

Opt

for better

At Park Cakes,
Chemours and
Dawsonrentals are
savouring the sweet
success of the first
implementation of
Opteon™ XL40
(Refrigerant R-454A).



Opteon™

The Chemours Company (Chemours) and Dawsonrentals temperature control solutions (Dawsonrentals), a UK-based supplier of cold storage solutions for temperature-critical products, collaborated on the first commercial implementation of very low global warming potential (GWP) HFO-(hydrofluoroolefin) based refrigerant blend technology in a new logistics and storage facility at Park Cakes' production site in Oldham, UK, opting for Opteon™ XL40 instead of R-404A.

The leading-edge project between Chemours and Dawsonrentals demonstrates how the use of groundbreaking, innovative technology can help meet the needs of Cold Chain operators under the F-Gas Regulation throughout Europe. To those installing new equipment, the project serves as an excellent example of how to avoid the pitfalls that come with continued use of high GWP legacy HFCs.



EU regulations and tighter quotas

Within the European Union, under the EU regulation 517/2014 since January 1, 2015, high GWP refrigerants have come under severe pressure due to the phase down of HFC-quota available for placing products on the EU market. This has led to reduced availability of products such as R-404A, R-410A, R-407C and even R-134a. End-users are therefore seeking alternative refrigerants with a low GWP.

A number of options exist:

- **Carbon Dioxide** - considerable development costs are necessary and limited equipment is available. Equipment does exist but the cost is significantly higher than fluorocarbon-based refrigerant technology and the performance and reliability has yet to be proven for this type of application.
- **Hydrocarbons** - are already widely used but there are charge limitations and costly requirements must be taken to ensure their safe use as they are ASHRAE flammability Class 3 (i.e. highly flammable).

- **Use an alternative, low GWP fluorinated refrigerant** - Chemours has developed a very low GWP (239) HFO-based blend for use in non-hermetic equipment. Opteon™ XL40 is intended for use in specifically designed new equipment and although it has the ASHRAE flammability classification 2L, it can be safely used as specified within the EN378 standard published in 2016.

With the significant major reduction in HFC quota in 2018 and beyond, and the ban on servicing and installing equipment with refrigerants of GWP >2500 from 2020, industry needs tried and tested solutions to help meet the European climate objectives. In the short term, some quick and easy solutions are already available such as Opteon™ XP40 (R-449A) A1 HFO blend from Chemours. However, in the longer term as quota becomes even tighter, there will be a need for much lower GWP solutions, the chemistry of which brings in the need to use flammable refrigerants. Products such as Opteon™ XL40 (R-454A) from Chemours allows end users to reduce the risk of using flammables as they are A2L class and only mildly flammable.

Innovation at Chemours

Since 2011, Chemours has been working to develop low GWP HFO blends based on HFO-1234yf. The first products brought to market were non-flammable blends designed to replace legacy HFCs in existing equipment. Products such as Opteon™ XP40 (R-449A) are now well established in the market with widespread use.

At Chillventa 2016, Chemours launched the Opteon™ XL range of very low GWP HFO blends for use in new equipment for refrigeration and air conditioning. Following recent publication of EN378 in 2016, there is now clear guidance on using mildly flammable A2L class products. Opteon™ XL40 (R-454A) is one such product and is a blend of R-32/R-1234yf (35%/65%) designed to replace R-404A in new equipment for refrigeration applications such as condensing units.

Opteon™ XL40 characteristics

ASHRAE Number	R-454A
GWP (AR4)	239
Boiling point	-48.3°C
Safety classification	A2L
Temperature glide	~ 5K

Environmental benefit

The GWP of Opteon™ XL40 is only 239 compared to R-404A at 3922. This represents a reduction in GWP of 94%. In addition, the HFO blend has been developed to ensure that, while having a capacity similar to R-404A, its C.O.P. is better in both medium and low temperature applications. This means that the overall carbon footprint of XL40 is reduced from both a direct (potential leakage) and indirect (energy used to run the system) standpoint. Opteon™ XL40 is expected to be sustainable with respect to the F-Gas phase down and is therefore a good choice to replace R-404A / R-507A in refrigeration equipment that can meet the EN378 standard safety requirements.

Long-term replacement for R-404A

Dawsonrentals introduced the concept of mobile cold stores in Europe and now offers more than 2,500 mobile cold rooms, industrial freezers, blast chillers and tempering units for rent, making Dawsonrentals the market leader in renting cold storage solutions. Many of these units use R-404A as the refrigerant, which was chosen when there was a need to move away from R-22 following the ban on ozone depleting substances.

