SPECIAL EDITION MAY 2016

ACCELERATE

ADVANCING HVAC&R NATURALLY

CORPORATE

NEXT-GENERATION INDUSTRIAL REFRIGERATION

FROM JAPAN TO THE WORLD

Editor's note
by Nina Masson

'NEXT-GENERATION' TECHNOLOGIES SHAKING UP INDUSTRIAL REFRIGERATION SECTOR

Building on the success of the *Accelerate* suite of magazines for North America, Europe, Japan and Australia / New Zealand, we are delighted to welcome the latest member of the family today: *Accelerate Corporate*.

Accelerate Corporate captures market leaders' drive to advance the uptake of natural refrigerants use across applications, industries and continents. Every issue of the magazine is prepared in partnership with an influential corporation, organisation or group of entities striving to accelerate the positive momentum for climate-friendly, natural refrigerant-based technologies, helping to progressively remove obstacles to their wider uptake. *Accelerate Corporate* content combines shecco's editorial work and expert knowledge of underlying market, policy and technology trends with end users' experience of investing in progressive technology.

For this first edition of Accelerate Corporate, shecco has partnered with Japan-based global firm Mayekawa to zoom in on key trends for natural refrigerants in industrial refrigeration. While ammonia has been an accepted industry standard especially in larger installations, a new generation of natural refrigerant technology is shaking up the industry. Driven by regulatory and technology change, lowering ammonia charges and increasing energy efficiency has become the key to unlocking the full potential of HFC-free systems around the world. The range of cutting-edge technologies delivering on this promise is wide, from low-charge ammonia systems and ammonia/CO_2 cascade and secondary systems to CO_2 transcritical systems and, to a smaller extent, systems using hydrocarbons and air.

Accelerate Corporate seeks to support companies and end users who have real-life success stories to share, about next-generation systems, products, services and projects that may help to trigger a global movement towards future-proof, safe, profitable and sustainable HVAC&R solutions. NM

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Brought to you by shecco, the worldwide experts in natural refrigerant news, *Accelerate Corporate* is a magazine prepared in collaboration with a leading business, organisation or group. It provides an update on technology, market and policy trends for natural refrigerant solutions across different HVAC&R sectors, and shares end user experience with the technology.

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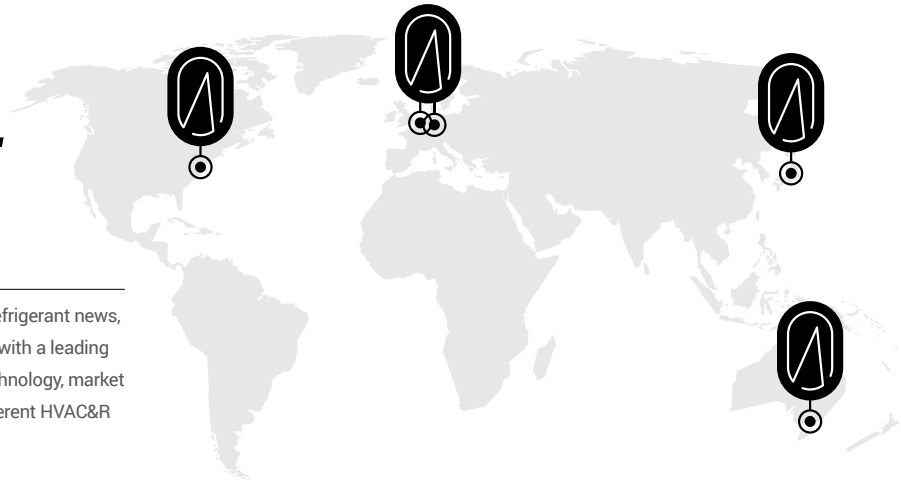

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'NEXT GENERATION' TECHNOLOGY MAKING INROADS INTO INDUSTRIAL REFRIGERATION

Ammonia has been known as one of the most energy-efficient and cost effective refrigerant for industrial refrigeration across the globe. With growing legislative pressure on safety and increased efficiency, a new generation of natural refrigerant systems with vastly lower refrigerant charges has begun to challenge traditional ammonia technology.

– By Klara Skacanova

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With many cold storage, ice rinks and food and drink processing installations seeking out alternative systems there has been an associated rise in the use of newer, more advanced natural refrigerantbased systems. These systems of choice include: low-charge ammonia, ammonia/CO_2 cascade and secondary systems, CO_2 transcritical systems and to a smaller extent systems using hydrocarbons and air.

it is not just conversions from R22 that are fuelling the transition to 'next generation' solutions. There is also a switch from standard ammonia systems to state-of-the-art industrial refrigeration systems. While there are a variety of options available, the level of penetration varies for each major region, with market preferences due to regulatory policies and market trends differing.

Safety first

The reduction of ammonia charges has various benefits, not least safety, where in the event of a refrigerant leak the area of contamination would be greatly reduced. The cost of both the system and refrigerant are also much more palatable. In addition, as standardised systems, low-charge ammonia units are easier to maintain, take up less space and lower the on-site assembly costs.

A NH_3/CO_2 cascade system can effectively reduce the ammonia charge by as much as 90% compared to a traditional ammonia system. This makes it possible to apply natural refrigerant-only systems even for large-scale cold storage facilities, where direct ammonia systems are not feasible due to charge limitations. In addition to this, the confinement of NH_3 to an engine room, with limited access for cold storage staff increases safety and lowers the risk of food contamination.

Japan turns to NH_3/CO_2 to replace R22

Currently, there are more than 10,000 facilities using ozone-depleting substances in Japan and with the HCFC phase out quickly approaching in 2020, the cold storage sector constitutes a huge opportunity for natural refrigerants in Japan.

While there was a shift from ammonia in the 1970s, the Japanese government gradually lessened their restrictions for NH_3 equipment in 1999 (Ministerial Ordinance of Refrigeration Safety) and prefectural governments have accepted NH_3 equipment with a low refrigerant charge such as 100kg or less. In reaction to this, Japanese manufacturers have developed NH_3/CO_2 industrial refrigeration systems in order to further reduce the ammonia charge and provide an easy-to-maintain system with increased safety for the end-user.

Deployment of these technologically advanced systems has been aided by the Ministry of Environment, which has been providing financial incentives to cold storage and food manufacturing facilities using natural refrigerants since 2014. So far over 1,000 units have been placed on the Japanese market, which equates to just over 300 separate installations, with 113 of these installations subsidised by the government. Japanese technology is also receiving a growing appreciation worldwide, with 42 units exported to Asia and Australasia, seven to North America, and South America to commence imports in 2016.

