dry coolers in the summer months."

Also, thanks to built-in parallel compression, an approximate 10% energy saving can be obtained compared to a booster system.

CHALLENGES

As CRS is South African-based, the team had to learn about UL certifications – not only conforming to UL manufacturing standards but also making sure they used UL certified components. This meant that a great deal of research was needed with the help of expert consultants from the U.S. as well as researching suppliers that have all the required UL certificates.

Exporting a complete rack to the U.S. was another new task due to having to learn the legalities and logistics that are required by the officials for transporting machinery and different components that made up the refrigeration packs. "While considering different methods for transport you can have high cost variances and varied lead times depending on shipping vs flying the equipment to the overseas destination," explained Hadfield.

OPENING THE DOOR FOR NATURAL REFRIGERANTS

The plant has just recently been commissioned and they have been able to reach the required temperatures. The client has stated that they happy with the way its running as it is a lot quieter and is showing signs of being more energy efficient. "So far, the system has performed to expectations providing refrigerated cooling for product storage and hot water through heat recovery," said Lau.

"It is an exciting new chapter with respect to natural refrigerant use, the possibilities are extraordinary for use of CO_2 with facilities such as this," said Beitler. ■ IK

YOSEMITE'S REFRIGERATION IN NUMBERS

- 87 evaporators
- 65 compressors
- 2,450 compressor HP
- 1,398 tons of CO_2 refrigeration capacity

SYSTEM CAPACITIES

- ***Full system capacity***: 4MW (1,137.38TR)
- ***Medium temperature*** at -6°C (21.2°F) suction
- ***Low temperature*** at -32°C (-25.6°F) suction
- ***Heat reclaim capacity***: 2.2MW (625.6TR) at 20-30% of full capacity

SUPPLIERS

- ***Compressors***: Bitzer
- ***Liquid receiver, oil separator, oil reservoir, and filter drier***: Temprite
- ***Strainer, solenoid valve, and PD Valve***: ESK
- ***Brazed plate heat exchangers***: SWEP
- ***Oil regulator and oil filter***: Emerson
- ***Pressure gauges***: Ashcroft
- ***High pressure valve, bypass valve, controlled relief***: Danfoss
- ***Safety valves and change-over valve***: Refrigera
- ***SS ball valves***: Castel

Taking South African CO_2 Expertise to Australia

CRS/Sphere has designed, manufactured, and supplied a total of nine transcritical CO_2 refrigeration systems in the Australian market over the past two years.

With the help of Australian contractor MB Refrigeration, CRS/Sphere has successfully supplied eight commercial transcritical CO_2 retail systems and one light industrial cold store in Australia.

In 2017, there were a limited number of CO_2 refrigeration rack manufacturers in the Australian market, which meant that this equipment was usually imported from Europe, explained Wynand Groenewald, Sphere Chief Technology Officer (CTO). However, not only was this expensive, but the equipment was often not suitable for higher ambient climates such as Australia. As such, it made sense for MB Refrigeration to partner up with CRS/Sphere. (Read more about how the relationship with CRS/Sphere and MB Refrigeration started on the page… Q&A with Chris Paulson.)

The first refrigeration rack Sphere's Commercial Refrigeration Services (CRS) business supplied into Australia was for an IGA supermarket in 2017 – IGA Clarinda Village in Cranbourne West, Australia. This brand new IGA supermarket was kitted out with a transcritical CO_2 booster system that comprises a mix of scroll compressors on the low temperature side and semi-hermetic ones on the medium temperature.

THE RACK IS CAPABLE OF THE FOLLOWING CAPACITIES:

- Low temperature: 18kW (5.12TR) at -30°C (-22°F)
- Medium temperature: 70kW (19.9TR) at -5°C (23°F)

On the medium temperature, the system feeds the following: a 20-door glass door cold room for cold drinks; two produce cases; four deli cases; two dairy cases and one cooler for the meat prep area. There is also a 30-door glass door cold room in the liquor area. On the low temp side, the system supplies the four glass-door freezer and one 15-door freezer room.

The system was fitted with parallel compression to meet efficiency and sustainability goals. Heat reclaim of the CO_2 refrigeration system was incorporated into the pack therefore it makes no use of electrical elements or natural gas for space heating.

The rack was built in the CRS workshop in Johannesburg, South Africa and then shipped complete to Australia where it was piped into the system and connected to the cabinets and gas cooler.

It took about 10 weeks to build the plant at CRS before it was packed up and shipped to Australia where it arrived on site well in time for the ongoing project. It was shipped in December 2017.

