

Climalife Contact #12

THE EUROPEAN MAGAZINE FOR CLIMATE
CONTROL SYSTEM PROFESSIONALS

October 2017



Regulation to eliminate high GWP refrigerants.

Quotas have a major impact
on the refrigeration and air
conditioning industry

NEWS

CLIM'APP, THE NEW
MOBILE APPLICATION
OF PROFESSIONALS

REPORT

OIL FOR COMPRESSORS
OPERATING WITH R-744

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NEW LUBRICANT EXXONMOBIL

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Price: 2,50 €

news in brief

Clim'app

Climalife launches Clim'app, a mobile application that provides everyday support for cooling industry professionals.

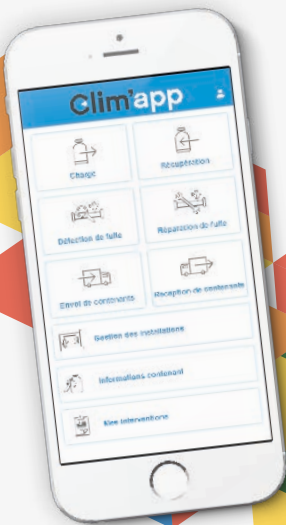
Clim'app is a mobile application for:

- managing and reporting services,
- managing equipment and containers,
- producing regulatory documents (e.g. French form FI BSD & Appendix 1).

Clim'app is also a web application for:

- viewing inventory of refrigerants,
- managing cooling industry work environments (sites, equipment, vehicles, detectors, etc.),
- dashboards that summarise your most important business information.

The app is currently available in France and will soon be developed and adapted for other countries.



Download on the
App Store

Get it on
Google play

Regulations for eliminating high-GWP refrigerants

Quotas have a major impact on the refrigeration and air conditioning industry!



the future, as we've been saying for several years.

The changes are now largely being implemented through the establishment of quotas for tonnes of CO₂-equivalent (tCO₂eq) emissions. This approach differs from that used to ban CFCs and HCFCs, where an implementation schedule was followed. Currently, companies are working to replace HFC refrigerants. However, this is made difficult by the poor availability of products, a trend that will only get worse in the coming months.

A page is turning in the history of the cooling industry and there's no going back. Players in the refrigeration and air conditioning industry must now incorporate these changes into their plans for

It's important to understand that market dynamics are in flux because demand for refrigerants and tCO₂eq credits is greater than supply. On the market, this has resulted in a shortage and a spike in prices, particularly for high-GWP refrigerants, like R-404A.

To fix this problem, it is important to act now. More than ever, companies need to work fast to educate those who own cooling equipment. There are many existing substitutes for HFC refrigerants. The entire Climalife team is at your service to help you choose the best eco-friendly and energy-efficient alternative. Also, case studies presented in this edition will tell you about the latest developments in commercial and industrial refrigeration applications.

Happy reading!

Luc Dehon
Managing Director of Climalife

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R-744

Choose the lubricant adapted for each type of compressor



Lubrication for compressors operating with R-744

PAO, PAG OR POE? HOW DO YOU CHOOSE THE RIGHT LUBRICANT FOR EACH DIFFERENT TYPE OF COMPRESSOR?

Interview with Jean-Yves Clairé and François Péricat from ExxonMobil.



Jean-Yves Clairé,
Lubrication Engineer



François Péricat,
Industrial Engineer,
France/Spain/
United Kingdom

How does the lubricant needed for CO₂ compressors differ from other types? What kinds of challenges are involved?

J-YC/FP: R-744, which has an ODP* of 0 and a GWP of 1, has a number of advantages, including a high latent heat of vaporization and a low specific volume. It is also non-toxic and non-flammable. However, a certain amount of expertise is required to solve the various technological challenges associated with its use, such as its extreme solubility in lubricants and CO₂ high solvency when it is in the form of liquid or mist.

What types of lubricants do you recommend?

J-YC/FP: Refrigeration by compression is based on the well-known principle of vaporization, whereby the refrigerant transforms from a liquid to a gaseous state, a process during which a large amount of heat is absorbed, resulting in "cold production". Although this basic principle does not change, numerous variants are used in industrial facilities operating with CO₂, such as cascade systems, dry or flooded evaporators, boosters, and sub or transcritical refrigerant cycles. The refrigerant gas and the design of the facility are what will determine the type of lubricant needed. Thus, for a facility requiring a perfect miscibility between the CO₂ and the lubricant, one would use POE type oils (polyolesters), whereas for systems that do not favour miscibility, one would rather use a PAO (polyalphaolefin) or PAG (polyalkylene glycol) lubricant, as shown in Figure 1.

These three types of lubricant – POE, PAO and PAG – are the ones that are used with R-744. As the oil is key to the successful operation of a facility, it is important to understand how each type of compressor needs to be lubricated.

Can you briefly explain how each type of compressor needs to be lubricated?

J-YC/FP: There are two categories of CO₂ compressors: reciprocating compressors and screw compressors. The general constraints associated with lubricating the bearings on reciprocating refrigeration compressors are comparable to those for other types of compressor: for small units, the oil is applied to the connecting rods and cylinders by splash lubrication, while for large units, a coupled pump lubricates the bearings and connecting rods by oil circulation. So regardless of the type of application, miscible or non-miscible, it is important to understand that lubrication of the compressor's components is made by the combination of the lubricant and CO₂. The solubility of the refrigerant in the lubricant will depend not only on the inherent behaviour of the refrigerant/lubricant mixture but also on the pressure level: the higher the pressure, the higher the solubility and the greater the decrease in viscosity. This rule applies to CO₂ and to POE, PAO and PAG oils.

*ODP: ODP: Ozone Depletion Potential.



Because the viscosity decreases with the temperature, the lubricant will be much more viscous on the suction side than on the exhaust side. So one faces two opposing effects: the oil must not be too viscous in order to quickly create a thin film over all of the surfaces that need to be lubricated, but it must be viscous enough to provide an appropriate protection against wear, despite the solubility of CO₂. One also needs to remember that the lubricating oil will be carried over in the system by the refrigerant, so the miscibility factor will then become very important, as I will explain in a moment below.

When a reciprocating compressor operating with CO₂ is not in use, the oil temperature is maintained by electrical heating resistance inside the casing to help CO₂ degassing from the oil, thus guaranteeing a higher viscosity when the compressor goes back into service. This prevents a sudden degassing effect when the compressor is restarted, which would washout the oil film.

The oil in the crankcase is subjected to the suction pressure (low pressure). The solubility of the CO₂ at the temperature of the crankcase and the suction pressure must be taken into account in order to estimate the real viscosity of the lubricant using the viscosity, pressure and temperature charts. The minimum viscosity required to lubricate a reciprocating compressor properly is 30 centistokes on the crankshaft and 7 centistokes at the contact point between cylinder and piston ring. So one would use a viscosity grade between 46 and 100 centistokes at 40°C to achieve the minimum viscosity needed to lubricate a reciprocating compressor's components correctly, bearing in mind CO₂ solubility.

And what about screw compressors?

J-YC/-FP: Lubricated or "wet" screw compressors are also used in CO₂ facilities. With these systems, the oil lubricates the screw compression elements as well as the bearings. The lubricant creates a seal between the screws and the casing, cools down the compressed gases and allows hydraulic controls. Remember that for lubricated screw compressors, the pressure increases continuously along the entire profile of the screw. This means that the solubility of CO₂ in the lubricant is maximum at the compressor's exhaust conditions (pressure and temperature); this leads to a significant drop in viscosity. A lubricant with a higher viscosity grade is used for screw compressors than for reciprocating compressors: typically between 68 and 220 centistokes at 40°C to offset the drop in viscosity.

As far as lubrication is concerned, are there any challenges common to both types of compressor?

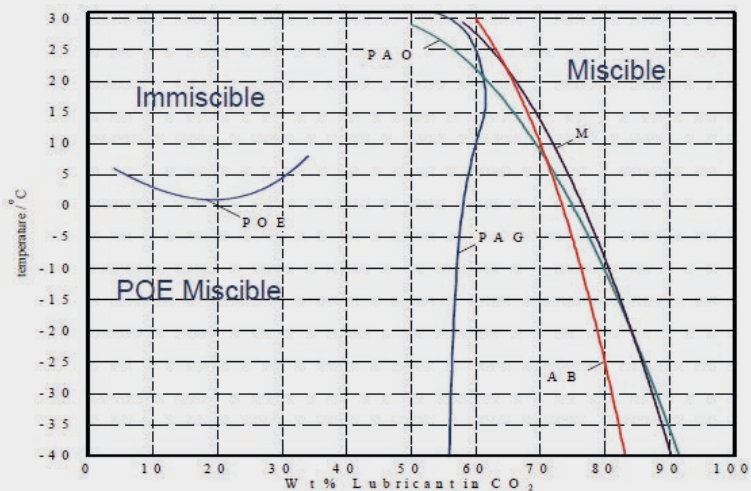
J-YC/-FP: Yes, there are. The CO₂ solubility is maximum at the separator outlet. It is best practice to consider a heating system to extract as much dissolved CO₂ as possible from the lubricant before reinjecting the oil into the compressor casing. If the dissolved CO₂ is not removed, the degassing will occur in the compressor sump, generating foaming which might lead to lubrication failure and lubricant lifetime reduction.

