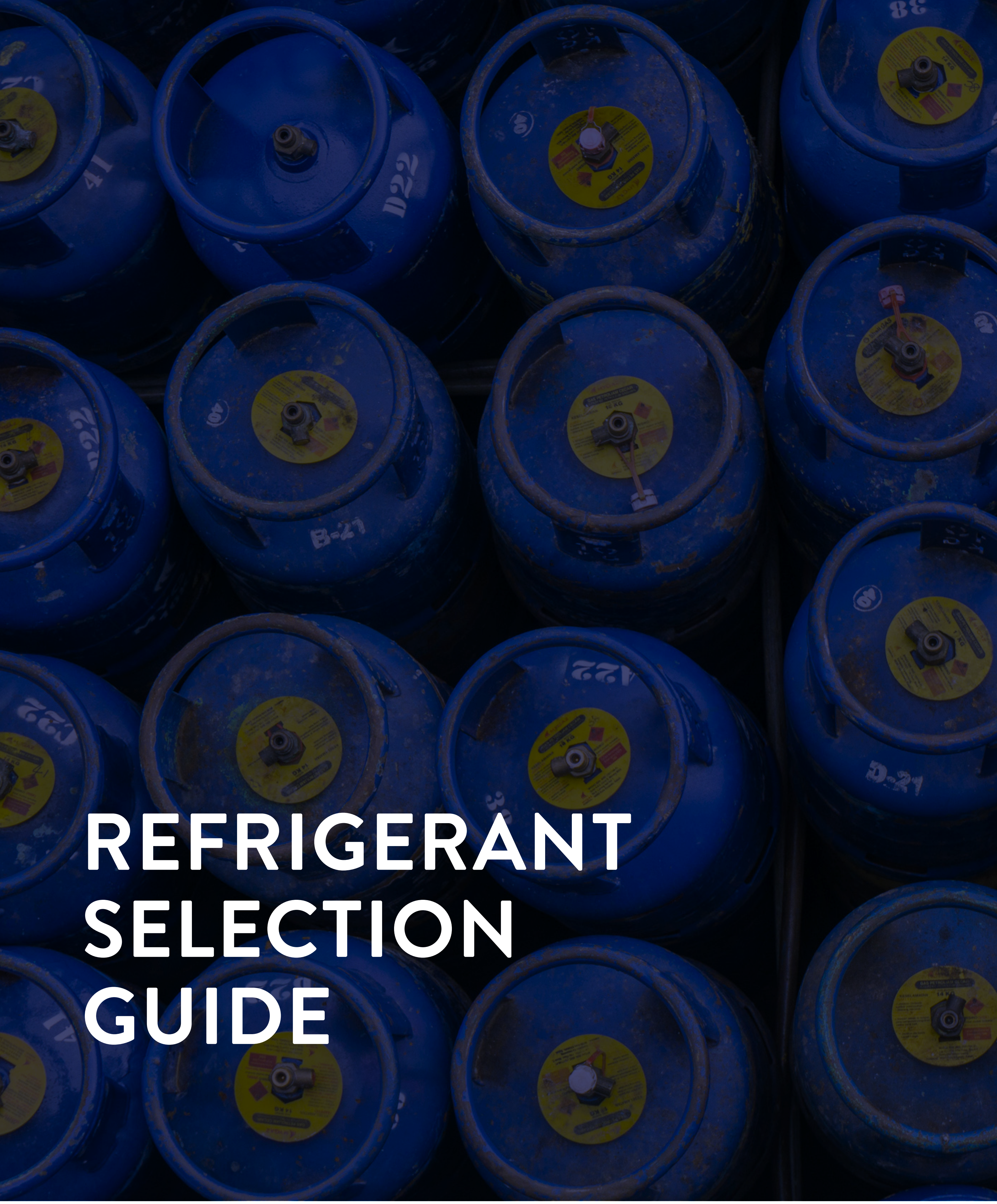


REFRIGERANT SELECTION GUIDE

ics cool energy

INTRODUCTION

Refrigerants are the lifeblood of any industrial cooling system. Finding the most appropriate, efficient and environmentally-compliant refrigerant is vital to maximising system efficiency. However, it is easier said than done.

This guide will walk through the current state of play throughout the global refrigerant industry, identify the most commonly-used refrigerants, and outline the options for UK industrial end-users as legislative-led phase-outs are set to take the industry in a new, sustainable, and long-term direction.

HOW DID WE GET HERE?
A BRIEF HISTORY OF REFRIGERANTS

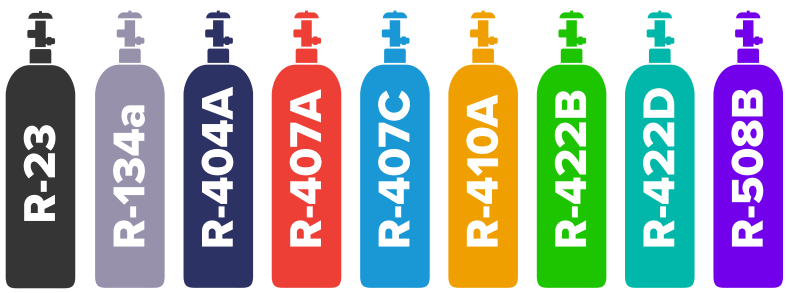
The basic concept of refrigeration – using air or water to provide cooling – is thousands of years old. However, it was from the mid-nineteenth century that 'natural' refrigerants, such as ammonia, carbon dioxide, sulphur dioxide and chloromethane, first came into use, and the industrial refrigeration industry started to take shape.

