

Case study:

Creard R-407H

For supermarkets, the time to act is now

Daikin's refrigerant R-407H is a replacement for R-404A in conventional supermarket applications. This year's strong reduction in F-Gas quota has led to both a massive price increase and a decrease in availability of the high-GWP refrigerant R-404A. Many users need to decide quickly how they want to operate their R-404A systems in the future.

The German supermarket chain Klaas + Kock (K+K) took the initiative in January 2018 and made the switch from R-404A to DAIKIN R-407H in a supermarket in Epe near Gronau (Westfalen).

K+K Klaas + Kock B.V. & Co. KG is a family owned company, operating 215 supermarkets centred in the north-west of Germany. The supermarkets are located within 150 kilometers of their head office and distribution centre in Gronau. Their 120+ truck fleet supplies each market daily with almost 35.000 different products. K+K has an internal technical service department which is responsible for HVAC and Environmental Services with a staff of 12.

The service team, over the course of several months, analysed the F-Gas regulation and its consequences for the company. Currently, refrigeration systems using R-404A are installed in around 150 of K+K's supermarkets. K+K made the conversion from R-404A to the new Daikin refrigerant R-407H as one of the first supermarkets in Germany.

[The conventional multi-pack refrigeration system for commercial cooling applications.](#)

The K+K supermarket in Epe near Gronau is a grocery store of around 800 m², including a bakery. Central cooling is done with a Multi-pack system for normal and low temperature (NT/LT) refrigeration from TEKO. The system was originally installed in 1997 with a charge of R-404A.

The NT circuit supplies five cold storage rooms (+2 °C to +4 °C; meat, meat processing, dairy, high pressure) and 14 meter long chilled dairy cabinet (+4 °C). The LT circuit supplies one cold-room (-20 °C), two island freezers (-20 °C) and four NT counters (+2 °C to +4 °C) for meats and cheeses.



Heat is rejected from both refrigeration circuits through a common segmented condenser by Güntner. LT and NT circuits can also function for on demand heat reclaim providing domestic hot water, via three-way valves.

The R-407H refrigerant charge quantity after the retrofit was 65 kg for the LT circuit and 56 kg for the NT circuit.

NT circuit	LT circuit
Multi-pack Refrigeration system equipped with 3x Frascold Semi-hermetic Compressor Type F5 24 Y	Multi-pack Refrigeration system equipped with 3x Frascold Semi-hermetic Compressor Type F4 24 Y
Cooling capacity: $Q_0 = 46,5 \text{ kW} (-10 \text{ °C} / +32 \text{ °C})$	Cooling capacity: $Q_0 = 16,0 \text{ kW} (-35 \text{ °C} / +32 \text{ °C})$

Quick conversion during normal operation

It was never an option for the K+K service team to close the market while replacing the refrigerant. “We finished conversion, including fine adjustment of both circuits, with three people over the course of two and a half days, all during normal business operation. The conversion worked without a hitch, as we know our system very well and could adapt routing without problems.”, says David Wesseling of the K+K service team.

What to consider when using R-407H in R-404A systems

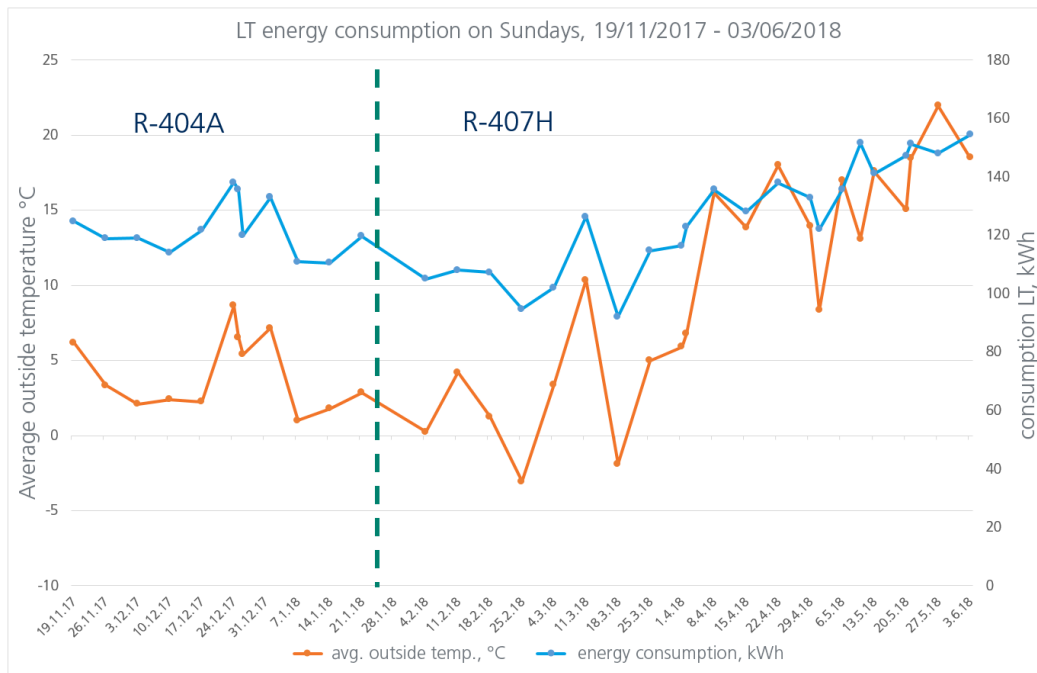
A switch to R-407H can be done as a retrofit, which includes changing the refrigerant and adjusting the system components, or as a drop-in, simply replacing the refrigerant. K+K opted to proceed with a retrofit which would help achieve the