Looking now at the suction line, a small variation of temperature or pressure may lead to

the formation of CO₂ mist. These very fine droplets of liquid CO₂ can potentially wash out the oil film, resulting in a metal to metal contact in the inner parts of the compressor, such as piston ring/cylinder wall or bearing/crank pin contact surfaces.

The transformation of the liquid phase (mist) into a gas phase (vapour) can also blow away the lubricant film, resulting in the same mechanical damages. To prevent these problems, designers and installers recommend heating the gaseous CO₂ by 10 to 15° Kelvin at the compressor's inlet.

Figure 1: Indicative miscibility ranges by type of lubricant with CO₂:



M: Mineral oil, AB: Alkylbenzene, POE: Polyolester, PAO: Polyalphaolefin, PAG: Polyalkylene glycol

Advantages and disadvantages of different types of oils: POE, PAO and PAG

POE: high level of purity, chemically stable, resistant to thermal stress, able to withstand very high temperatures (+210°C), miscible with CO₂, low volatility.
Disadvantage: hygroscopic. **Typical CO₂ applications:** miscible applications.
PAO: stable to hydrolysis, high level of purity, highly resistant to thermal stress, able to withstand temperatures ranging from -45°C to +175°C, very low viscosity at low temperature, low volatility at high temperature, excellent protection against wear.
Typical CO₂ applications: non-miscible applications.
PAG: high level of purity, excellent lubricating capacity, stable when subjected to heat and thermal stress, able to withstand constant temperatures up to 210°C. **Disadvantage:** more hygroscopic than POE, incompatible with some seals and paints, PAG are generally incompatible (non-miscible blend) with mineral and PAO lubricants.
Typical CO₂ applications: non-miscible applications.

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INDUSTRIAL REFRIGERATION | FOOD INDUSTRY



Process innovation in food production sector:

INCREASED PRODUCTIVITY, REDUCED INVESTMENT, LOWER TAX AND GWP<1 THANKS TO HFO 1234ZE REFRIGERANT

Frimavi is a small family-run business currently employing nine members of staff. Established in 1994 the company offers industrial-scale refrigeration, processing, air-conditioning and maintenance solutions to SME's mainly in the food production and processing industry. Working alongside a British company, Frimavi is a specialist of post-harvest pre-cooling tunnel solutions. The Frimavi founders had previous experience in hospitality and catering sectors providing commercial and industrial cooling services.

Frimavi specialises in working with a vast range of solutions including HFCs, ammonia and more recently, HFOs (hydrofluoroolefins). Always at the forefront of technological advancements Frimavi came across HFO 1234ze from the Honeywell Solstice® range. With a GWP less than 1 and enhanced efficiency HFO 1234ze is an attractive solution for those looking to reduce their environmental impact.

The biggest challenge at Zanemi's site in Villena (Alicante, Spain) was a very outdated system suffering from a number of leaks and costing the company a significant amount in tax. Frimavi were asked to renovate the site and design an ammonia-based system to reduce the tax paid.

After studying the properties of HFO 1234ze, Frimavi proposed to design the system using a HFO 1234ze chiller reducing the investment cost by 20%.

In comparison to an ammonia-based system the COP is similar but the new installation is a lot less complicated, requires less investment and reduces maintenance costs by 70%. The new system does not require cooling towers.

To process 10 tonnes of carrots per hour, Zanemi requires 250kW to maintain two rooms at 1 °C and to supply a continuous tunnel in which products enter at 25 °C and leave at 2 °C.

The chiller, which can use an A2L refrigerant, is installed outside, conforming to the requirements laid out in the ATEX directive. The installation operates correctly under the lowest service pressure.

The chiller and the refrigerant are working with excellent productivity and with Temper, as the heat-transfer fluid for this installation, which has proven to be more efficient than glycol.

Success

experience

José Luis Sánchez Ruiz,
Technical Sales
Representative
at Frimavi

« Our mission is to develop and deliver innovative, efficient and economical solutions to our customers. HFO 1234ze refrigerant not only helped us to achieve our goal but it also allowed us to reduce the impact on the environment, ».

Solstice® ze: the solutions of the future

“We had a great experience with HFO 1234ze. We intend to use a chiller with an economiser in order to improve sub-cooling. We believe that it's possible to boost efficiency by 15% at a reasonable cost. Two other installations are already using this refrigerant, and others are currently in design.” José Luis Sánchez, Manager at Frimavi

Benefits:

- GWP < 1
- Lower tax burden
- Reduced investment cost
- Low maintenance costs
- No malfunctions
- Excellent COP

+ More info on:
climalife.dehon.com/
solstice-ze

FRIMAVI IN BRIEF:

1994
Year founded

9
employees

Industry: Industrial refrigeration- air conditioning.
Location: Villena (Alicante - Spain).



Solstice® ze
20%
cost
reduction

Cuisine Centrale de Saint-Brieuc: First equipment in Europe to use R-1234ze/R-455A

MICKAEL ROUXEL, HEAD OF CENTRAL FROID, CHOOSES AN INNOVATIVE WAY TO ADOPT VERY LOW GWP REFRIGERANTS FOR REFRIGERATION, HOT WATER, AND HEATING IN A COMMERCIAL KITCHEN.



Established in June 1989, the Cuisine Centrale de Saint-Brieuc was designed to deliver up to 3,000 meals per day. The kitchen's main mission is to provide meals for public primary school canteens in the town of Saint-Brieuc (~2,500 meals/day) using a cook-freeze method. Over the years, the Cuisine Centrale added home delivery of meals to the elderly and some canteens for adults. The Cuisine then diversified by establishing hot food delivery for meals at childcare centres, which require special procedures. The site has a team of 24 people working Monday to Friday. Using the cook-freeze production method makes it possible for them to prepare meals for several different customers for different delivery days. Meals are cooked and put in trays, then cooled to 7°C before being stored in a cold room where they are kept

until they are distributed no more than three days later. The hot delivery system makes it possible to adapt to the needs of little ones by cooking and delivering specific meals with varying textures every morning. The system also makes it possible to make the last-minute meal changes if needed. The Cuisine Centrale de Saint-Brieuc delivers meals to around thirty food service locations every day. Since 2009, organic products have been included in the preparation of meals and currently make up about 16% of all the orders.

Energy saving: a key factor in the decision to replace the heat transfer system

The kitchen decided to replace their original refrigeration systems, which had become outdated and difficult to keep in service, requiring several fluorine

Selection

■ The Cuisine Centrale de Saint-Brieuc puts its trust in Central Froid

Since its founding, Central Froid has been an expert in commercial and industrial refrigeration. The company has four locations in northern Brittany and continues to grow to keep up with customer demand. In 2016, Central Froid founded the company IGC 22, which specialises in commercial kitchens.

At the helm of Central Froid is Mickael Rouxel. He has been aware of environmental issues since the start of his career in Switzerland. He has a comprehensive understanding of the energy efficiency of an installation—from its design, to its operation, to its maintenance. Mr Rouxel proactively tracks developments in the refrigerant world, which allows him to constantly innovate and offer long-term solutions.

Use of the innovative combination of R-1234ze and R-455A is proof of his commitment. It got the attention of the Cuisine Centrale de Saint-Brieuc, which had a heat transfer system installed that combines energy performance with sustainability.