Europe sees growing interest in next generation technology

Large industrial refrigeration in Europe has traditionally been based on ammonia. While this continues to be the case, with over 90% of large-sized facilities using the refrigerant, the usage of 'next generation' technology is making inroads into Europe's refrigeration systems. Low-charge ammonia and NH_3/ CO_2 cascade systems, in particular, are attracting increased interest among Europe's industrial refrigeration facility operators.

While HFCs are still prominent in smaller industrial refrigeration installations in Europe (around 65%), a number of natural refrigerant-based solutions have emerged over the last few years. The strongest trend can be seen in the introduction of CO_2 transcritical technology in larger supermarket applications, especially in cold stores and distribution centres. This shift is a result of a wide-scale uptake of CO_2 technology in European supermarkets (over 5,500 installations) and growing availability of bigger components, such as compressors. With over 150 CO_2 transcritical industrial refrigeration installations, Europe is a clear leader in the use of this technology in industrial applications.

Low-charge NH_3 leads way in Canada, growing in U.S.

The use of ammonia is a standard in North America, with more than 90% of industrial refrigeration systems using the refrigerant in the U.S. While historically the region has a strong base in natural refrigerants, the market has evolved notably over the last five years, with an increasing adoption of advanced natural refrigerant-based technology used for industrial refrigeration applications, in particular low-charge ammonia and CO_2 transcritical systems.

While all areas in the United States and Canada show penetration for the use of low charge ammonia systems, Canada is the clear leader in adoption with 187 installations; Québec and Ontario having 102 installations between them.

While the use of low charge ammonia is less prevalent in the United States, with 22 installations, the range of locations shows the varied temperatures it is able to work within, making it a potential solution for the whole of North America. Altogether, these low-charge ammonia systems make up nearly 80% of next-generation industrial refrigeration installations.

Besides the innovative low-charge ammonia installations, technology using CO_2 transcritical has emerged in North America. Currently there are at least 44 CO_2 industrial-sized transcritical installations in Canada and 10 in the United States.

Bright future for NH_3/CO_2 cascade and secondary systems in China

In 2014, China had the third largest cold storage capacity in the world, after India and the U.S., with 76 million m^3 of space. The increase in cold storage construction in China has reached an all-time high as a result of urbanisation and change of lifestyle in cities. By 2017, China will likely surpass the capacity of the U.S. cold chain, which is currently at 115 million m^3 of space.

Ammonia is a standard refrigerant used in industrial refrigeration facilities and currently there are more than 30,000 end-users in China using ammonia as a refrigerant. The rapid development of ammonia in large-scale refrigeration systems does not match the amount of trained personnel able to handle such technology. As a result of this, safety issues regarding ammonia usage in cold storage has attracted a great deal of attention from the government and the industry in the last few years. The industry is gradually taking steps to ensure higher safety to comply with necessary requirements. In particular, reduction of ammonia charge and introduction of ammonia/CO_2 systems in industrial refrigeration, is gaining ground in China.

The development of NH_3/CO_2 secondary and cascade refrigeration systems has been gaining popularity since 2013, when the technology was developed and tested by a Chinese manufacturer. According to market data gathered from leading Chinese industrial refrigeration manufacturers, CO_2 as a refrigerant has been applied in more than 30 projects in China. The installations vary from ice making facilities and cold storages through meat, aquatic products and prepared food processing, to ski halls and ice cream production facilities. In the majority of facilities, CO_2 is used as a secondary coolant or as a low stage refrigerant in cascade systems with ammonia.

Potential for reducing NH_3 charge Down Under

According to a study commissioned by the Australian government in 2013, there is an estimated total cold storage capacity of 13.05 million m^3. A great majority of this (around 12.4 million m^3) relies on ammonia refrigeration for cooling. While most of the cold storage already uses natural refrigerants in large-scale refrigeration, the use of HFCs is predominant in medium to small-scale facilities. There are around 100,000 refrigerated warehouses in Australia, the majority of which are using HFC systems that are in need of conversion.

Industry experts estimate there are around 3,000-5,000 facilities suitable for low-charge NH_3 system conversions, all standing to save 40-70% on their power bills. At least six installations of low-charge ammonia systems have been installed mostly for cold store/food processing facilities. In addition, the industry explores potential of NH_3/CO_2 systems, four units of which have been installed already. Apart from technologies with low NH_3 charge, CO_2 transcriticial systems are gaining popularity, with at least three installations in the field by now. KS

KEEPING IT COOL WITH CO_2, AMMONIA AND AIR

While ammonia still remains the primary natural refrigerant of choice in new medium and large-sized industrial refrigeration plants, CO_2 is starting to make significant inroads as a secondary refrigerant in Japan and other parts of the world.

By Klara Skacanova

The use of NH_3/CO_2 cascade and secondary systems can be found in several different applications including food and chemical manufacturing & processing while the use of air as a refrigerant is also gaining popularity in ultra-low temperature industrial refrigeration facilities.

One example of a NH_3/CO_2 installation is at Kobeya Baking Company's facility in Chiba, Japan. The company converted the R22 refrigeration system to a NewTon F-600 NH_3/CO_2 solution at its 7,034m^2 frozen dough production facility.

The new system delivered average energy consumption savings of 38-48% in summer and 25% in winter, due to the innovative system design and in particular, an inverter-driven air compressor. The switch to an air-driven inverter system, with one operating at 15kW and two at 11kW, achieved 27% power savings.

In addition, NH_3/CO_2 systems continue to be deployed in ice rinks, where the technology achieves not only significant energy savings, but also better quality ice. Compared to R22-refrigerated ice rinks, annual power savings of up to 30% are recorded and that saving rises to 46% when compared to R22/glycol ice rinks.

There are currently at least eight ice rinks in Japan using the NH_3/CO_2 secondary systems. With 150 old ice skating facilities in need of upgrading in Japan, natural refrigerant technology has tremendous potential for the future, especially given the energy and cost savings that can be achieved.

Greening the construction sector

NH_3/CO_2 systems can also be used for ground freezing in construction work, which is being explored by Japan-based Chemical Grouting. A comparison of a NH_3/CO_2 freezing system to a conventional R22 system shows a vastly greater coefficient of performance of 2.55 compared to 1.63.

Test results show that the NH_3/CO_2 system reduces power consumption by 60% compared to a conventional R22 system. Chemical Grouting intends to help green the construction sector in Japan, with a metropolitan expressway and bullet train among projects planned in the near future.

Besides the application of 'next generation' ammonia/CO_2 technology across a variety of end users, systems using CO_2 transcritical technology have been deployed in ice rinks, cold stores as well as food distribution facilities in Europe and North America.