Inside the IGA Cranbourne store.

The challenge of exporting CRS's first rack to Australia was found to be easier than anticipated. South Africa and Australia regulations are very close to each other and compliance was easy. The only challenge was getting third party sign off on the system design and supplying a receiver that complies with Australian regulations.

"Overall, we at CRS enjoyed the project a lot and were happy to see the first plant operating at optimum conditions," commented Groenewald at the time. "We hope that what we have learned from using CO_2 in high ambient conditions can be beneficial to the Australian market by implementing our solutions."

This was but the beginning and soon more IGA projects followed. In 2018 and 2019, CRS designed, manufactured and supplied seven more CO_2 transcritical systems, all booster systems with parallel compression. All systems were complete with heat reclaim and featured either Danfoss or Carel controls. Copeland compressors were used throughout, except for the Nowra project, which featured Franscold compressors.

THE PROJECTS HAD THE FOLLOWING SPECIFICATIONS:

SIMS Footscray

- Low temperature capacity: 18kW (5.12TR) at -28°C (-18.4°)
- Medium temperature capacity: 142kW (40.38TR) at -5°C (23°F)

Salt Water

- Low temperature capacity: 16.35kW (4.65TR) at -28°C (-18.4°)
- Medium temperature capacity: 63.79kW (18.14TR) at -5°C (23°F)

Oasis

- Low temperature capacity: 16.35kW (4.65TR) at -27°C (-16.6°)
- Medium temperature capacity: 37.38kW (10.63TR) at -5°C (23°F)

Cockatoo

- Low temperature capacity: 21.2kW (6.03TR) at -27.5°C (-17.5°C)
- Medium temperature capacity: 111.9kW (31.82TR) at -6°C (21.2°F)

Keysborough (two systems)

- Low temperature capacity: 19.86kW (95.65TR) at -33°C and 20.68kW (5.89TR) at -26°C (-14.8°F)
- Medium temperature capacity: 85.39kW (24.28TR) at -8°C and 78.48kW (22.32TR) at -6°C (21.2°F)

Nowra (cold stores and freezer rooms)

- Low temperature capacity: 109kW (31TR) at -33°C (-24.7°F)
- Medium temperature capacity: 148.6kW (42.25TR) at -7°C (19.4°F)

One of the latest projects CRS completed in Australia was the new IGA Supa retail and liquor store, which opened in Creswick, Australia on August 8, 2019. The refrigeration system was also a CO_2 booster system with parallel compression where the excess heat generated by the CO_2 system is used for heating and hot water needs.

THE RACK COMPRISED:

- Three low temperature compressors;
- Three medium temperature compressors;
- Three parallel compressors;
- 60bar intermediate pressure rating; and
- Two ejectors.

CAPACITY:

- 29kW (8.25TR) at -27°C (-16.6°F)
- 134kW (38.1TR) at -8°C (17.6°F)
- 88kW (25TR) AC load

"From the success of these projects using CRS's technology and the influence of MB Refrigeration to penetrate the market, the opportunity to grow the pipeline in Australia and New Zealand is optimistic," said Maurice Robison, Marketing and Sales Director of Sphere. ■ IK

The CO_2 Revolution is Spreading

As transcritical CO_2 installations take an ever-growing share of the food retail market, the technology is expanding into sectors for which it was previously thought unsuited.

- By Ilana Koegelenberg, sheccoBase

From just 140 transcritical CO_2 installations in 2008 (all of which were in Europe), the technology has spread rapidly around the world with an estimated 30,000 systems installed globally today. But transcritical CO_2 is no longer seen as an exclusively supermarket solution, with various opportunities within the small store and even the industrial sector also driving the shift towards a more "natural" future.

The number of transcritical CO_2 installations keeps growing as industry finds innovative ways to realize the potential of CO_2, even in warmer ambient climates previously thought incompatible with transcritical systems. Ice rink applications in particular are also becoming ever-more popular globally.

INSTALLATIONS AROUND THE WORLD

sheccoBase, the market intelligence arm of Accelerate Magazine publisher shecco, estimates that although 89% of the transcritical CO_2 installations in Europe are still in the supermarket sector, small stores are taking 8% of the market share now with 3% for the industrial market.

Currently at around 23,000 installations, continued exponential growth is projected for transcritical CO_2 installations in Europe with an estimated 4,000 to 7,000 new stores annually. Europe is expected to reach between 73,000 and 92,000 CO_2 installations by 2030. Although still significantly less than in supermarkets, industrial projects with CO_2 transcritical refrigeration systems are becoming increasingly popular with over 700 known installations in Europe so far.