+ More info on:
climalife.dehon.com/r-455A

Description of the installation

- HK Refrigeration above-zero refrigeration unit
Capacity: 33.7 kW.
Refrigerant: 50 kg of HFO 1234ze.
GWP: 6
2 Bitzer 4PES-12Y compressors.
Danfoss AK-PC 551 capacity controller.
Speed and floating HP control
Boosterm heat recovery system (45 kW) for heating, with a 1,500-litre buffer tank and a 30-kW air handling unit (AHU).
Expected savings: around 2,000 euros per year.
- HK Refrigeration sub-zero refrigeration unit
Capacity: 5.8 kW.
Refrigerant: 7.5 kg of HFO R-455A.
GWP: 146.
1 Copeland Scroll ZF24K4E compressor.
Boosterm heat recovery system (20 kW) for hot water, with a 2,000-litre buffer tank and three 1,500-litre tanks.
Expected savings: around 6,600 euros per year, based on consumption of 3,750 litres per day.



refrigerants for separate pieces of equipment. Jean-Luc Pennec, Service Manager, led deep discussions about changes to be made, working closely with Arnaud Loriferne, Energy Manager at the Saint-Brieuc town hall. According to Mr Loriferne, 'The change to a comprehensive refrigeration unit for cooling needs was a clear choice and, in order to save energy, it was essential that we put in place a process to recover heat to produce hot water and heat the building. CETIA Ingénierie, produced Energy and Refrigeration Usage Assessment at the beginning of the project. An above-zero refrigeration unit using R-134a and a sub-zero unit using R-407F were chosen to cover all needs. The project specifications, with a total budget of 80,000 euros, was brought before the town hall's tenders commission by the project team. The focus of this project was energy saving and return of investment. The call for tenders was published in late 2016 and attracted several refrigeration companies. Central Froid stood out with their environmental and technical approach, using the latest HFO refrigerants with lower GWP, and was awarded the project.

System installation without disrupting food production and storage

Implementation began in March 2017 with installation of an HK Refrigeration sub-zero refrigeration unit with a Copeland scroll compressor, adapted by Central Froid to work with R-455A. This refrigerant, with a GWP of 146 on the IPCC AR5 scale, is sold by Honeywell under the brand name Solstice® L40X. Mickael Rouxel was relying on technical support from Climalife in the process of getting approval from compressor and part manufacturers for this project.

The refrigeration unit cools the sub-zero cold room to -20°C for frozen products. The project continued in April with installation of the above-zero refrigeration unit, which required special scheduling to not disrupt the production. 'Scheduling the switch over two days, getting one cold room online at a time, allowed us to avoid the storage problem that we would have had with other installers, who wanted to switch over four cold rooms simultaneously. The special schedule was an important advantage for us,' said Jean-Luc Pennec. Central Froid put the HK Refrigeration above-zero refrigeration unit modified to use the latest HFO refrigerant R-1234ze into service. Equipped with variable speed drives, the unit produces the cooling needed for the two 10°C cold preparation areas and seven cold rooms, which have temperatures between +2°C and +6°C. These cold rooms are for storing food supplies, daily production, fresh meat, deli meat, fruits, vegetables, dairy products, and cooked dishes.

The two units are installed outside, near the plant room that held the old refrigeration units. The old units were dismantled and the freed-up space was used to install the Boosterm heat recovery system that relies on the refrigeration units' condensers. The recovered energy is used to pre-heat hot water to 55°C, with 45°C water flowing out to three 1,500-litre tanks. The hot water that goes out for usage is heated to 60°C. The building's electric resistance heating system was replaced with the France Air AHU using heat recovery from the above-zero refrigeration unit charged with R-1234ze.

The solution

■ Solstice® ze / Solstice® L40X, a sustainable alternative with very low GWP


'With the arrival of new HFO molecules and the impact of quotas on the market, it is extremely important to move towards solutions with very low GWP, like R-1234ze and R-455A, to ensure that equipment can be used in the long term and that the required refrigerants will be available.'

Doing so allows you to work with refrigerants while keeping peace of mind,' said Pierre-Emmanuel Danet, Technical Support Manager at Climalife.




+ More info on:
climalife.dehon.com/solstice-ze


CENTRAL FROID IN BRIEF:



1982
Year founded



22
employees



3
millions euros (2016)

Business: Commercial and industrial refrigeration - Professional kitchens - Heat pumps and AC.

Location: Saint-Brieuc, Côtes-d'Armor, France, with 3 other locations in northern Brittany.



From left to right: Jean-Luc Pennec, Service Manager for the Cuisine Centrale – Arnaud Loriferne, Energy Manager at the Saint-Brieuc town hall – Cédric Devendec, CETIA Ingénierie – Mickael Rouxel, head of Central Froid – Pierre-Emmanuel Danet, Technical Support Manager at Climalife.

Energy savings estimated at more than
8 600
per year!



Solstice® N40: The eco-friendly alternative to R-404A

DIFISA INSTALLED A REFRIGERATION SYSTEM USING SOLSTICE® N40 (R-448A) FOR MEDIUM- AND LOW-TEMPERATURE ROOMS AT THE NEW ASCASO BAKERY IN HUESCA, SPAIN.



DIFISA is a company based in Spain's Aragon region. Founded in the late 1970's, the company specialises in industrial refrigeration and air conditioning. DIFISA is committed to provide the best customer service offering the greatest reliability possible when installing custom design refrigeration systems. Guided by the highest service standards, DIFISA presented Ascaso, a well-known bakery, with a bespoke solution for their new facilities in Huesca, Spain. The pastry makers moved their production to the new 1,680-m² site equipped with state-of-the-art production equipment. However, Ascaso is keeping its artisanal touch and renowned expertise, particularly for one of their creations called the 'pastel ruso' (Russian cake).

System	Equipement	Service
Above-Zero	6 Refrigerated storage rooms and work rooms	Waste, finished products, semi-finished products, raw materials, sweets, nuts, and chocolate.
Sub-Zero	3 Freezer rooms	Finished and semi-finished products

Project objectives
The option selected and proposed by David Leal, CEO of DIFISA, was to install two independent units. The first installation: a low-temperature unit for the three freezer rooms, charged with R-448A, a refrigerant sold by Honeywell under the brand name Solstice® N40.

The second unit for the six zero-degree cold rooms and the work rooms charged with R-134a. This choice has a direct impact on costs and also offers the advantage of a lower GWP, ensuring that the equipment installed at the Ascaso bakery will work more efficiently in the long term.

Implementation
The choice to use two different refrigerants is due to the specific characteristics of each. The first is R-134a, a refrigerant commonly used in commercial refrigeration, with very suitable properties and better operating costs for above-zero equipment. The system was designed so that, in the future, the R-134a can be replaced with a refrigerant such as Solstice® N13 (R-450A). With a 58% lower GWP and a cooling capacity only 8% to 10% lower. Switching to R-450A would reduce the impact on the environment. The second refrigerant being used is R-448A. It is an ideal combination of low GWP and high energy efficiency - perfectly adapted to work at low temperature.

Description of the installation
The direct-expansion refrigeration system provides cooling to the freezer rooms for finished and semi-finished products, the cold storage (raw ingredients, nuts, etc.) and production rooms. Once the production is completed, products go into the blast chiller. After that, they are stored in a cold room before being sold. Humidity in the storage room for nuts and chocolates is strictly controlled and the temperature must be maintained between 12°C and 14°C.

DIFISA IN BRIEF:



1979
Year founded



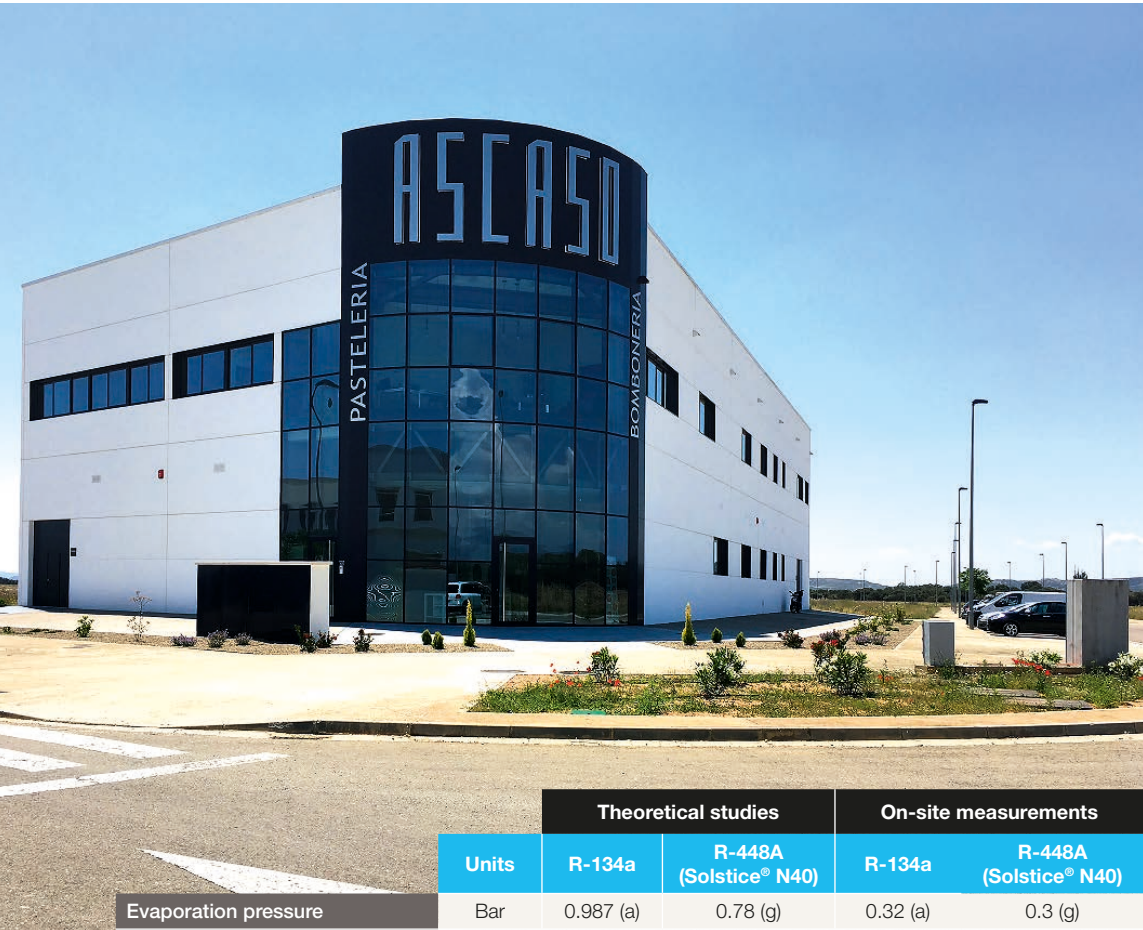
11
employees

Business: Commercial refrigeration and industrial processes - Air conditioning.

Location: Zaragoza (Spain).



Solstice® N40:
simple, effective
implementation!



	Units	Theoretical studies		On-site measurements	
		R-134a	R-448A (Solstice® N40)	R-134a	R-448A (Solstice® N40)
Evaporation pressure	Bar	0.987 (a)	0.78 (g)	0.32 (a)	0.3 (g)
Evaporating temperature	°C	-10	-30	-20	-37
Condensing pressure	Bar	5 (a)	9.9 (g)	8.6 (a)	15.4 (g)
Condensing temperature	°C	22	22	38	37
Condensing temperature	°C	55.5	76.5	80	84 *
Discharge temperature	kW	21.4	16.18	15.8	16.18
Refrigeration capacity	kW	9.4	11.48	7	11.48
Compressor capacity	kW	33.7	66	33.7	66
Amount of refrigerant	kg	60	70	60	70
External ambient temperature	°C	35	35	6	6

(a) absolute pressure - (g) manometer pressure - (*) fans (indicates that the compressor's discharge temperature is reduced by the action of the fan)

Settings and initial results
Implementation was simple and efficient. The only operation that was a little more complex was adjusting the thermostatic valves to take into account the flow of the Solstice® N40 and to optimise the performance of the equipment. The compressors for the freezer rooms are equipped with head cooling fans. As such, no other measures had to be taken for discharge temperature.

Testimonials

'This was our first time working with this new refrigerant and I am pleasantly surprised with the performance of the equipment. The advice from Climalife Friogas and Honeywell was valuable help in developing this project. I am very happy with the results and we will certainly continue working together.' David Leal, DIFISA.

'The project was executed well, the installation is done correctly for piping, condensate draining, insulation, and wiring. The assembly of compressors, condensers, fans, and control boxes shows high-level installation. The two systems were temporarily working at set points lower than the expected operating conditions because the equipment was not yet totally operational. These set points were then fixed when the equipment was put fully in service.' Pawel Wisnik, Honeywell.

'The equipment and refrigerants were well chosen. We have found the perfect combination between sustainability and environmental friendliness. We saw the experience and professionalism of DIFISA in both the execution of the project and their advice to the customer.' Jesús Gutiérrez, Major Accounts Manager, Climalife Friogas.

'As we were not familiar with the technical aspects of the project, we chose the service provider who, in our eyes, seemed the most trustworthy. With that said, we can now say that we made the right choice with DIFISA. I would like to sincerely thank them, not just for their work and the great results, but also for having teams of very genuine and professional employees. We are completely satisfied.' Vicente Ascaso Martínez, Head of Ascaso.



From left to right:
David Leal, CEO of DIFISA – Juan José Abad Martínez, Refrigeration Technician at DIFISA – Jesús Gutiérrez, Sales Manager at Climalife Friogas – Monica Leurette, Spain Management & Marketing Assistant at Climalife – Pawel Wisnik, Senior Application Engineer at Honeywell.



Innovation for CO₂ Service

Use R-744 with ease, with the light Mooviz® and Mobil SHC Gargoyle



Mooviz®, the lightweight CO₂

- Portable: equipped with wheels
- Lightweight: composed from high-tech materials
- Mobile: ergonomic handle
- Guaranteed quality: 99.99% purity to meet compressor specifications

Mobil SHC Gargoyle™ 80 POE CO₂ oil

- POE oil miscible for CO₂ use
- Improved lubrication and extended servicing intervals
- Low compression wear
- Improved performance and energy efficiency

Discover the full R-477 range at Climalife

climalife®

Mobil™

INDUSTRIAL REFRIGERATION



Equipment installer Black Koudetechniek says: "No more R-404A"

IN 2016, CONSCIOUS OF ISSUES OF GWP AND THE AVAILABILITY OF R-404A, BLACK KOUDETECHNIEK DECIDED TO BEGIN RECOMMENDING SOLSTICE® N40 FOR ALL OF THE NEW REFRIGERATION PROJECTS.

Working in the Netherlands and Belgium, Black Koudetechniek specialises in designing, supplying, installing, repairing, and maintaining refrigeration equipment, such as cooling systems, cold production and storage room units, ice machines, and tunnel freezers. Their main customers are food production and packing industries, hospitality wholesale and retail industries, to name a few. Since the implementation of the F-gas regulation and the launches of new HFC and HFO solutions on the market, Black Koudetechniek has chosen R-448A as a replacement for R-404A in all of the company's new projects. For existing systems, a policy of retrofitting can be more difficult to implement as it depends primarily on the end users.

Example of a project completed for the wholesaler HANOS, based in Utrecht

HANOS - ISPC is a wholesale company specializing in the HORECA sector offering full range of products and services. They have the total of 19 establishments in Netherlands and Belgium. Black Koudetechniek is managing maintenance in a number of those establishments, including Hanos Utrecht. HANOS Utrecht opened its doors in 2009 with a 6,000-m² store and used refrigeration equipment taken from another HANOS site.

In 2016, the store added another 4,000 m² of sales space for fresh foods and non-grocery items. Black Koudetechniek was in charge of the refrigeration part of the project. The goal was not only to install a new condensing unit using R-448A for freezers and an R-134a unit for above-zero refrigeration, but also to install new Viessman refrigerated cases and to connect old cooling systems to the new system. Implementation took place over the period of six-month from April to October 2016 and was managed by two technicians.

The R-448A unit consists of two Bitzer 6GE60Y compressors with variable speed drives. They have a cooling capacity of 54 kW, with an evaporating temperature of -30°C and a condensing temperature of +45°C. An optimised Danfoss ADAP-KOOL system is used to control and monitor the refrigeration equipment, as was the case for the previous refrigeration units. The Danfoss system facilitated installation of the new equipment, with the new R-448A settings incorporated. Solstice® N40 is similar to R-404A, but is more environmentally friendly. HANOS is very satisfied with the performance results 'HANOS isn't concerned with the technical aspects. They just want the temperature to be perfect,' says Thomas Gerritsen.

BLACK KOUDETECHNIEK IN BRIEF:



1979
Year founded



12
employees

Business: Refrigerators and freezers - air conditioning - ice cream equipment.

Location: Drimmelen, North Brabant province, the Netherlands.



The solution

■ **R-448A**, "the refrigerant with the lowest GWP on the market"

experience



Thomas Gerritsen,
Project manager
at Black Koudetechniek

At Black Koudetechniek, we believe in anticipating the future and providing the right equipment for each project. Solstice® N40 (R-448A) has the following advantages: it has a good coefficient of performance; of all the non-flammable R-404A replacements on the market, it has the lowest GWP; and it helps reduce energy consumption. Why wait until 2020? We inform our customers about the issues with R-404A and we always recommend Solstice® N40 because it works perfectly for our applications and it is employed in exactly the same way as R-404A.'