Dawsonrentals was looking for a long-term replacement for R-404A for its new installations and had been working with Chemours on the new A2L blends at its site in Sutton-in-Ashfield, Nottinghamshire. The tests showed that Opteon™ XL40 (R-454A) was an ideal replacement for R-404A in many of the applications. Existing equipment designs could be used with only minor modifications to take into account the use of A2L fluids following the guidance in the new EN378 standard.

Following the commercial launch of Opteon™ XL40, Dawsonrentals planned an introduction with one of its newest projects in the UK, at Park Cakes' production site in Oldham.

Installation at Park Cakes

Park Cakes Ltd., the subject of a recent high-profile management buyout and a leading supplier of premium private label cakes and desserts in the UK, is a very environmentally aware company that supplies its products to a number of high profile retailers who also have high expectations when it comes to environmental sustainability. With this in mind, when Park Cakes was looking to install a new low temperature cold store, the company asked its equipment supplier, Dawsonrentals, to propose a low GWP option for the refrigeration system.

Dawsonrentals had been in contact with Chemours and had successfully trialled Opteon™ XL40 in its mobile cold store rental units.

When they received the request from Park Cakes, Dawsonrentals proposed using Opteon™ XL40.

The 1,805m³ cold store was designed and installed by Dawsonrentals. Due to the lack of equipment rating data for Opteon™ XL40, Dawsonrentals designed the refrigeration systems on R-407F and initially used R-407F to commission the system. The cooling was provided by three Zanotti HCU5180B941J condensing units, each comprising a Bitzer 4HE-18Y-40P semi-hermetic compressor using BSE 32 oil and a Danfoss TE5 R407A/F thermostatic expansion valve with a #2 orifice.

Dawsonrentals carried out risk assessments for the use of Opteon™ XL40 and found there was no need to include any additional safety measures. After initial commissioning, the R-407F was replaced by 23kg of Opteon™ XL40 in each of the three units. Under EN 378, as the machine room was outside (Class II), the cold store had restricted access (category c) and a very low occupancy level (<1 person/10m²), there was no charge limit for using Opteon™ XL40, but even for a higher occupancy level the charge limit was

25kg, so the design would still be compliant with EN 378.

The new Park Cakes unit, which was operational in October 2017, replaces ten modular units, each capable of holding 36 pallets, supplied on rental to the Oldham Bakery over preceding years. The new building, designed to run on the latest Opteon™ XL40 (R-454A) refrigerant gas, takes the same volume of pallets, but in a smaller and far more controllable area. The new unit is fully racked and forklift-compatible inside, offering the producer faster and easier access to the stock it needs. The mono-pitch steel structure is constructed to BS EN 1993-1 with 40mm thick, Loss Prevention Certification Board-approved, PIR roof and fascia cladding.

The team installing the refrigeration units was fully trained in the handling and use of flammable refrigerants and the installation followed the guidance given in the applicable standards such as EN 378. Kevin Smith, Technical Manager at Dawsonrentals comments: "Refrigeration is handled by a number of the latest low noise,



The cold storage facility is fully racked and forklift-compatible.

energy-efficient units, utilising the industry-leading R-454A refrigerant gas with a very low GWP of 239. It took the Dawsonrentals on-site team just 22 weeks to build and get operational!"

System performance data

The performance of the cold store is to the satisfaction of the end user. This section details the data collected for one of the condensing units positioned closest to the main door of the cold store. The system was not monitored with R-407F and so a direct comparison was not possible. However, using the data collected, it was possible to estimate a performance for R-407F and R-404A, making the assumptions that the operating parameters would be the same as for Opteon™ XL40. With this assumption, it was estimated that Opteon™ XL40 would operate with 6% and 11% more capacity than R-407F and R-404A, respectively, with a 14% and 12% better energy efficiency than R-407F and R-404A, respectively.

A Climacheck data logger was used to collect data from the system. Sensors were fitted to log the suction and discharge pressures and temperatures as well as the liquid line temperature at 5-second intervals.

The condensing unit monitored was for the evaporator nearest the door and at the time the monitoring was performed, the cold store was being loaded and therefore the outside door was often open resulting in a near constant operation of the system for the logging period rather than the normal cycling that might have been expected.