In North America, there are more than 550 transcritical CO_2 installations, 93% of which are for supermarket projects, 7% for industrial. Canada has 320+ installations: 84% supermarket and 16% industrial sites.

In Japan, small stores have traditionally been the most active user of CO_2. However, there has been strong interest in larger installations over the past two years thanks to eased restrictions on CO_2 usage. Government incentives play a big role for transcritical CO_2 growth in all applications in Japan. The country boasts more than 4,500 installations: 94% small stores, 5% supermarkets and 1% industrial sites.

In South Africa, retail still takes the lion share of CO_2 installations, with interest slowly growing in the industrial market. Local OEM Sphere has supplied three small stores, seven industrial sites and 119 supermarket installations so far with other competitors supplying numerous other supermarkets.

Unfortunately, Australia is slow on the uptake of CO_2 with most of its transcritical CO_2 installations in the retail sector. This number is estimated at about 35, with New Zealand at around 60.

Other countries are also showing interest, with Malaysia installing its first CO_2 system in 2017 and Indonesia boasting 13 CO_2 stores so far. Transcritical CO_2 installations have been documented all around the world, even in Jordan, Columbia, Argentina, Taiwan, and Russia. China only has three installations that we're aware of.

CO_2 TECHNOLOGIES FOR SMALL STORES

The condensing unit market is largely dominated by high-GWP HFCs, primarily supplied by Asian manufacturers.

CO_2 is the most environmentally friendly alternative for condensing units, applied already in a large number of convenience stores. An estimated 6,000+ stores use CO_2 condensing units and mini boosters globally, with a growing number of suppliers offering such equipment. There are more than 20 companies known to provide CO_2 condensing units and mini boosters in the market today.

In Japan, CO_2 condensing units have been a well-established technology for many years with more than 8,500 units running in the market by the end of 2017. One of the major suppliers of the technology recently presented findings on tests conducted with its new 20HP CO_2 condensing unit featuring heat reclaim. The system, which has an evaporating temperature of -15°C (5°F), also has the ability to supply 8.5l (2.25gal) of hot water per minute at 70.4°C (159°F).

In Europe and other parts of the world, retailers that have gained experience with CO_2 in supermarket refrigeration have pushed manufacturers to commercialize and decrease the cost of CO_2 condensing units and mini boosters. The result of this is a growing number of commercially available CO_2-based products to fulfil the cooling needs in small stores.