+ More info on:
climalife.dehon.com/refrigerants

New R-448A/CO₂ cascade system installed at the Romans-sur-Isère Hyper U supermarket



■ The Hyper U supermarket in Romans-sur-Isère got an upgrade!

This U supermarket currently employs 130 people and had turnover of 32 million euros in 2016. The goal is to reach 40 million euros after the renovation. A large island of cases for fresh and frozen products was installed. The refrigeration system for these cases uses energy efficient and more sustainable solutions (choice of refrigerant, recovery of heat for the store's hot water, refrigerated cases that close). Total electricity consumption has been reduced from 20% to 30%, with more natural lighting and smart management.

This new people-centric store with optimised accessibility is designed for the comfort of customers and employees.

Built in 1997, this U supermarket was once bustling. However, turnover has been falling at the store for the past few years, creating the need for serious change. Gary and Philippe Doire acquired the store in January 2017 with a clear goal: 'give the store a makeover and revitalise it for better energy-efficiency and improved profitability.' At U supermarkets, better management of the planet's resources involves action on many different fronts, including preserving marine resources, encouraging eco-friendly construction, reclaiming waste from stores, and reducing energy consumption. The company has deployed a rigorous energy optimisation policy based on improved management of energy consumption at all U supermarkets, making energy optimisation tools available to promote best practices, and incentivising renovations that improve energy-efficiency.

The Doire family took these significant measures into account for their Hyper U expansion project in Romans-sur-Isère, a town in Drôme department, France.

The store expansion project
The new Hyper U management decided to expand 3,960 m² floor space to 4,500 m² in order to introduce new products and in-store services (butcher, cheese counter, bakery, etc.). Construction began in February 2017 with a reverse-scheduling plan carefully drawn up under the shrewd guidance of the senior Mr Doire, who coordinated all contractors.

So started the seven months of work!

The store was previously equipped with a direct-expansion system with two retrofitted R-22 units, a more recent R-404A above-zero unit, and many independent units for departments such as the bakery. The renovation and layout-update plan for the store included changes to cooling systems for refrigerated sections and hot water. The store's existing rooftop heating and air conditioning systems were left unchanged. A cascade system was planned, with the peace-of-mind provided by a CO₂ unit for sub-zero refrigeration.

'At U supermarkets, store managers are educated about new technologies. As such, it was important to propose a solution that was both energy-efficient and sustainable,' said Christophe Luna, Manager of Reynet Froid.

Implementation of the R-448A/CO₂ cascade system

The Bonnet Névé-brand glass-door and other refrigerated cases were selected directly by the store manager. The system has a Profroid sub-zero unit with a capacity of 38 kW, equipped with four Bitzer compressors and loaded with 90 kg of R-744. This refrigeration system primarily chills chests of frozen products and the cold storage rooms.



Once the product displays were put into operation, the second stage of work began connecting refrigeration equipment and all cooling systems across fresh product (deli meats, dairy, etc.) food preparation and chilled product (seafood, meat, ready meals, etc.) aisles.



Two Profroid above-zero refrigeration units, each with 280 kg of R-448A (Solstice® N40), cover all refrigeration needs. The two units are equipped with four Bitzer compressors and variable speed drives.

A Carel monitoring system is used to control temperature, pressure, and humidity in refrigerated equipment.

Heat is recovered from the above-zero refrigeration units to generate hot water, with a 1,000-litre tank. All of the new equipment is installed on the upper level of the store to open up the former plant room, which has been converted to sales floor space.

'Construction took more than 150 nights of work across all of our contractors,' says the Hyper U manager. 'It was a very long, well-organised phase and it took longer than expected to implement. The project was essential for improving store sales and for customers comfort.'

The supermarket now awaits approval of the application for energy-saving certifications and is getting ready 'to welcome customers into a store that is adapted to modern shopping habits and that has the goal of connecting economic performance with environmental performance,' said Gary Doire.

The solution

■ R-448A / CO₂ cascade système

experience



Christophe Luna,
Manager of Reynet
Froid et Climatisation

'Working with the R-448A refrigerant hasn't changed our habits at all. It's a refrigerant with low GWP, classified as A1, supplied in standard cylinders that are easy to use. As for settings, we haven't encountered any particular issues. Indeed, the feedback that we have received with this refrigerant has been very positive.'

'It's different for CO₂. We had to adapt to this high-pressure refrigerant. Profroid, our unit supplier, has helped us implement sub-zero units. This type of system requires special precautions for installation and it was important to have the manufacturer present.'

+ More infos on:
climalife.dehon.com/solstice-n40/r-448a

REYNET FROID ET CLIMATISATION IN BRIEF:


1981
Year founded

Business: Commercial refrigeration and air conditioning - Commercial kitchens.


10
employees

Location: Privas (Ardèche, 07 - France).



From left to right:
Gary Doire, Hyper U Store Manager
Christophe Luna, Manager of Reynet Froid et Climatisation
Delphine Martin, European Marketing Manager at Climalife
Florent Bresson, Key Account Manager at Climalife.

Eco-Efficiency Comparison of Supermarket Architectures

HONEYWELL REFRIGERANTS ARTICLE WRITTEN BY NACER ACHAICHIA, TECHNOLOGY LEADER EMEA AND PAVEL WISNIK SENIOR APPLICATION ENGINEER - JULY 2017

Commercial refrigeration has been under scrutiny by politician and regulators around the world, because of the use of high GWP (Global Warming Potential) fluids like R-404A and because of high leak rates. In Europe the F-Gas Regulation has a ban on high GWP refrigerants, and also a phase down on the use of HFCs based on their CO₂ equivalent. The use of refrigerants with low GWP will provide a future-ready solution. To respond to the challenges of the F-Gas and to reduce energy consumption in commercial refrigeration, many new architectures are under investigation and development.

Current solutions available that can be used to help the commercial sector meeting Fgas targets, are twofold. For existing R-404A systems, retrofitting with a lower GWP refrigerant is the quickest, most economical and environmentally friendly solution. For new build, several architectures are being explored. The combination of R-744 with newly developed HFOs and HFO blends offers added benefits of safety and performance.

Eco-efficiency is one of the best basis to compare various architectures in terms of not only environmental, but also economic impact.

Eco-efficiency concept

Many metrics have been developed to measure carbon footprint of refrigeration systems. GWP, used by many legislators for its simplicity, is a measure of the direct impact of emissions on the environment.

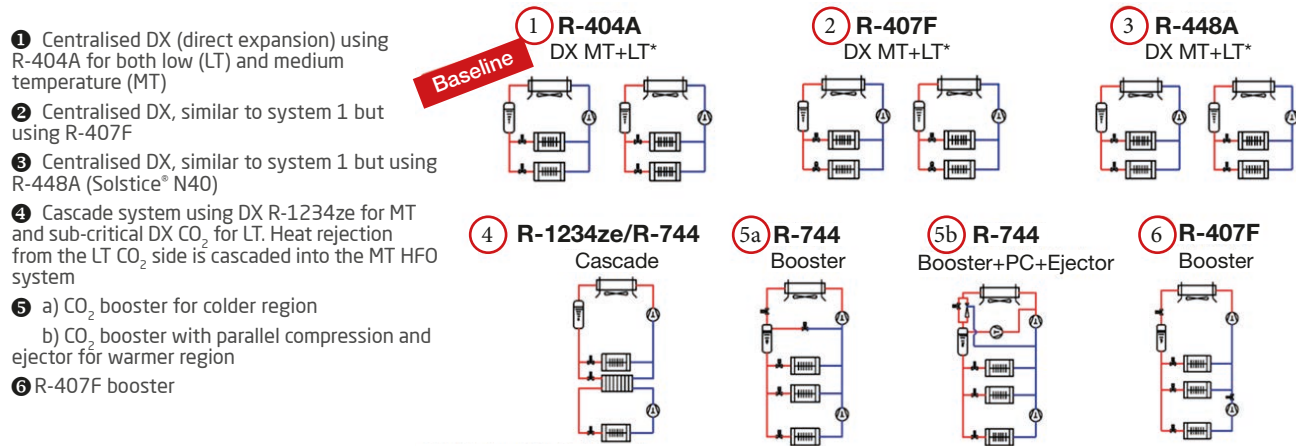
Depending of the system leak rate, GWP can only capture 10 to 35% of the total environmental impact.