best performance and energy efficiency results. During conversion, K+K modified the 14 m chilled cabinet in the NT circuit with modern Danfoss AKV Type electronic expansion valves and WURM Frigolink control modules. An advantage to these types of valves is the fine and continuous superheat adjustment that they provide. In the LT circuit, the size of the thermostatic expansion valve (TXV) nozzles in the evaporators were adjusted to work with R-407H.

When using retrofit refrigerants such as R-407H in R-404A systems, the higher discharge temperature associated with the refrigerant needs to be considered. Some measures to decrease discharge temperature such as liquid or vapor injection could be necessary depending on the environment. For this system in Epe, this was not necessary, as the existing semi-hermetic Frascold compressors in the TEKO Multi-pack were already equipped with Head cooling.

Before and after conversion – data monitoring and energy efficiency comparison

A WURM Frigolink HVB001B controller is used to control the TEKO Multi-pack n Refrigeration system. Using remote monitoring, the K+K service team can access both circuits at any time to display run time data, any alarms, or to make configuration changes.



Energy consumption (blue) and outside temperature (orange) in the K+K supermarket on Sundays between November 2017 and June 2018.

To assess the change in energy consumption after the retrofit, the operation data with R-404A was compared to R-407H. To exclude possible deviations due to product loading and unloading, only Sundays were compared. The Sunday consumption is plotted against average daytime temperatures.

By analyzing the days with comparable temperatures (see table 1) R-407H shows a 9% decrease in energy consumption for LT operation compared to R-404A.

T outside °C	R-404A consumption, kWh	R-407H consumption, kWh	Difference
1°C	111	107	96 %
3°C	118,92	102,3	86 %
3°C	119,64	102,3	86 %
5°C	119,96	114,74	96 %
7°C	135,68	122,94	91 %
7°C	132,96	122,94	92 %
		Mean	91%

Table 1: Extracted LT energy consumption on Sundays with same average outside temperatures

At the higher evaporation temperatures in NT conditions, the difference in energy consumption between R-404A and R-407H is smaller, with 2% on average improvement with R-407H (see table 2).

Reduce R-404A – Be successful with R-407H.

The EU F-Gas regulation 517/2014/annex III contains specific bans for using high-GWP refrigerants in stationary devices. Starting January 1st, 2020, stationary refrigeration systems may no longer use new refrigerants with a GWP ≥ 2500 and a charge of ≥ 40 tons of CO₂ equivalent. Looking at refrigerant R-404A (GWP 3922), systems with a refrigerant charge of 10.2 kg or greater are affected. Additionally, for servicing existing installations, new refrigerant of this kind may no longer be used. As a result, several refrigerant producers have announced a stop to sales of R-404A.

In applications like supermarkets with a central Multi-pack Refrigeration system, R-404A is covered by the ban. With R-407H, Daikin offers a great alternative to R-404A for both operators and installers of these systems. The refrigerant has a 62% lower GWP (1495) compared to R-404A while offering comparable thermo-physical properties, suitable pressure characteristics, compatibility with materials and oils, and high energy efficiency. Other important factors are its A1 safety classification and the wide availability of equipment parts like valves and compressors. Evaluation of the K+K system shows that an increase in energy efficiency of 9% for LT operation and 2% for NT operation could be achieved, at constant cooling capacity.

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