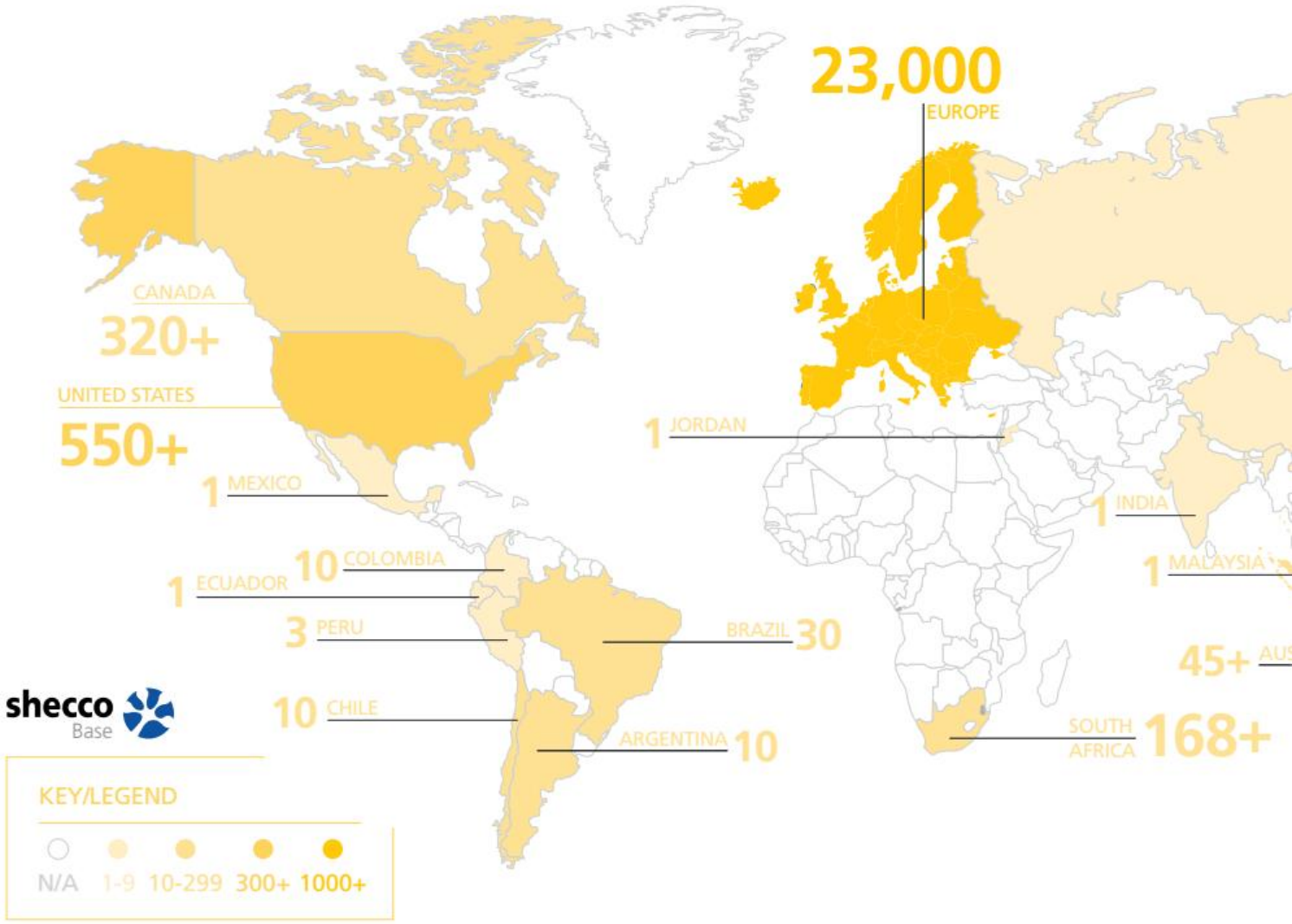
There are more than 4,000 CO_2 plug-in self-contained units (with the condensing unit built in) installed today. Interestingly, besides CO_2, hydrocarbons are also making headway in the self-contained sector. The potential for hydrocarbon technology is significant and may become a more serious competitor to CO_2 provided that safety standards allow higher charges of the flammable refrigerant in a single refrigeration circuit.

GROWING MARKET FOR CO_2 IN INDUSTRIAL APPLICATIONS

After becoming well established in the commercial refrigeration market, manufacturers are focusing on developing transcritical CO_2 systems for larger applications in industrial refrigeration. Numerous examples from Europe indicate that

CO_2 transcritical installations in the world

October 2019



CO_2 is becoming increasingly competitive as a solution for this segment, with existing systems up to 2-3MW (568.7-853TR)– an area that until recently was exclusively dominated by ammonia. shecco estimates there are more than 200 known installations with CO_2 transcritical in industrial refrigeration, with more than 25 known suppliers offering such technology globally.

New technological developments, particularly for compressors, have allowed CO_2 transcritical systems to reach higher capacities and capture a part of the industrial refrigeration market. All major compressor manufacturers now claim to offer large-capacity compressors, with some aiming to push limits even further.

The industrial market is also moving toward CO_2-only systems due to the safety and technical challenges of using ammonia. According to engineers, CO_2 compressors can last as long as ammonia models without the need for special and more expensive components.

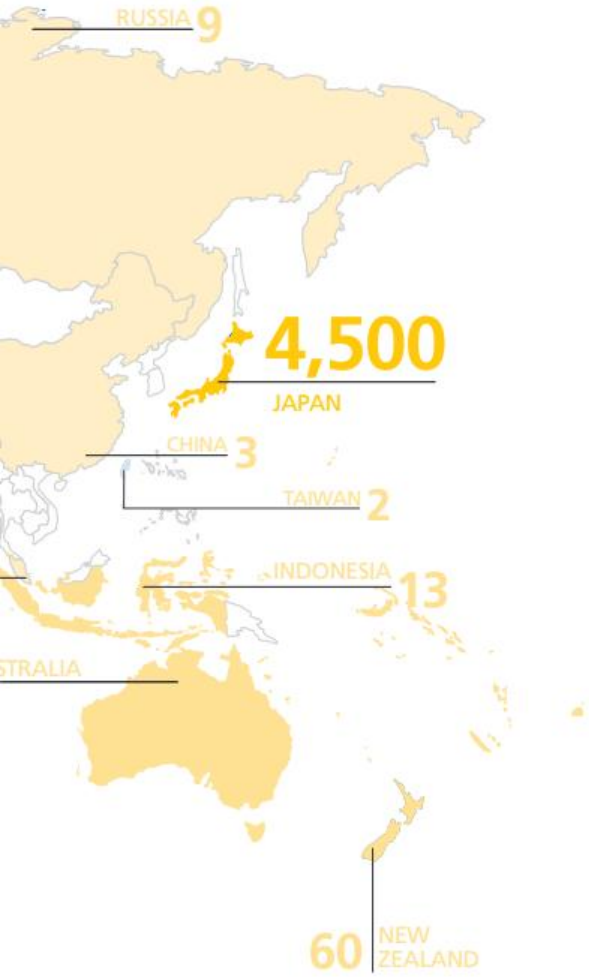
Transcritical CO_2 in this sector is expected to grow five-fold in the immediate future.