TEWI (Total Equivalent Warming Impact) is the measure of the direct and indirect impact being the indirect energy usage to drive the refrigeration system. Unlike GWP, TEWI can capture up to 95% of the environmental impact. The residual impact can only be captured through a comprehensive LCCP (Life Cycle Climate Performance) analysis; but this involves making several assumptions, like embedded energy to produce components and fluids, transport and assembly of the equipment, service and maintenance, disposal, etc., which make the approximation difficult and not always more accurate.

A shortfall of all these metrics is their one dimensional nature. It is always possible to reduce environmental impact of any system by using better performing components, larger condensers, ejectors etc... in short, it is always possible to improve environmental impact by spending more money on a given system. The system total cost is therefore an important parameter that should be taken into account when comparing system environmental performance. The Eco-Efficiency, is a two dimensional metric that takes into account the environmental impact of the system and its total cost.

Commercial Refrigeration Architectures

The drive behind development of new architectures is to reduce supermarkets' carbon footprint and ensure compliance with regulations. For a comparison, six architectures have been selected as they represent some of the main stream systems used today and new ones that are based on low GWP refrigerants.



Hypothèses

Comparison is based on a typical 2,000m² supermarket, with loads of 68kW for MT and 18kW for LT. Two distinct European regions are considered: colder, represented by Hamburg (Germany), and warmer, represented by Seville (Spain). Temperature bin data have been obtained from meteorological database for 2016. For each location, monthly day time and night time temperatures were identified. Nominal supermarket loads were associated to day-time temperatures. The night time refrigeration loads were taken as half the nominal loads in order to account for the reduced energy losses during non-trading hours.

For electrical consumption the following components were considered: compressors, condensers fans, air cooler fans, display cabinets fans, display cabinets light, defrost heaters (only in LT units), defrost heaters assumed working 4 times per 24 hours, each defrost cycle 30 minutes. The electric power cost used 0.097€/kWh and the resulting CO₂ emission at the power generation plant is 0.43kg/kWh.

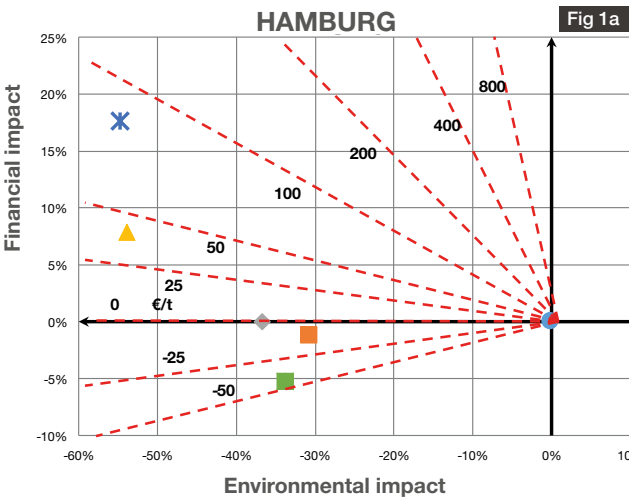
A critical parameter to the study is the CAPEX, or initial cost of the system. A detailed Bill of Material was developed for each system to include compressor racks, heat exchangers, system components (pipes, valves, insulation, initial refrigerant charge, hangers, and solders). Installation costs also included, based on normalised tabulated hours for assembling standard refrigeration system components (HEX, racks, pipes, insulation, cable ducts, system commissioning etc.). Another component of the total cost, is the operating cost (OPEX), which was based on regular maintenance work (oil, filter change, minor repairs). The analysis is done over the 15 years lifetime of the unit, assuming a yearly leak rate of 15%.

Results

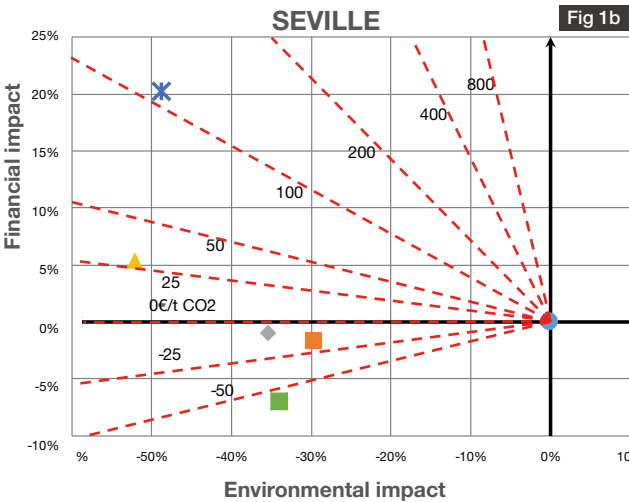
All architectures were simulated using in-house system simulation complemented with third party software for compressor selection and heat exchangers sizing.

Derived results are shown on the eco-efficiency chart shown in fig.(1a&b) for both Hamburg and Seville respectively, as a % on R-404A system baseline.

ECO-EFFICIENCY CHART FOR HAMBURG AND SEVILLE



1. DX R-404A for MT & LT - Hamburg
2. DX R-407F for MT & LT - Hamburg
3. DX R-448A for MT & LT - Hamburg
4. Cascade R-1234ze / CO₂ - Hamburg
5.a Booster CO₂ - Hamburg
6. DX Booster R-407F for MT & LT - Hamburg



1. DX R-404A for MT & LT - Seville
2. DX R-407F for MT & LT - Seville
3. DX R-448A for MT & LT - Seville
4. Cascade R-1234ze / CO₂ - Seville
5.b Booster CO₂ with parallel compression and ejector - Seville
6. DX Booster R-407F for MT & LT - Seville



All alternatives show reduction in environmental impact versus baseline R-404A, but with different financial impacts.

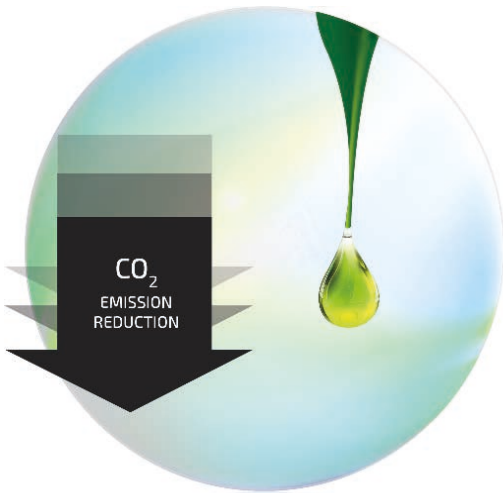
Architectures 2&3 are very similar to the base line with only refrigerants being different. The refrigerant environmental impact is shown to be an important one. R-407F and Solstice® N40 have been adopted by many supermarkets already because of their lower GWP and also the energy savings demonstrated in many applications, both in MT and LT: both show reduction in environmental impact, with similar to lower total cost. The cascade HFO/CO₂ and CO₂ systems achieve the lowest environmental impact. This is due mainly to the lower direct impact as the refrigerants used have ultra-low GWPs. The cascade system shows very promising performances both environmental and economic.

The dotted red lines represent constant €/tonCO₂ removed. The R-744 architecture 5a&5b show important reduction in environmental impact, but it is at the expense of an important financial impact. Both R-744 systems reduce the CO₂ at a cost of 80 to 110 €/tonCO₂.

The cascade system with HFO and R-744 also result in considerable reduction in environmental impact, but at a reduced economic impact of 25 to 40€/tonCO₂ removed. The HFC solutions R-407F and R-448A exhibit environmental reduction between 30 and 40% with the added benefit that these reductions are obtained at a neutral or reduced financial impact. Opting for such a solution, a supermarket chain could actually meet its environmental targets with a economic benefit in the long term.