It was not possible to log the evaporator exit temperature and so it was assumed that the superheat was constantly at the reported setting of 10K. Using the logged data, it was possible to calculate the mean condensing temperature, mean evaporating temperature, total suction superheat, total liquid subcool, capacity and C.O.P. Using the measured system data (Chart 1) and calculated operating parameters (Chart 2), it

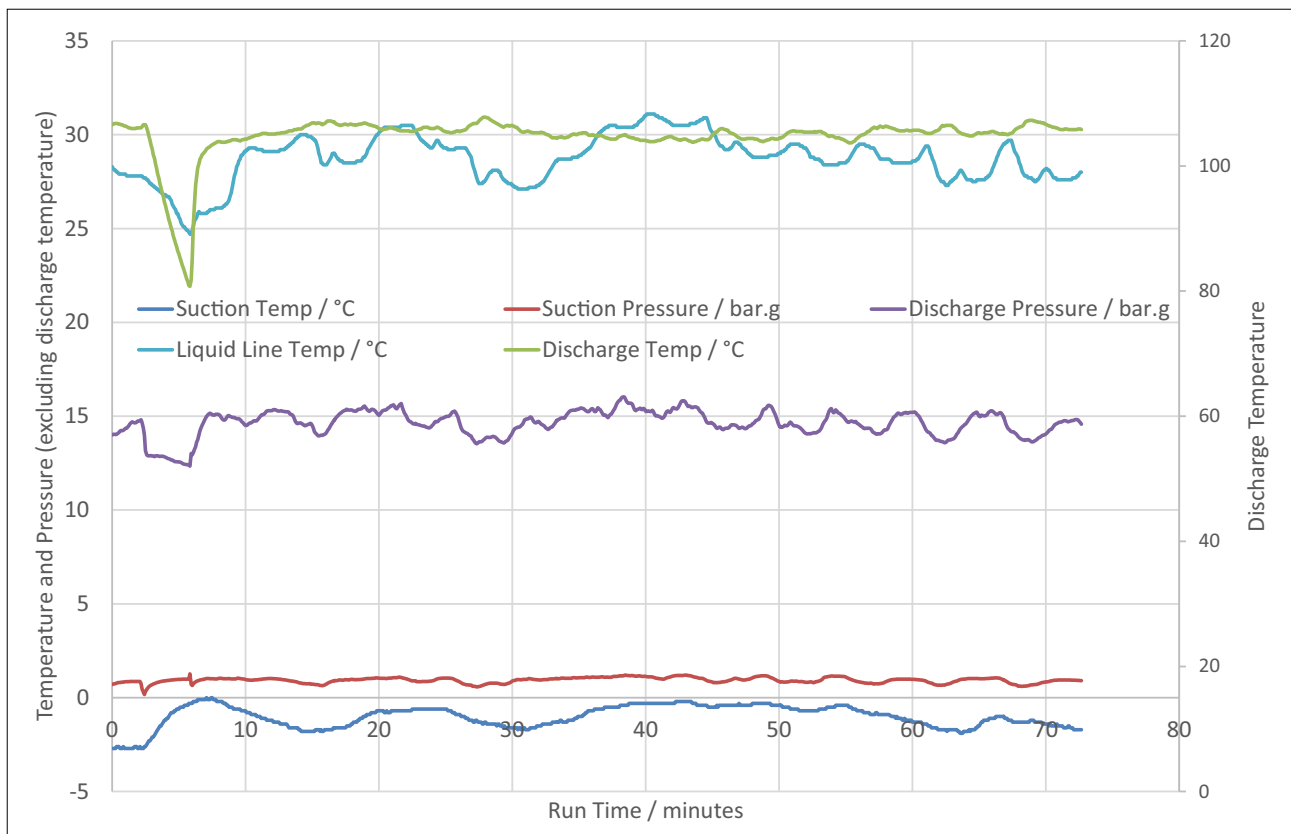


Chart 1: Measured system data for Opteon™ XL40

was then possible to estimate how R-407F and R-404A may have performed at the same system operating parameters (Table 1). Using the Bitzer compressor selection software as a reference, there was a strong indication that liquid injection was used with R-407F to control the compressor discharge temperatures and therefore for the

modelling it was assumed that any compressor discharge temperature above 108°C, the maximum observed with Opteon™ XL40, would require liquid injection.