CO_2 ICE RINKS ON THE RISE

The market for CO_2 in ice rinks is relatively new, totalling about 60 installations in 2018, mostly in Europe and North America. Technology manufacturers believe that the running costs of transcritical CO_2 systems in ice rinks whether direct or using a secondary brine/glycol, are lower as compared to fluorinated refrigerants and ammonia, especially in mild and cold climates. This is mainly due to the possibility to use heat reclaim and the fact that CO_2 performs efficiently in such climates.

In terms of installation cost, a transcritical CO_2 direct ice rink system can run higher than systems using synthetic refrigerants or ammonia, mostly due to the stainless-steel piping required under the rink.

As a direct system, CO_2 is believed to produce better quality ice than a secondary glycol system, because CO_2 changes from liquid to gas under the rink, cooling the rink at a constant temperature throughout, in contrast with glycol, which produces slightly different temperatures across the rink.



Technologies to enhance energy efficiency of CO_2 in warmer climates

With innovations such as parallel compressor, ejectors, mechanical sub-cooling, and adiabatic/evaporative coolers, CO_2 transcritical technology is now suitable for climates up to 45°C (113°F).

Adding an adiabatic gas cooler to a CO_2 transcritical system in warmer climates offers additional annual energy savings of 8-12%, according to the 2018 Environmental Investigation Agency (EIA) "Summary: Technical Report on Energy Efficiency in HFC-free Supermarket Refrigeration" report. Parallel compression delivers 6-8% savings, and in combination with gas ejectors, savings can reach 8-10% compared to a transcritical system not using these enhancements. Some experts in the field believe that ejector technology is the solution to remove the CO_2 equator – a geographical line below which CO_2 systems were believed to be less energy efficient than their HFC counterparts.

CO_2 systems using ejectors have been reported to offer up to 40% energy savings compared to HFC systems. With parallel compression and ejectors the CO_2 transcritical technology is suitable for warmer climates up to 45°C (113°F). A study, supported by the Swiss Federal Office of Energy (SFOE) and published in December 2017 by the German magazine Kälte Klima Aktuell, reported that, "according to estimates, several hundred [CO_2] ejector systems are currently in use, the majority of which are in Europe." Migros, the largest retailer in Switzerland, in 2017, counted 60 stores fitted with CO_2 refrigeration technology using ejectors, and said it planned to add 30 more every year.

Although advanced CO_2 technology is now more expensive than HFC-based systems in terms of initial cost, costs are expected to go down as technology becomes more widespread (as has been proven for the standard CO_2 booster system). Industry experts estimate that with ejector technology and parallel compression, the price of a system is a maximum 10% higher.

GLOBAL TRENDS

Integration saves: There is a growing trend towards net-zero stores and the integration of refrigeration systems with HVAC to further reduce energy bills. Often the heat exchangers on the CO_2 refrigeration rack can also provide cold water for the air-conditioning needs of a project.

Heat recovery has also become a standard on many new installations, often negating the need for any additional domestic hot water heating. This can realize a significant energy saving, lowering the expected time for return on investment.

Energy providers: As supermarkets become more energy efficient, there is an opportunity to go from green grocers to green energy providers – connecting stores to the grid to provide clean energy. In many countries, CO_2 offers great opportunities in this regard without legal uncertainties.

Alternative finance models: Alternative financing models to reduce/avoid the initial cost barrier of installing a CO_2 system are becoming popular. The high CAPEX is no longer seen as a challenge with various options to lease or even outsource the refrigeration system. For instance, in South Africa, the outsourcing model is becoming more popular. End users simply pay for the cooling they use, as if they were paying a utility, without having to worry about the total cost or even maintenance of the system.