Air as a perfect fit for ultra-low temperature applications

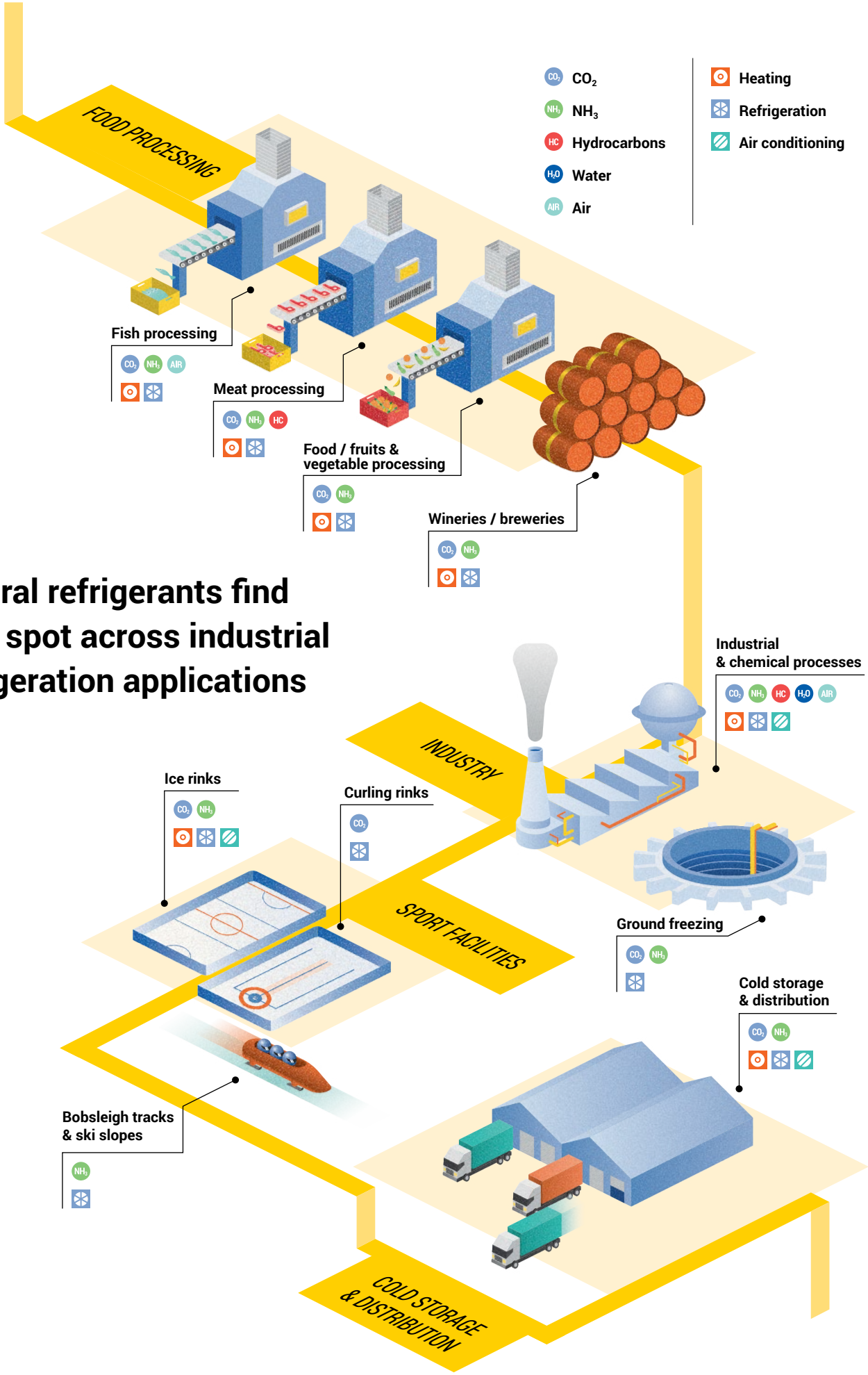
A refrigeration system using air as a refrigerant was developed in cooperation with the New Energy and Industrial Technology Development Organisation (NEDO). Today, at least 54 units have been installed in a number of applications, including ultra-low temperature warehouses, rapid food freezing systems, and in the chemical process cooling industry.

In terms of COP, the air refrigeration system has an advantage over conventional systems, and because its application is limited to ultra-low temperatures (below - 50°C) - a troublesome range for natural refrigerants to date – it sets itself apart from conventional systems.

Future application areas for this technology include vacuum freeze-drying, semiconductor manufacturing, and low temperature milling, among others.

At Sea Sky Global's state-of-the-art tuna processing plant, located in Busan, South Korea, there are three Pascal Air units installed to keep the company's 2,500 tonnes of raw tuna and processed products fresh. A major benefit of the system is that it contributes to the reduction of costs; the system has reduced electricity usage by 40%. In addition, because air is a harmless gas, there is no need to hire a safety manager, which again reduces labour costs. KS

Natural refrigerants find their spot across industrial refrigeration applications



END OF R22 SIGNALS OPPORTUNITIES FOR NATURAL REFRIGERANTS

With HCFCs soon to be phased out and HFCs facing increasing restrictions, firm policy guidelines are giving industry a strong impetus to innovate and adopt future-proof natural refrigerant technology.

– By Klara Skacanova

Japan's cold storage industry is still heavily reliant on R22 and the country's obligations to phase out HCFCs pose a challenge to end-users, not just in Japan, but throughout the world. This transition is expected to accelerate as the 2020 deadline for use of R22 is approaching in Japan and other developed countries. After this date, it will not be possible to service existing equipment with reclaimed R22, rendering the equipment obsolete.

Meanwhile, developing countries have until 2030 to transition away from ozone-depleting substances like R22. Adoption of natural refrigerant technologies gives them a unique opportunity to leapfrog synthetic refrigerants and avoid unnecessary conversion costs.

In addition, the ongoing debate on the global HFC phase down, hoped to be finalised between world economies by end of 2016, give further indication that fluorinated refrigerants are on their way out. This gives motivation to cold store operators to purchase equipment that will not be affected by future policies.