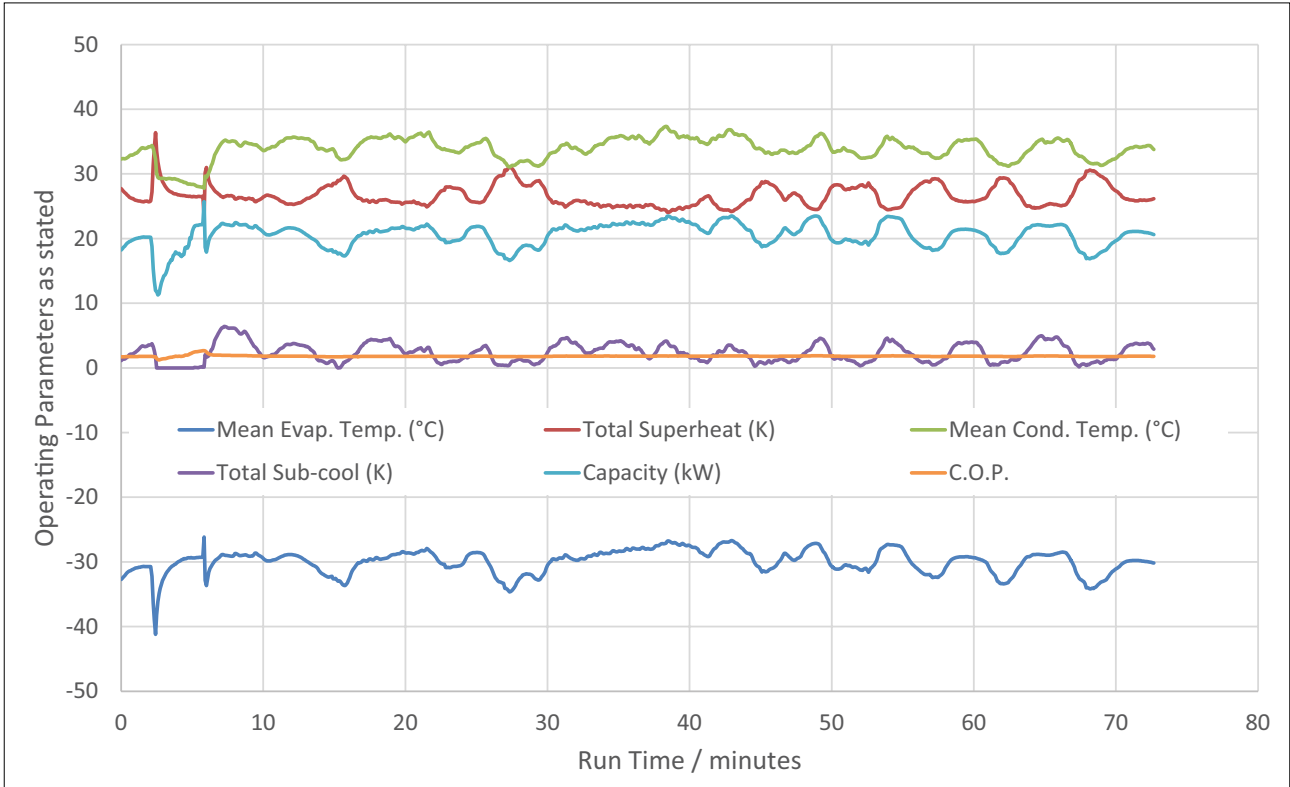


Chart 2: Calculated operating parameters for Opteon™ XL40

Table 1: Estimated performance comparison of Opteon™ XL40, R-407F and R-404A

	Opteon™ XL40	R-407F	R-404A
Mean Evaporator Temperature / °C	-29.8	-29.8	-29.8
Mean Condenser Temperature / °C	34.2	34.2	34.2
Evaporator Pressure / bar.g	0.994	0.769	1.048
Condenser Pressure / bar.g	14.75	14.69	14.80
Suction Temperature / °C	-1.0	-1.1	-3.0
Discharge Temperature w/o cooling / °C	105.4	119.8	88.8
Total Liquid Subcooling / K	2.4	2.4	2.4
Evaporator Inlet Temperature / °C	-32.1	-32.0	-30.1
Evaporator Exit Temperature / °C	-17.5	-17.7	-19.6
Total Suction Superheat / K	26.6	26.6	26.6
Cooling Capacity / kW	20.7	18.4	19.4
C.O.P.	1.81	1.55	1.58

Conclusions

The innovative use of Opteon™ XL40 proved a winning choice, from installation to overall performance to GWP reduction. The installation of the system using Opteon™ XL40 did not present any additional complexity compared to installing a system operating on R-407F. The risk assessment for this installation did not reveal any situations that required additional safety measures and the charge calculations for this installation did not prove to be a barrier either.

Park Cakes is extremely pleased with the results to date. As George Walsh, Supply Chain Manager at Park Cakes confirms: "We went for what we believed was a low cost option with those original modular units, but suffered in terms of both innovation and service. I'm very happy to be working with Dawsonrentals this time. The

new building is far better value: delivering the same storage capacity from a much smaller footprint, and with the added benefits of lower running costs and easier access. It is far more economical and convenient in every respect. The fact we are not opening and closing ten individual doors, and now have R-454A gas at work, this makes a significant contribution to reducing our environmental impact."

The system has performed as expected since it was installed in October 2017, without any reported problems and the calculations based on the measured data indicate that the system is performing better than R-407F or R-404A would have done if operating at the same system parameters. Opteon™ XL40 has been proven to be a satisfactory replacement for R-404A with improved performance, as well as a 94% reduction in the GWP of the refrigerant.

**For more information on the Opteon™
family of low GWP products, visit opteon.com**



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