Smart systems and IoT: Integration of smart systems and IoT can be a game changer for HVAC&R. The principles of IoT are fundamental to the creation of a successful control and smart system strategy. Insight and automated processes lead to improved efficiencies, reducing operating costs, energy consumption and carbon footprint. ■ IK

COMING SOON: WORLD GUIDE TO TRANSCRITICAL CO_2 REFRIGERATION

shecco is currently working on the "World Guide to Transcritical CO_2 Refrigeration," which will be released in 2020 as a free online download.

This comprehensive report on CO_2 transcritical refrigeration will focus on commercial refrigeration (convenience stores and supermarkets) and industrial refrigeration, identifying market and technology trends in different parts of the world. It will answer the most pressing questions about the current and future market for transcritical CO_2, identify the key manufacturers and end-users, legislative drivers, and key technology innovations.

The report will be published in three parts, each focusing on a specific end user: supermarket refrigeration, industrial refrigeration and convenience stores (and other small store formats).

A survey will soon be released for industry input – please get involved!

CRS/Sphere Takes CO_2 Training into Own Hands

Sphere's Commercial Refrigeration Services (CRS) division has built three life-size, fully functioning transcritical CO_2 systems at its offices to enable training – both internally and externally.

In January 2019, CRS received its accreditation certificate from the Quality Council for Trades and Occupations (QCTO) to train and access the three HVAC&R qualifications registered by the South African Qualifications Authority (SAQA). It was the first South African company to be accredited for CO_2 training and also have in-house refrigeration racks.

The company now boasts three functional CO_2 training systems, configured using different components. The first system was initially built to exclusively train Woolworths staff and is a 60kW (17TR) system with Danfoss components. The company subsequently built another 60kW (17TR) system with Emerson components. Afterwards, it also completed a 5kW (1.4RT) CO_2 system with Carel components for more domestic applications.

With CRS manufacturing CO_2 plants for the entire range of applications, it intends to address the CO_2 Refrigeration Mechanic qualification in the following categories:

- CO_2 Refrigeration Mechanic up to 4kW (1.1TR)
- CO_2 Refrigeration Mechanic up to 100kW (28.4TR)
- CO_2 Refrigeration Mechanic up to 160kW (45.5TR)

These can easily be taught using the three transcritical refrigeration plants CRS currently has in the registered assessment center. For the industrial systems, meaning those over 400kW (113.8TR), assessment will be done on sites with the relevant capacity.

A GROWING NEED FOR TRAINING

"With having relied on using synthetic refrigerants for so long, there is a lack of knowledge on how to handle natural refrigerant in high ambient temperatures," explained Shaun Hadfield, CRS Managing Director. "The advancements have been off-putting and a stigma of the supposed complexity of building the new technology, has created a mentality of 'why change something that works?'."

Also, living in Africa has created an environment of its own unique challenges, but locally manufacturing the systems itself means that CRS is aware of difficulties that could arise and is able to create solutions to mitigate these potential problems. "We have found that there is a lack of skills development in natural refrigerant industry which has made it challenge when trying to hire new employees as the company expands locally in South Africa as well as globally around the world," said Hadfield. It was also challenging trying to sell the product to contractors to install with very little knowledge on new technology…

When interviewing qualified refrigeration mechanics for positions available, CRS found that some only have one year of working experience but are in possession of a valid, recent trade test certificate. During the interview, the candidates could not identify the components in the commercial refrigeration plant, while others only had working experience in air conditioning but also possessed the current refrigeration-mechanic trade test.

Even the candidates that they employed with more experience, who received their trade test in the early 1990s, are also experiencing difficulties with the current technology in refrigeration systems using synthetic refrigerants, never mind CO_2 systems.

As CRS's global CO_2 footprint grew, its need for training increased. However, there was nowhere to turn. So, they decided to take on the challenge

> *We have also realized the need for sharing the knowledge as it assists in expanding the company's growth, awareness, and knowledge required to help the fight against global warming and sustaining the environment.*
>
> - Shaun Hadfield, CRS

themselves, investing in an in-house training center for technicians, contractors and end users. This now allows for easily accessible training through courses and an open training facility in Johannesburg on the use of CO_2 and the benefits of such a system.