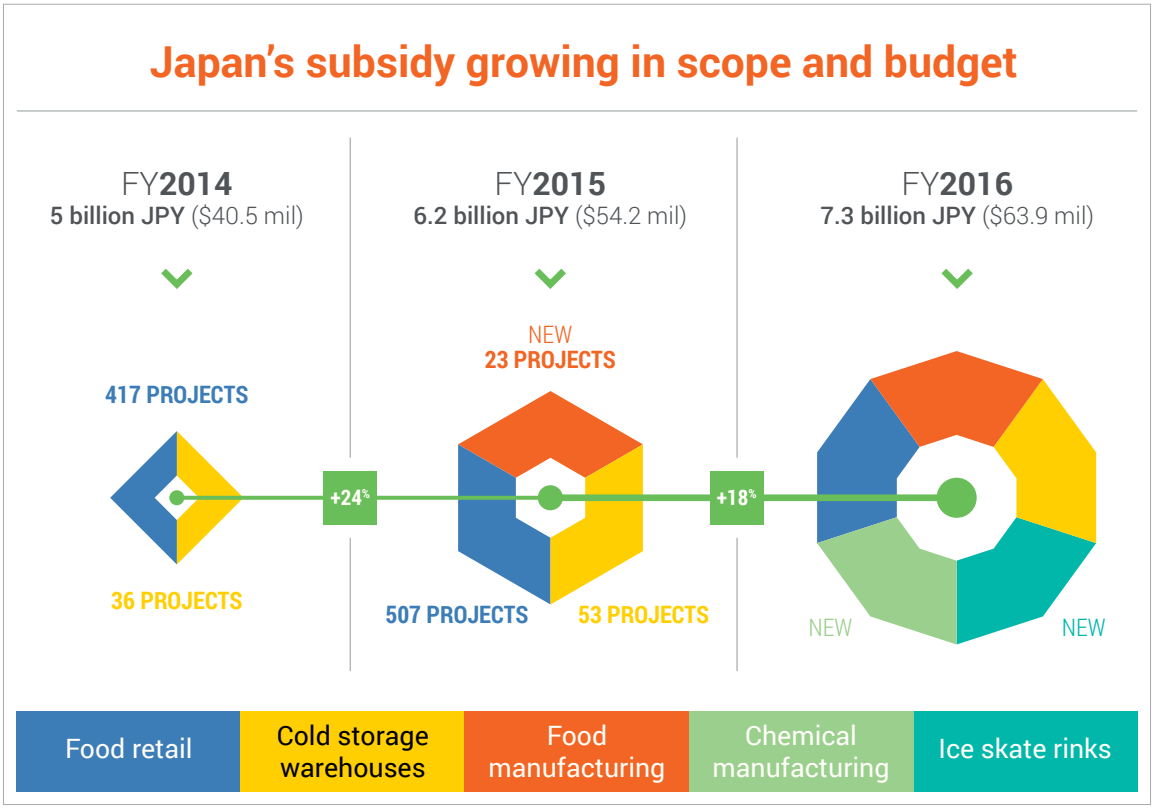
Advancing regulatory restrictions on HFCs

In addition to the R22 phase-out, countries are advancing regulatory restrictions on HFCs at national and regional level. The EU F-Gas Regulation will reduce the emissions of f-gases by 79% by 2030, with all sectors having to contribute to this target. Additional restrictions on the use of high-GWP HFCs apply in specific sectors, including industrial refrigeration.

California is currently considering a similar approach, whereby the proposed bans in industrial refrigeration would apply to HFCs with GWP over 150 as of 2020 - such a ban would be in line with the timeline for the R22 phase-out and would give end-users a clear indication as to which technology they need to invest in.

In Japan, the government has recently (April 2015) strengthened its regulatory framework for managing fluorinated gases. The scope of f-gas measures was expanded from the previous focus on the recovery and destruction to the whole life cycle, including f-gas manufacturing, maintenance and leak checking, promotion of low-GWP / non-fluorocarbon refrigerants in certain sectors.

GWP targets for so-called 'designated products' are expected to bring about the most significant emissions reductions. Instead of imposing bans on the use of high-GWP refrigerants in certain applications, as is the case in some other regions (EU F-Gas Regulation), the Japanese law sets GWP targets per product group, which each manufacturer needs to reach by a certain target year. For cold storage warehouses larger than 50,000 m^3 the GWP of 100 must be adhered to by 2019. This measure is expected to accelerate the adoption of climate friendly and energy efficient technologies for cold stores that use ammonia and CO_2 as refrigerants in time to meet the R22 deadline.



Financial subsidies sparking uptake

Despite the R22 phase-out looming just four years away on the horizon, some cold storage operators seem to be hesitant to switch to equipment using natural refrigerant-based technology without financial support from the government. The reasons for this are partially rooted in the history of government policies for the industrial refrigeration sector. In the past, the government had provided incentives for companies to move away from ammonia to HCFCs, which were then considered more stable.

In order to bridge the gap between the cost of cutting edge natural refrigerant technology and traditional equipment, the Ministry of Environment (MOE) revised its incentive scheme to motivate cold store operators to make the shift. The subsidy aims to create a level playing field for cutting-edge technology that is not yet widely available, to help reach higher production capacities, which would then push the price down.

The incentive scheme introduced in 2014 has been providing financial support to end-users in a growing number of applications in commercial and industrial refrigeration sectors. Coupled with the growth of resources allocated for this scheme, the market for natural refrigerants has seen a significant boost. With the budget of 5 billion JPY, the scheme supported 36 natural refrigerant cold store projects in 2014, covering up to 50% of the investment cost. Those 36 cold stores were for 34 end-users, including brands such as Meiji, Baskin Robbins, Kewpie and Maruha Nichiro.

An increased budget of 6.2 billion JPY for the 2015 financial year aided 76 installations including the food-manufacturing sector, which was added as eligible for the funding. For the 2016 financial year, the MOE has increased the available budget once again to 7.3 billion JPY and the scheme now includes ice rinks and chemical manufacturing plants as eligible to receive a subsidy for up to 1/3 of the investment cost. KS

Soichiro Tsukada,
Managing Director and
General Manager of Production

NOTHING BUT THE BEST FOR **NITTOBEST**

By James Ranson & Jan Dusek

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NittoBest's Yamagata facility with nine NH_3/CO_2 NewTon units

For us, there are no other options but natural refrigerants," says NittoBest Corporation's Managing Director and General Manager of Production, Soichiro Tsukada.

After an extensive review of its production processes and a critical need to reduce energy consumption and boost efficiency, NittoBest had only one future solution in mind when it installed its first NH_3/CO_2 refrigeration system in 2014.

"Who is taking the lead in shifting to natural refrigerants? This is the most discussed topic at roundtable talks with other companies in the industry," highlights Tsukada. Indeed, the company's insistence is clear in all of its environmental initiatives and communication to its clients and employees. Just as clear is which side of the fence NittoBest sits on when it comes to natural refrigerant and high-GWP (global warming potential) alternatives.

METI, MOE subsidies critical

NittoBest Corporation specialises in the production of frozen, canned, packed, chilled, and retort-pouched food products with a total of 13 factories and affiliated companies throughout Japan. Yamagata Prefecture is the heartland of the company's operations with eight factories situated there.