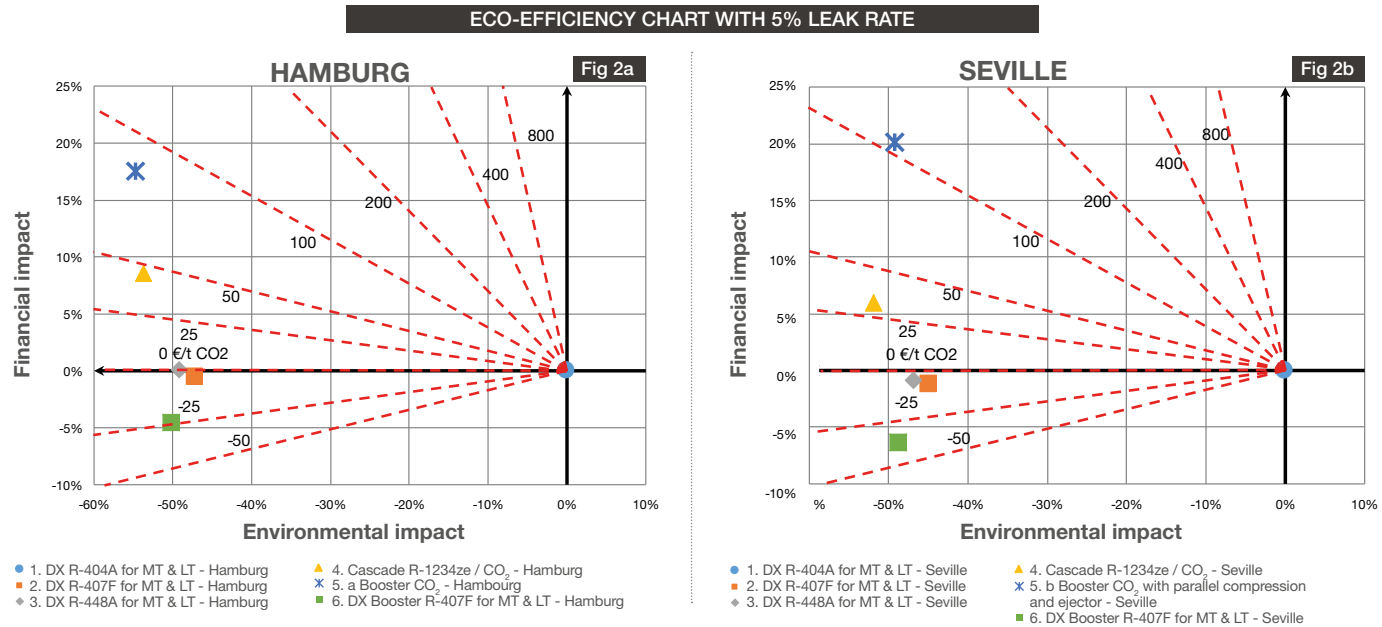
Architecture 4 relies on R-1234ze an A2L in a DX system. Current standards allow an important charge size with such refrigerant. Work is in progress to remove barriers to increasing further the charge size for A2L refrigerants in the near future. Solstice® ze is also non-flammable according to the GHS (Global Harmonized Standard) and European flammability regulation. The results demonstrate that refrigerants like Solstice® ze should be allowed (in a safe way) to be used in much higher quantities in DX system in view of their environmental performance.

Standard systems based on R-407F and Solstice® N40 have not only the lowest CAPEX but also the best energetically performance in both cold and hot climates. The environmental impact can be further improved with simply reducing the leakage rate.



The benefits of leak reduction

A reduced leakage rate to 5% for both R-407F and Solstice® N40 (R-448A) systems was then studied. A 10% increase in the maintenance cost of these system was also added in order to reflect the associated cost to such a leak reduction. The results are shown in fig.(2a&2b). As expected the impact of leak reduction has reduced further the environmental impact of such systems with little or no impact on the financials.



Conclusions

Eco-efficiency is a bi-dimensional metric and covers close to 100% of both environmental and financial impacts, resulting in the best evaluation tool to compare different systems.

Comparison table versus R-404A baseline. The lower, the better.

	Systems	Environnemental Impact	Financial impact	Cost €/ton CO ₂ e removed
15% leaks	R-407F & R-448A systems	-30 to -37%	0 to -7%	0 to -50 €
	R-1234ze/R-744 cascade	-53%	5 to 7%	25 to 30 €
	R-744 system	-49 to -54%	17 to 20%	80 to 100 €
5% leaks	R-407F & R-448A systems	-45 to -51%	0 to -7%	0 to -35 €
	R-1234ze/R-744 cascade	-53%	5 to 7%	25 to 30 €
	R-744 system	-49 to -54%	17 to 20%	80 to 100 €

Although R-744 systems have a good environmental impact, this is mainly achieved because of the ultra-low GWP of the refrigerant, but at a considerable extra cost.

Standard HFC DX systems can equally have a considerable reduction in environmental

A practical example to our industry

According to the Gapometer from EPEE (European Partnership for the Energy and the Environment), there is a need to cut 51 million tons of CO₂eq to meet F-gas regulation phase-down objective of 60% emission reduction by 2021,

impact but with financial benefits. Reducing leaks from 15% to 5% would make HFC/HFO blends based systems the most advantageous ones considering both environmental/financial benefits. These systems can be installed till 2022 and have no end date for service and maintenance.

and new installations need to contribute to 52% of this reduction (26 MT CO₂eq).

- Using only R-744 systems could **COST** the industry up to 2.1-2.6 Billion € (26 MT CO₂eq * 80 to 100 €/T CO₂eq = 2,123 to 2,654 M Euro).

Solstice® ze /R-744 cascade systems offer the most balanced alternative for new installations, and a wider use is expected after barriers to allow higher charges for A2L refrigerants are removed.

- Using HFC/HFO systems (up to 2022) could **SAVE** the industry up to 910 Million Euros(26 MT CO₂eq * 0 to -35 €/T CO₂eq = 0 to -910 M Euro).

By leveraging the eco-efficiency tool, the industry could potentially avoid a cost of 2-1 - 2.6 Billions €.

This study is still being developed. Other architectures such as water-loop groups, R-455A boosters or cascade 1234ze/R-455A system will be studied. Sensitivity to key parameters (electricity cost, solution costs and tax) will also be measured.

NEW

Refrigeration • Climatisation • Cuisines professionnelles

LEAK DETECTION

PRESTOBUL MAX: optimised leak-detection using the bubble method!

Prestobul Max is a leak detection spray for refrigeration and air conditioning installations. It is now available in 400ml aerosol cans and is ideal product for locating the smallest leaks in the systems.

In the event of a leak Prestobul Max will form bubbles and stay in the position allowing the engineer to pinpoint the exact location of the leakage much quicker.

Prestobul Max has been tested and approved by refrigeration and air conditioning technicians and they have highlighted the main advantages:

AVANTAGES

- A new white formula quickly forms bubbles to help find the smallest leaks faster.
- Greater aerosol content (400 ml compared to 250 ml previously).
- The Prestobul Max spray has two positions. It can be used with or without the built-in capillary tube for more precise or general spraying. The grip of the spray improves product's functionality.

Prestobul Max is indispensable, non-toxic, non-corrosive, non-flammable and biodegradable product for daily use. It can be used for all types of refrigerants and gases, except oxygen, combustive and high-purity gases.

Easy to use, functional and efficient leak detection spray ideal for all of those looking for leaks.



+ More info on:
climalife.dehon.com/detecting-leaks

OILS

TWO NEW ExxonMobil lubricants for today and tomorrow's refrigeration systems!

Mobil Gargoyle Arctic™ 68 NH: developed to meet the growing use of ammonia.

The new oil is designed for large industrial reciprocating and rotary refrigeration compressors used in food freezing, cold storage and marine applications.

Thanks to a balanced formulation, Mobil Gargoyle Arctic 68 NH offers stand out performance compared with conventional mineral based refrigeration oils. Extended oil drain intervals, superior oil flow and wide temperature performance are among the many benefits.

- Excellent low temperature performance
- Low volatility
- Thermal stability

Mobil SHC™ Gargoyle 80 POE: specifically formulated from polyolesters (POE) for CO₂ in miscible applications.

Its miscibility with CO₂ refrigerant and the viscosity/temperature/pressure ratios ensure an adequate thickness of film, even at high operating pressures and temperatures, as can be seen in piston compressors that use this refrigerant.

With a naturally stable viscosity index, high shear strength and fluidity at low temperatures, this oil offers additional benefits in intensive usage conditions, including fewer leaks from the shaft seal and potential for improved evaporator efficiency.

- Excellent wear protection
- High viscosity index and excellent fluidity at low temperatures
- A low traction coefficient for improved system efficiency



+ More info on:
climalife.dehon.com/oils

Dates for your diary!

Spain
25 & 26 OCTOBER 2017
TECNOFRÍO'17

Taking place for the second consecutive year, following a smashing success in 2016, the TECNOFRÍO '17 conference will bring together all refrigeration professionals on 25th and 26th October 2017 in Madrid. The main goal is to have discussions about legal and technological changes aiming to reduce the energy consumption of refrigeration equipment. Climalife is a partner for this conference. To register, visit: <http://www.congresotecnofrio.es/inscripciones.php>.