CRS/Sphere trains its staff and contractors to have the knowledge to understand its technology so that they can keep up with the maintenance and services of the client's projects, therefore giving them the assurance of the know-how of their products. "We believe in growing the economy of the country in which we operate and empowering the people of the country to stay employed and self-sustainable," said Hadfield.

"Having expanded in other countries such as the U.S., Australia and Vietnam, we have also realized the need for sharing the knowledge as it assists in expanding the company's growth, awareness, and knowledge required to help the fight against global warming and sustaining the environment," he said.

GROWING THE CO_2 SKILLS POOL

Being accredited has also allowed Sphere to take on apprentices to grow the virtually non-existent CO_2 technician skills pool in South Africa. The first intake of 10 apprentices started earlier this year, aiming to complete a part-qualification certificate once they have successfully completed the modules conducted in the workplace. They undergo added training on Saturdays according to the training schedule and will be enrolled for three years.

Apprentices will swap between companies (CRS and Matador) annually to gain working experience on different components and types of projects, becoming all-rounders in the commercial and industrial refrigeration trade.

"After completing the three-year experience with the 10 apprentices, integrating the occupational qualification, we will then be in a position to train larger groups internally and for the industry," explained Rudi Botha, Sphere's Training Manager. "Right now, it's CRS's priority to receive the occupational qualifications to be purposeful for the industry and to get our current employees qualified."

"This training process has benefited the company by having the apprentice onsite and not away for three months of training," explained Botha. "The benefit the apprentice received from this training is the practical and theoretical component is integrated every day. We intend to be completed with phase one of the training schedule by the end of this year." ■ IK

Rudi Botha, Sphere's Training Manager (on right) busy with internal training.

One of the CRS CO_2 training racks at its offices.

Cooling as a Service: A Game-Charger for Clean Cooling

Sphere has joined forces with this global pay-per-service model to help accelerate the adoption of natural refrigerants.

Sphere has partnered with the BASE (Basel Association for Sustainable Energy) in its Cooling as a Service (CaaS) initiative. CaaS is a concept business model especially developed to overcome key market and financial barriers to accelerate the adoption of energy efficient cooling technologies and the use of climate-friendly refrigerants.

BASE and Sphere have been working on the CaaS model for over a year to make it continent specific and help address the African need for environmentally friendly refrigerants without any bottlenecks to implementation such as prohibitive CAPEX costs.

"We are honored to be associated with Base and the CaaS program," said Marcel Steinberg, CEO of Sphere. "Sphere is a company truly focused on driving the adoption of natural refrigerants and we believe this partnership will help us achieve our goal of assisting Africa to leapfrog the use of HFCs as refrigerants and be early adopters of CO_2 refrigeration."

The CaaS initiative is led by BASE, along with the Kigali Cooling Efficiency Program (K-CEP), and endorsed by the Global Innovation Lab for Climate Finance. It aims to decrease energy consumption and GHG emissions from cooling use through a pay-per-service model for more efficient cooling systems, according to the BASE website.

Despite the lower life cycle cost of efficient technology resulting from reduced electricity consumption, investment decision is sensitive to purchase price, according to the CaaS website. Barriers such as limited knowledge of the benefits of energy efficiency, and high perceived performance risks of new technologies also hinder investments in clean and efficient cooling, such as natural refrigerant technology. "Cooling as a Service can help the much-needed transformation of the cooling sector so that the cooling needs of consumers, businesses and governments can be met without blowing the world's carbon budget," said Dan Hamza-Goodacre, Executive Director of K-CEP.

CaaS offers a pay-per-service model with integrated financial tools to recapitalize technology providers who own the equipment and take on all future costs related to operations and maintenance, including water, electricity, and repair bills, according to the CaaS website. CaaS can also encourage manufacturers of cooling technology to design for reuse rather than obsolescence, thus supporting the circular economy.

"The added energy efficiency savings of natural refrigerants help us serve our clients' needs by not condemning them to high energy prices and the risk of future penalties or taxes on the use of F-gasses by adopting systems that are future proof and energy efficient," said Maurice Robinson, Sales Director of Sphere.

BASE is supporting the implementation of the model in the Dominican Republic, Jamaica, South Africa, India, and Mexico. The World Green Building Council and BASE have started a partnership to build capacity and raise awareness about CaaS for their members in Latin America.

The model was recognized as one of the most innovative new financing instruments in 2019 by a prestigious group of international financiers at the Global Innovation Lab for Climate Finance ■ IK

Wynand Groenewald Looks at Future CO_2 Technology Trends

"We should be focusing on making CO_2 delivery more industrial and not just for large-scale retail systems."