The company started investigating natural refrigerants in 2010, but decided to take a cautious approach and continue researching the available solutions. In February 2014, the company made its move, installing an NH_3/CO_2 system from another local supplier through its Kyushu Best Foods chain at a facility in Fukuoka Prefecture.

Fast forward another nine months and NittoBest installed a total of nine Mayekawa NewTon units at its Yamagata facility. A decisive factor in the decision, Tsukada says, was funding received from Japan's Ministry of Economy Trade and Industry (METI) and Ministry of the Environment (MOE). The latter helped subsidise one third of the total cost of installation, while the former aided in financing one third of the difference in total cost between a system based on fluorinated refrigerants and a natural refrigerant-based one.

The total cost of the NH_3/CO_2 installation was approximately 50% more than a conventional R404A unit, but comes with negligible GWP compared to R404A's 3,300.

It's true that only around 15% of food-processing facilities in Japan utilise non f-gas alternatives for refrigeration. However, of the companies that have gone down the natural refrigerant route, typically around 60% of their systems are natural refrigerant-based – indicating that the subsidies do encourage long-term commitments from end-users.

"Funding programmes are essential in further expanding the use of natural refrigerants," emphasises Tsukada. Such programmes enable manufacturers of natural refrigerant components, systems and equipment to establish dedicated manufacturing capacity, which NittoBest believes will eventually drive down costs.

First NewTons of many?

At 66,200m^2, NittoBest's flagship facility in Yamagata is its largest by some way. It is also worth noting that it is considerably larger than most food processing facilities in Japan. Equipped with two hamburger production lines and three ham-cutlet production lines, the facility produces 13 tonnes of hamburgers and 15 tonnes of ham cutlets daily.

> We hope to use natural refrigerants for our overseas businesses. In the long run, we aim to switch to natural refrigerants in all our facilities"
>
> – Soichiro Tsukada.

A total of nine NewTon units supply refrigeration and freezing for five hamburger production lines and four ham-cutlet production lines, incorporating heating (cooking) and cooling (freezing) the product. Mayekawa also supplied EcoCute CO_2 heat pumps to utilise the waste heat produced for potable hot water.

Mayekawa's Food Division Director Syoji Miyajima has been an integral influence on NittoBest's first, and so far, only NewTon installation. The idea for recovering waste heat via a heat pump had not been explored by NittoBest at its other plants prior to Mayekawa's involvement in the Yamagata project. Mayekawa has also provided maintenance support since the installation was completed in 2014.

As the entire process requires the hamburgers to be cooked, steamed, pre-cooled and then frozen, the EcoCute maintains the heat balance at the factory: with the heat used to produce hot water and the cold energy to pre-cool food products.

Outstanding efficiency

The company insists that despite the higher initial cost of the NewTon, the facility's energy consumption is 15% lower than its other plants using conventional systems. It comes as no surprise, then, that companies from Thailand, Indonesia and South Korea have visited the factory.

This is in part because the NewTon uses CO_2 as the secondary refrigerant and thus reduces the amount of ammonia used from around 300-400kg for an all-NH_3 system to approximately 25kg. In addition, the cooler operates without the oil injection system required by a conventional NH_3 system, therefore maintaining the temperature for longer periods of time and leading to savings of 8-9%.

Bright future

Such has been the success of NittoBest's largest Yamagata factory that it plans to relocate production lines there from other facilities. Tsukada said NittoBest intends to switch to natural refrigerant technology when that transition occurs, including replacing old freezers with new ones. "Natural refrigerants is the only alternative that we are considering shifting to, and this is irreversible," he said.

Although additional costs will be incurred to retrofit or replace systems with natural refrigerant technology, the company's ultimate goal is to achieve its targets even if subsidy programmes in Japan are discontinued.

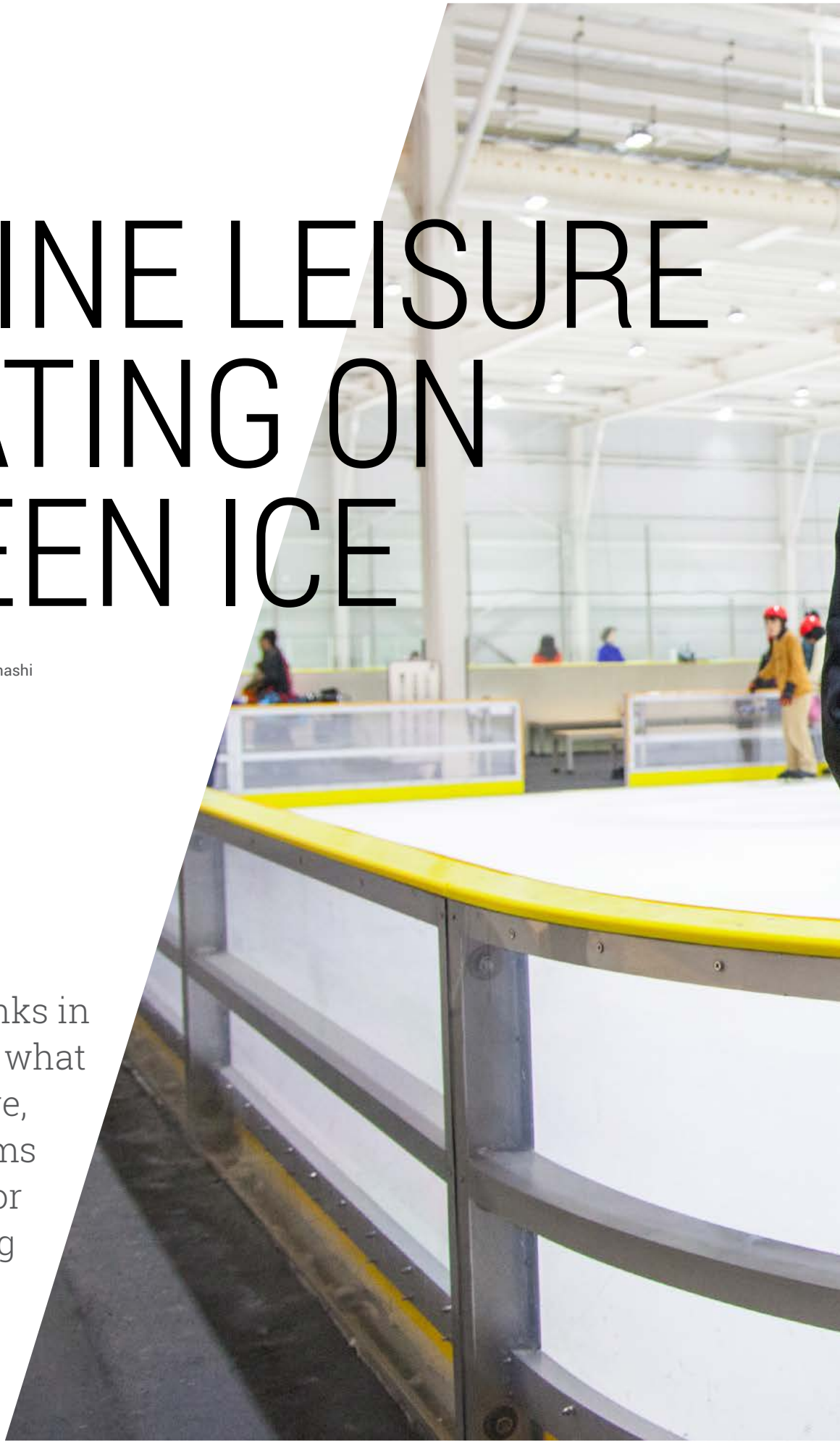
The company has worked hard to communicate the positive changes made to its employees, who are also fully aware that the food produced is made from locally sourced pork and natural spring water from the surrounding mountains in the Yamagata Prefecture. Its employees are actively engaged in equipment and facility management, including training programmes for NH_3 refrigeration and leakage handling.