Belgium
18 & 19 OCTOBER 2017
COOL & COMFORT HAPPENING



Cool & Comfort Happening is a biennial networking event for the HVACR industry. It is aimed at installation technicians, design consultants, architects, and manufacturers. The 9th edition will take place this year on 18th and 19th October at the Brabantia convention centre in Leuven's Haasrode Research Park. Doors open at noon on Wednesday, with a soirée going on until 9:00pm. The event will end at 7:00pm on Thursday. The event will include various sessions and Climalife will be presenting on Wednesday, 18 October at 2:30pm, with the topic 'Facing the critical situation of R-404A, which refrigerant should you choose now for a worry-free future?'

Also, the entire Climalife team will be happy to meet with you at stand No. 3.2.1 to talk with you about technical solutions for the future in light of regulatory issues. Plus, you'll get one of our famous pressure-temperature slide rules with all new refrigerants, for free!

Register now for free at: <http://coolandcomfort.be/fr/happening/enregistrement>

Switzerland
8 NOVEMBER 2017
SWISS COOLING EXPO



For its second edition, the Swiss Cooling Expo will take place on 8th November 2017 in Fribourg. This national expo brings together the country's three main linguistic regions. It is jointly organised by the three central associations for refrigeration professions in Switzerland. The event will be home to 36 expo stands and a number of sessions for discussions about experiences in the HVACR world. Climalife will be at stand 8 to talk with refrigeration professionals and introduce them to the latest innovations for refrigerants and heat transfer fluids with low environmental impact.

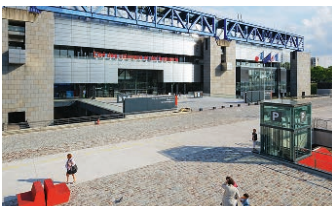
Hungary
22 TO 24 NOVEMBER 2017
ANNUAL CONFERENCE

The Hungarian Refrigeration and Air Conditioning Association will hold its annual conference from 22nd to 24th November 2017 at the Thermal Hotel Visegrád. Climalife will have a stand and will participate in technical presentations.

Iran
25 TO 28 OCTOBER 2017
IRAN HVAC & R

Climalife Galco will be presenting alongside the company's distributor, Enteghal Sarma Dena, at this international expo in Tehran dedicated to heating, ventilation, air conditioning, and refrigeration. The goal of this expo is to display the industry's latest developments and technologies and to facilitate business networking.

International - France
5 DECEMBER 2017
EXHIBITION: FROID AT CITÉ DES SCIENCES



Along with other organisations, including the Association Française du Froid, Dehon Group's Climalife will be one of the major partners for the exhibition 'Froid' (Cold) at the Cité des sciences et de l'industrie starting 5th December 2017 and lasting 9 months. The exhibition will offer visitors an interactive, stimulating, and experimental experience of the many aspects of cold. What are the effects of cold on living organisms? How can you generate cold? How is cold used in daily life and in industry? How has mastering absolute-zero cold opened up unexpected avenues for research? The fascinating answers to all of these questions will be given at this brand-new exhibition focused on cold-based objects and applications that continue to transform our daily lives.

After the exhibition's initial run at the Cité des sciences et de l'industrie, it will travel around France, Europe, and the world.

Climalife Contact is published by Climalife, a Dehon group company. 26, av. du Petit Parc - F - 94683 Vincennes Cedex Tél. : + 33 1 43 98 75 00 Fax : + 33 1 43 98 21 51

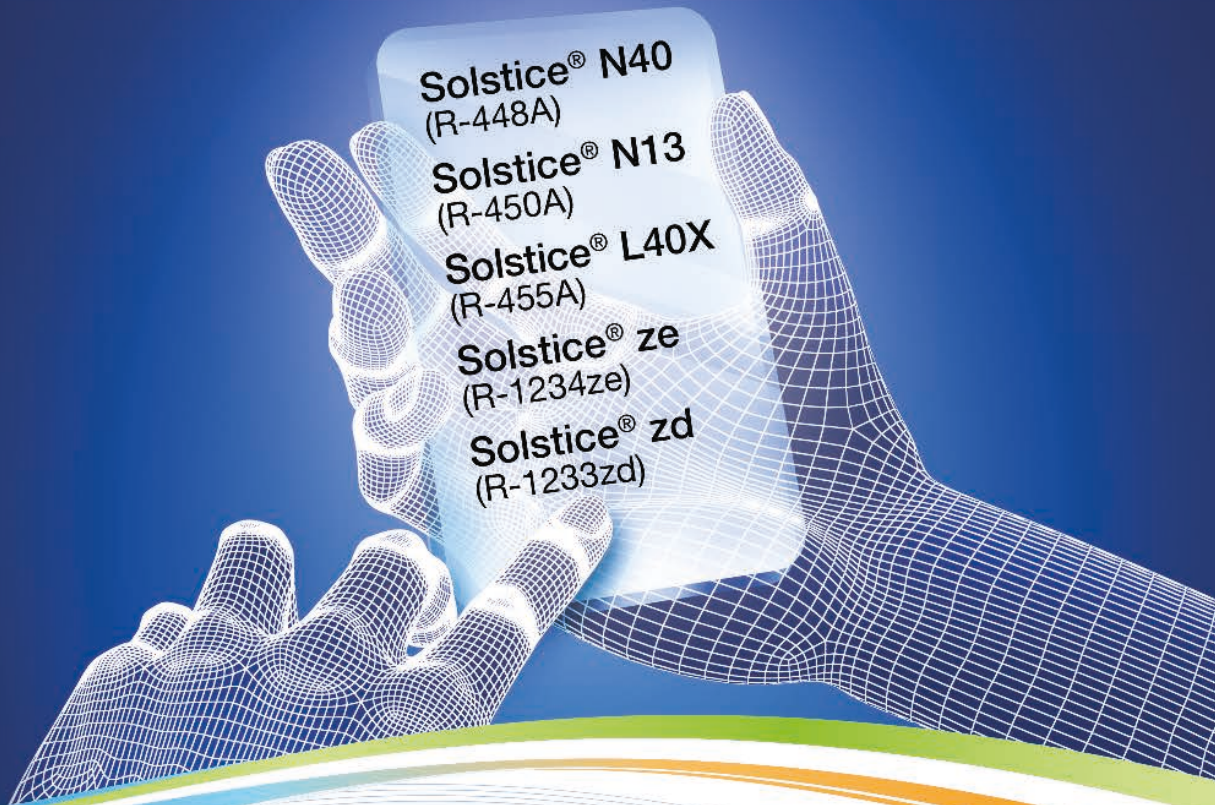
• Publishing supervisor: Pierre-Etienne Dehon
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E-mail : climalife.fr@climalife.dehon.com
• Associate Editors: Emilie Kugener, Monica Leurette.
• Design, production: www.alternatif.com











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Solstice® HFO range: a complete solution to face tomorrow's challenges



Solstice® product	Traditional refrigerant replacement	Applications	Benefit
 Solstice® N40 (R-448A) GWP* = 1387	R-404A 	Medium and low temperature applications Condensing units Self contained unit Refrigerated transport	<ul style="list-style-type: none"> • ODP = 0 • GWP is 65% lower than R-404A • Reduced energy consumption by 5 to 16% • Non-flammable (ASHRAE A1)
 Solstice® L40X (R-455A) GWP = 148	R-404A 	Condensing units Self contained units at low temperature Hermetically Sealed Low Temperature Systems Chillers, Heat Pumps	<ul style="list-style-type: none"> • ODP = 0 • GWP < 150 mildly flammable (ASHRAE A2L) • Better efficiency • Greater allowable charge than propane
 Solstice® N13 (R-450A) GWP = 605	R-134a 	Medium temperature refrigeration CO ₂ cascade	<ul style="list-style-type: none"> • ODP = 0 • GWP is 58% lower than R-134a • Non inflammable (ASHRAE A1)
 Solstice® ze (R-1234ze) GWP < 1	R-134a 	Heat pumps Medium and high pressure chillers Refrigeration equipment	<ul style="list-style-type: none"> • ODP = 0 • GWP is 99.9% lower than R-134a • Low flammability (ASHRAE A2L)
 Solstice® zd (R-1233zd) GWP = 1	R-123  R-245fa	Low pressure chillers High temperature heat pumps Organic Rankine cycle	<ul style="list-style-type: none"> • ODP = 0 • Non-flammable (ASHRAE A1)

*GWP values are those stated according to the 4th IPCC assessment as per F-Gas regulation except for Solstice® yl/zd/ze (IPCC revision 5)

Climalife refrigerants:
solutions for today and tomorrow

Honeywell
THE POWER OF **CONNECTED**

Refrigerants

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