We talk to Wynand Groenewald, Sphere CTO and well-known ATMOsphere presenter, about the future trends for CO_2 technology in Africa and the rest of the world. Where are we going?

What is your personal history with CO_2 and natural refrigerants?

I studied Mechanical Engineering and came across a post graduate study on CO_2 heat pumps. From there, I started to learn about the refrigeration industry and fell in love with it. This was a good 15 years ago, and I have been pursuing to implement CO_2 into the industry ever since.

Why do you believe in CO_2 technology? Why CO_2 specifically?

I believe that the refrigeration industry not only has a considerable impact on the environment but also that it is an industry where we can make the biggest change in the shortest time. I believe CO_2 fills a large gap within the refrigeration industry where other natural refrigerants perhaps do not suit the application as well. Other than that, the properties and capabilities of CO_2 open a lot of opportunity to achieve best working applications.

What changes have you noticed in this market, both in SA and globally?

I would say in South Africa, over the last two years, we have definitely seen stronger moves towards CO_2 as a refrigerant. People are finally seeing the future of natural refrigerants and this has sparked an uptake in interest towards using natural refrigerants. Globally, I suggest we are reaching a tipping point soon where people no longer argue about whether naturals are the right choice or not, but instead label synthetic refrigerants as old tech. Europe has proven that it is possible to change over completely and I think the world has stood up and took notice.

Where do you think we are heading with CO_2?

In terms of trends, I think we will see a slow-down in terms of "new" technology like ejectors, etc. I think the focus now will be, and should be, more on fine tuning current systems for optimization and also to reduce cost as the demand increases. In terms of sectors, I do foresee that CO_2 will start playing a much larger role in the industrial and cold chain sectors. We should be focusing on CO_2 delivery into the industrial environment and not just to large-scale retail systems, here we need the help of suppliers to achieve this by getting more industrial products into the market.

How important is R&D to Sphere and what examples can you share to show what the company has done to develop natural refrigerant technology?

When you are focused on using CO_2 as a refrigerant or any "new" tech, every day includes R&D. It is important and we do focus on it on a daily basis. We went through the same process as many other companies making use of CO_2 as a refrigerant, looking at incorporating parallel compression, ejectors, DC-type systems, etc.

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>
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Currently, our R&D is focused on industrial type systems where we are constantly looking to see how we can incorporate CO_2 into this field. From an R&D point of view, it is also important to improve daily on reducing total cost of CO_2 by finding smarter ways to install these systems.

What do you see as the biggest barriers to the uptake of CO_2 globally?

For me the biggest barrier is still awareness. If you are in the industry you know all about what is going on but as soon as you speak to someone outside of the industry, they have no clue what impact a refrigeration system has on the environment. This impact must be communicated to the consumer not closely related to the industry.

When it was announced globally that CFC in aerosols are creating a hole in the ozone, the product was changed overnight, otherwise it wouldn't have been bought by the consumer. The sad thing is that the public is not aware that the same compound is still being used within refrigeration systems all over the world.

What is the biggest change that needs to happen globally in terms of mindset as well as policy to encourage the uptake of CO_2 on a large scale?

Sadly, most people do the right thing only when it suits their pocket. Therefore the mindset change should be focused towards the consumer. If the consumer demands sustainable refrigeration the whole industry will change. It's a catch-22 situation, demand will reduce the cost of these systems, so we need people that are willing to invest now for the benefit the future will bring.

What new technology has had the greatest impact on CO_2 systems, particularly transcritical systems in what is traditionally considered "high ambient conditions"?

I would have to say that it is a combination. Depending on the requirement of a facility, size and location, every new technology has a part to play. I do however think that the design around the technology is what makes the biggest impact. You can achieve a 3% energy saving with a 1K higher suction temperature; and 15-20% energy savings when using parallel compression… all these add up and designing around them is what gives the ultimate success. Installation also plays a bigger role in energy saving and doesn't get enough credit. It is about understanding the technology and making it work for every type of application; in some cases the technologies can work against each other as well. ■ IK

Wynand Groenewald

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Brought to you by the worldwide experts in natural refrigerant news, Accelerate Magazine is the first global news magazine written for and about the most progressive business leaders working with natural refrigerant solutions in all HVAC&R sectors. It builds on the legacies of five regional magazines: Accelerate America, Accelerate Europe, Accelerate Australia/New Zealand, Accelerate China and Accelerate Asia, and is published in coordination with the Japanese language magazine, Accelerate Japan.

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