NittoBest also plans to launch a business in Vietnam in 2016 and is investigating the potential to introduce natural refrigerant technology there.

But for now, NittoBest will continue to work closely with Mayekawa to improve its production capacity and will continue to navigate various factors affecting the introduction of natural refrigerant technology including initial and operational costs, the safety and security of products, and maintenance and support services following installation. JR + JD

PATINE LEISURE SKATING ON GREEN ICE

– By James Ranson & Yukari Sahashi



Ice-skating rinks in Japan are not what they once were, neither in terms of numbers nor accompanying technology.

continues on p.18

From left to right:
Emiko Iida, Operating Officer of the Overseas Department
Akinori Oginawa, President
Kazushi Kobayashi, Operating Officer of Kanto Block

From a peak of as many as 550 the number of rinks has sharply decreased to a figure believed to be between 150-170 in 2016. This is despite an upturn in interest in figure skating following native Shizuka Arakawa's gold medal-winning performance at the 2006 Turin Olympics.

Although the prevalence of privately run ice rinks is declining in Japan, owing largely to the heavy burden of energy bills, the sector is starting to shift thanks to the work of companies like Patine Leisure Inc., who are reverting to higher efficiency natural refrigerant cooling technology.

Patine Leisure is a specialist in the ice-skating business, designing, installing, operating and managing around 50 rinks throughout Japan, including ice resurfacing, ice skates and equipment. Its activities cover some 90% of the market in Japan, while expanding its business in other Asian countries.

As the company expands its market share, the challenge lies in tackling mounting costs. Patine Leisure is keen to use subsidies from Japan's Ministry of Environment (MOE) and continue implementing modern cooling technology to help relieve the burden.

In 2014, Patine Leisure partnered with Mayekawa, a leading distributor of industrial natural refrigerant cooling technology, to open a next generation ice-skating rink in Saitama. What started as an exploratory trip to Canada some 5-6 years ago for former speed skater and Patine Leisure President Akinori Ogiwara ended with an inspired solution.

During this trip to Canada, Mr. Ogiwara learned about an NH_3/CO_2 cooling technology available in Sweden. Mr. Ogiwara expected to hear about energy savings in the realm of 10%. What he learnt came as a shock: the energy savings were in fact closer to 30%.


1680 solar panels at Saitama Ice Arena

Excited by the prospect, Mr. Ogiwara and his team took the opportunity to see the system in the flesh at a Swedish national institute with representatives from Mayekawa. Following the expedition Mayekawa worked with Patine Leisure for 2 years on a joint R&D project to develop a NH_3/CO_2 trial system for an ice rink in Japan.

After returning to Japan, Ogiwara believed it could be possible to achieve higher energy efficiency through technical improvement and started trials at the company's own factory in Karuizawa. The testing took two years, using ammonia freezers and CO_2 refrigerant, and comparing cooling pipes made of copper, aluminum, and other materials. The results revealed even higher energy savings of 50%, figures that have been validated by Mayekawa's NewTon S system in operation in Saitama since its installation.

Now there are seven systems using natural refrigerants in operation, plus one experimental rink, in Japan. Around 150 rinks using high-GWP HCFCs (R22) as the primary refrigerant remain in operation but as Patine Leisure has a stake in a majority of them, it hopes to convert as many of them as it can to natural refrigerant technology and capitalise on considerable market share by 2020.

Patine's passion paying off

Most of Patine Leaisure's employees have ice running through their blood. Emiko Iida – Operating Officer of the overseas department at Patine – was once a figure skater herself, later coaching at a skating rink in Kawagoe and some other rinks.

Kazushi Kobayashi, Operating Officer of Kanto Block, meanwhile, is well versed in technologies and was a speed skater close to national team selection in his younger years. Whoever you speak to, most employees regard ice as a living organism, labeling the phenomenon of 'supercooled' ice as 'crying ice'.

Following the Fukushima Daiichi nuclear and tsunami disaster in 2011 – and the subsequent rise in the cost of grid and nuclear energy – the Japanese government actively promoted renewable energy solutions such as solar power generation.

NewTon S system at Saitama Ice Arena

Under the circumstances, Ogiwara turned to solar energy not only to save on energy bills, but also to bring profits to the business by producing and selling it. Solar power generation was tested at a curling facility in Karuizawa and another facility in Sapporo, Hokkaido Prefecture, before being installed at one of its rinks in Nishinomiya, Hyogo Prefecture. Given the positive results, Patine Leasure embarked on the construction of a new ice-skating rink in Niigata Prefecture through the Private Finance Initiative system (PFI) whereby a local government builds the facility, and a private company (Patine Leisure) manages administration.

The move led to a 50% drop in energy costs at the Niigata ice rink within two years and has helped Saitama Ice arena to become a model case for pairing solar energy with natural refrigerant technology. Since then, "becoming environmentally friendly and energy efficient by using natural refrigerants" has become one of the company's core ambitions, said Ogiwara.

Case Study: Saitama Ice Arena

After installing three NewTon systems at the Nishinomiya and Sapporo locations it was determined that two would suffice at the Saitama Ice Arena.

This has proven to be true even in summer time (inherently ice itself helps keep the refrigerant cool). As a result, initial costs were slashed while the solar panels installed also provided a heat insulation effect.

The two NewTon units were placed on the roof of the arena while the monitors are located in a staff room on the ground floor. Here, the temperatures of the ice (including underground – not to go below zero), as well as the CO_2 pressure, are monitored and modulated. The temperatures of the ice are measured at about 3cm above it, meaning that if a leak is detected, safety risks are averted whereby ammonia automatically dissolves into water in the scrubber.

The facility, which includes a main ice-skating rink and a sub rink (which can be used for curling games), can be used for 16-17 hours a day and includes illumination (LED) lighting. Overall, the facility has saved 50% on energy costs.

The introduction of CO_2, with its innate higher pressures and consistent temperature, has also assured a more even ice surface temperature and consistently higher quality of ice.

Future plans

As we speak, the company is working on a new 400m speed-skating ice rink project. If all goes according to plan, construction will start in 2017 and be completed in 2018, consigning yet another of the 150-odd HCFC ice-skating rinks to history.

Buoyed by system performance above and beyond preliminary expectations at its Japanese arenas, Patine Leisure also hopes to take Mayekawa's technology to Southeast Asia; however, the subsidy scheme places strict restrictions on follow-up projects, which may hinder those ambitions. For now, there are few manufacturers outside of Mayekawa and Mitsubishi Heavy Industries developing NH_3/CO_2 technology, another factor restricting greater competition and further reductions in system costs.

In addition, the price of energy is expensive in Southeast Asia while the cost of exporting systems and finding suitable components is higher, too. And yet the results are clear for all to see.
JR + YS

NISSUI'S LONG-TERM VISION VINDICATED

– By James Ranson & Jan Dusek

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Michinori Kogawa, General Manager of the Equipment Management Department

Installing the first ever NewTon, Mayekawa's market-leading NH_3/CO_2 system, was no small feat for Japanese logistics company Nissui Logistics.

In 2008, Nissui provided the first test case for Mayekawa's NewTon in Japan, at its Kawasaki facility. The logistics company has since installed a further two, in Osaka-Kou (port) and Osaka-Maishima, Japan. It now has offices in 40 locations around the globe.

Headquartered in Minato Ward, Tokyo and formerly known as Tokyo Logistics Center, Nissui Logistics provides refrigerated warehousing, storage and freight transportation services – predominantly processed salmon imported from places like Chile. Its 17 distribution centres include one in Osaka-Kou Port, which is jointly operated by Nissui and two other companies.

Nissui's General Manager of the Equipment Management Department Mr. Michinori Kogawa said Kawasaki's installation of three NewTons with 14,000 tons of refrigeration capacity at the facility saw the company immediately reduce its energy usage by 80,000 kW a year.

Back in 2008, with the Montreal Protocol firmly in view, Mr. Kogawa said the company had an obligation to "fulfill [its] corporate responsibility" and had felt that "the age of natural refrigerants [was] here".

With the help of Japan's Ministry of the Environment (MOE), Nissui was able to subsidise the additional cost of the NH_3/CO_2 system, as compared to traditional HFC systems on the market at the time. In turn, Nissui proved a valuable partner for Mayekawa, providing crucial energy efficiency, power consumption and maintenance logging data so that the Japanese manufacturer could continue to develop and hone its NewTon technology.

Case Study: Nissui Logistics, Kawasaki

Nissui's Kawasaki warehouse was first commissioned and planned in 2006 and completed in 2008. True to the company's 'scrap-and-build' philosophy for natural refrigerant technology, contractors worked from the ground up.

Initially three refrigeration systems were considered for the Kawasaki logistics centre: NH_3/CO_2, an ammonia direct expansion system, and HFC R404A. Tellingly, Mayekawa's NewTon was selected due to its "technological innovativeness, energy saving performance, and overall safety".

Mr. Kogawa explained that he had already sampled a smaller NH_3/CO_2 cooling unit at a company he previously worked at, while Nissui - like many at the time - used ammonia direct expansion systems in the 1970s and 80s, however, the old technology experienced ammonia leaks.


NewTon units installed at Osaka-Maishima facility

Mayekawa's NewTon at the Kawasaki facility was the first large-scale system installed in a refrigerated warehouse in Japan. When Nissui installed the first model of the NewTon in Kawasaki, they had a shared spirit and worked hard with Mayekawa to help develop a commercially viable product together. Operational data was supplied for measurement and verification and both parties reported that various modifications had been made as a result to enhance the technology and its safety.

The installation drew a swathe of interested parties from the industrial refrigeration industry, including government officials from Japan and abroad and other warehouse operators. That interest, and the MOE's subsidies, has helped Mayekawa grow the market for the NewTon around the globe.

Nissui followed that with NewTon installations at two other facilities - the joint Osaka-Kou venture and its Osaka-Maishima facility (operation initiated in April 2016). So far, compared to an R404A system, the NewTon set-ups have saved energy (excluding lighting and other equipment) at a rate of 23% in Kawasaki and 53% in Osaka.

MOE subsidies accelerating natural refrigerants growth

Japanese Ministry of Environment (MOE) subsidies originally encouraged end-users to purchase natural refrigerant technology by covering up to one third of the difference in total cost between a system based on fluorinated refrigerants and a natural refrigerant-based one. The subsidy now covers up to 50% of the total cost of the system, a key shift according to Mr. Kagowa. The third generation NewTon comes in a little under at 1.2-1.3 times more expensive than HFC systems, discounting the subsidy.

With half of the introduction cost of natural refrigerant systems having been covered since 2014, they are cheaper than HFC units. That saw the number of applications sharply increase, explains Mr. Kogawa.

Nissui Global Network

Operational costs of the NewTon are slightly higher than systems using HFCs, given the extra equipment required to fit the installation. Another difficulty is that the effectiveness of the subsidy has created a "bottleneck" between small and medium-sized warehouse operators vying for the MOE's assistance.

Kogawa estimates that retrofitting all R22 systems currently in use at the company would cost around ¥4-5 billion, making the subsidies essential for companies like Nissui.

"Of course, the [MOE] subsidy is necessary. To give momentum to the whole industry, we all hope the MOE continues the program. You don't hear about any companies in the industry talking about the installation of HFC systems at the time of 'scrap-and-build'. The industry as a whole is moving towards natural refrigerants," says Kogawa.

"If the subsidy project is discontinued, it [would likely] cause delay to [our] plans. However, we are committed to natural refrigerants. Tokyo Association of Refrigerated Warehouses (TARW) has made a submission urging the MOE to continue the subsidy." (Mr. Kogawa is a committee member of the association.)

Retrofitting an R22 system – or any other HFC-based system for that matter – is not a simple process. Ideally, warehouse operators like Nissui want the old system to remain functional during the retrofit, as production cannot cease, removing the old technology after completion. However, that is almost unrealistic given that retrofits involve replacing all piping where typically facilities are already restricted on space. Additionally, as the systems are located in cold storage areas, construction engineers are required to work in low-temperature environments.

Future plans

Although Mayekawa's NewTon is now mainstream technology in Japan, few competitors with viable technology exist on the market. Such a shift would be welcome, as it would reduce the cost of NH_3/CO_2 systems and create a whole other dynamic on the market. "We are telling our sales representatives and other domestic manufacturers [to go down this path]," Mr. Kogawa says.

R22 systems are still in place at Nissui's 14 other facilities throughout Japan. The synthetic refrigerant has a high global warming potential (GWP) of 1700, compared to CO_2 (1) and ammonia (0), but the company has plans to change that and are tightening their operational management to reduce leaks.

Nissui intends to continue its 'scrap-and-build' policy for installing natural refrigerant technology, with the anticipation that the new installations will be able to sustain the company for about 30 years.

Although Mr. Kogawa states that the company always hopes to deploy natural refrigerant or new technology in its facilities, the reality is new trends develop and different facilities have different cooling requirements. The company's focus remains on safety, with flammable refrigerants not under consideration in order to completely avert safety issues and charge limitations. Mr. Kogawa notes that large systems using only CO_2 are included in their list of possible alternatives.

Mr. Kogawa laments the fact that it is still possible to procure or even stockpile HCFCs until 2020 in Japan, predicting that their distribution and use would likely continue beyond that date (provided that no further regulatory action is taken in Japan).

"The [global phase-down of hydrofluorocarbons] will cause great difficulty for [end-users] but will serve as a driving force for businesses to make the shift to natural refrigerants," Mr. Kogawa emphasises. "Natural refrigerants will become mainstream in the future because they are safe and energy efficient." JR + JD

THE NATURAL FIVE

Mayekawa's green innovation on fast track to global reach

— By James Ranson & Marc Chasserot


Tadashi Maekawa

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As the wheel began to turn at at the global climate conference in Paris (COP21) in early December 2015, Mayekawa was busy presenting its 'Natural Five' solutions concept – the five natural refrigerants that will inevitably drive the phase-out of harmful HFCs (hydrofluorocarbons) in HVAC&R applications, in turn reducing the most harmful effects of climate change.

Indeed, the company has put environmental preservation, energy efficiency and technical innovation at the heart of its commercial activities for decades. Kisaku Maekawa founded the Tokyo-based company in 1924, beginning by producing industrial reciprocating refrigeration compressors for ice-making and cold storage.

Company President Tadashi Maekawa has proudly continued the legacy his father laid out. "Our endeavor on natural refrigerant technologies started from the conception that solving environmental issues is a global mission that has to be [solved] this century," he says.

"Mayekawa was originally involved in industrial refrigeration, and we chose natural refrigerants not only because they were friendly to the global environment, but also efficient, so our business developed towards the employment of the 'Natural Five'," he adds.

Five-year global strategy

Now, some 80 years after Mayekawa produced its first functioning compressor, the company has subsidiaries in 40 countries, expanding into new global markets each year, including the Middle East, Africa and Eastern Europe. In 2014, the company reached a turning point that demonstrated the global reach natural refrigerants have already today. For the first time, international sales outstripped domestic sales with a 60-40% split.

"Our sales overseas exceeded domestic sales [in 2014], and we believe our business will expand more overseas than in Japan in the coming years - the international market is huge compared to that of Japan," Mr. Maekawa states. "And without increasing our overseas sales, we cannot make a significant contribution to the global environment."

"This doesn't mean that the Japanese market is no longer important to us, but at least it already has environmental actions underway. We believe if such actions are conducted on a global scale, the global environment will be far better, even in China or India. That is what we hope to do in the next five years."

Mayekawa wants to share its experiences of the domestic market to a global audience. Mr. Maekawa knows expansion will incur costs but stressed the importance of maintaining open dialogues with local industries and governments, as it has done for decades in Japan.

The company has a strong tradition of working with the Japanese government, utilising the incentive programmes it has offered to expand Mayekawa's business. Building relationships in new global markets will likely prove to be Mayekawa's greatest challenge in the next five years. "This is a very important mission to us. There are a number of key accounts, world-leading end-users, outside Japan. Building relationships with these customers is crucial; in fact it is inevitable if we hope to expand our business abroad," Mr. Maekawa emphasises.

"I have great confidence in the environmental business that we conduct here in Japan. I therefore feel it is the best way to invite potential customers from abroad and show them the technology of Mayekawa in Japan."

Constant innovation

The company's philosophy of constant innovation is certainly true of Mayekawa's flagship low-charge NH_3/CO_2 system, NewTon. The systems are predominantly manufactured in Japan, where Mayekawa has sold over 800 units. Continuous innovation will be crucial for growth in new markets, where natural refrigerant cascade systems are starting to leave their mark in the industrial sector. "The NewTon series is really an important business for us. Although it has gained ground in the Japanese market, we also need to continue [marketing it] overseas, so that this system will be a standard throughout the world," Mr. Maekawa says.

> "In industrial refrigeration, Mayekawa originally chose natural refrigerants because they were friendly to the environment, but also efficient"

"We also need to introduce more products into overseas markets, and while increasing our sales, we will continue to develop a far more advanced NewTon that achieves higher efficiency using a smaller ammonia charge."

To meet the increased demand, Mayekawa will improve its service networks and collaborate with local companies with the aim of launching a smaller NewTon that uses an NH_3 scroll compressor, for the commercial market, in the first half of 2016. In addition, new production lines for NewTon motors will be constructed at the company's Higashi-Hiroshima plant. "We need to address compressors as well, but we will first enhance the efficiency of the motors. The construction will start [in 2016] and the plant will have a clean room."

While Mayekawa traditionally services a wide spectrum of industrial sectors, a move into commercial refrigeration and industrial air conditioning could have positive implications for the company's business. "We are going to construct a building that has NH_3/CO_2 air conditioning systems. Also, we are planning to develop NH_3/CO_2 systems for supermarkets and convenience stores," Mr. Maekawa unveils the company's future plans.

Anniversary in 2024 a big incentive

In 2024, Mayekawa will celebrate its 100th anniversary. But rather than use the milestone as an opportunity to reflect, the company is instead using it as a catalyst for further growth. "By 2024 we are aiming to achieve twice as many sales as in 2014. So our goal for 2024 is achieving 200 billion yen in sales. The number of staff will increase as well, and we are looking forward to working with [more] people around the world to advance our eco-friendly business."

Looking forward, Mr. Maekawa insists little would change by way of the company's philosophy. "We will continue to be pioneers but at the same time we hope other companies will [work] with us promoting the Natural Five, so as to make a better global environment for younger generations."

"I want people to perceive Mayekawa as an ecological company making a big effort to support the global environment." JR + MC

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