Early refrigerants were hazardous to handle with a poor safety record, however the personal safety factor was mitigated throughout the twentieth century due to the emergence of chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs). Yet, despite their ease-of-handling, it soon became clear that the accumulative use CFCs and HCFCs on a global industrial scale was having a damaging effect on the earth's Ozone layer.

Subsequent legislation – in particular the Montreal Protocol (1987) and Ozone Depletive Substance Regulations (1987) – forced the refrigeration industry to move away from CFCs and HCFCs, and instead adopt hydrofluorocarbons (HFCs). In the early 1990s, there were around 30 HFC refrigerants in circulation, yet these were soon whittled down to five or six commonly used variants, of which R404A, R410A and R134a became the most widely used.

However, while HFCs were again safe to handle, and had a benign effect on the Ozone, a number were identified as having a high Global Warming Potential (GWP).

To ultimately phase out high-GWP refrigerants, current legislation which now governs the industry – such as F-Gas regulations (2006 and 2014), the Kigali Agreement (2016) and the Paris Climate Agreement (2016) – advocates the development and use of 'natural' refrigerants which are both Ozone benign and have a low-GWP value.



WHAT ARE THE CURRENT GUIDELINES FOR REFRIGERANT USAGE?

As of 2019, the UK will be four years into the current phase-down period of high-GWP HFCs, which runs from 2015 – 2030.

	Retail & LT Commercial	Plastics & Process Medium size	Plastics & Process Larger size
Traditional	R404A	R410A	R134a
ICS Rec	R449A	R410A	R1234ze

The phase-out aims to gradually reduce the availability, and subsequently the use, of high-GWP HFCs over the next 11 years, to circa 21% of the starting figure. This will be achieved by a quota system which considers both the refrigerants GWP value, as well as its mass.

For example, a quota of 100kg R404A (GWP 3922) would be comparable to 280kg R449A (GWP 1397), given the latter's lower GWP value.

As part of the planned phase-down, some high-GWP refrigerants will be banned from 2020. However, the overall targets remain clear. If the average GWP value in 2015 was 2000, then by 2021 it should be <900, and <450 by 2030.

End-users should familiarise themselves with the GWP value of their current refrigerants, and if one is likely to be phased-out in the near future, to look for a low-GWP alternative where possible. Not only will this improve a business' sustainability credentials, but it will guard against drastic price rises linked to short supply, as has been the case in recent years with R404A, R407C and R507.

WHAT REFRIGERANTS CAN BE USED?

> Refrigerant selection is an extremely complex task as there is generally no 'off the shelf' solution, particularly for low-temperature applications. It is often a balancing act between GWP, toxicity and flammability, with the nature of the application dictating the extent to which each element is prioritised.

While any HFC can still be used, it would be prudent for UK industrial end-users to avoid any refrigerant which is facing an early ban or imminent service limitation. However, it is also incredibly important to understand that the phase-out will be a gradual process as, in some cases, a low-GWP 'drop-in' alternative that is safe to handle (and non-flammable) is not yet available.

Let's put these issues into context with the three most commonly-used refrigerants used as part of industrial cooling applications over the last two decades: R410A, R134a and R404A.

HFC REFRIGERANTS

R410A

R410A has been the go-to refrigerant for smaller operating loads below 200kW. R410A has a 'medium'-GWP value (2088). While this GWP value is not a sustainable long-term solution, currently there is no non-flammable 'drop-in' alternative which can be immediately substituted.

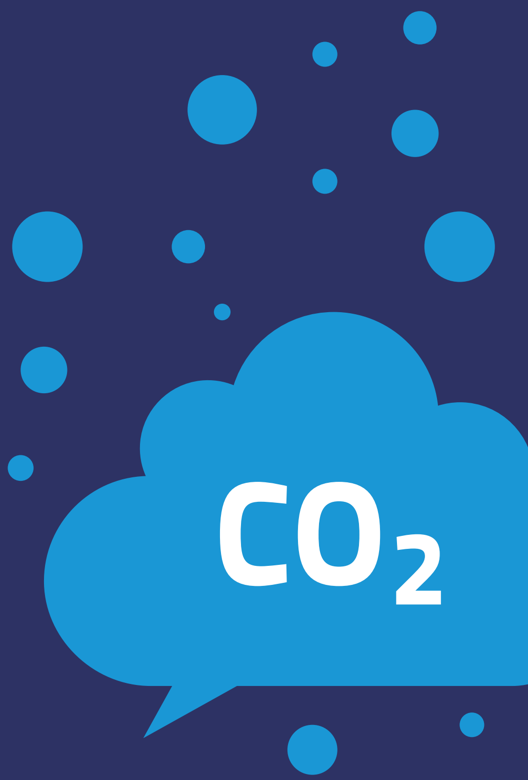
R134a

For applications with larger operating loads over and above 200kW, R134a has been the standard solution, as it offers a better efficiency level when used in systems which feature large screw and centrifugal compressors. However, while R134a has a low-GWP value (1430) and is not currently under threat of a ban, it is not likely to be low enough to remain in use indefinitely.

A more sustainable solution, which is also non-flammable, is R513a. With a very low-GWP value (631), it offers very similar levels of capacity and efficiency to R134a.

R404A

R404A has a very high-GWP value (3922) and new equipment which uses R404A (and other HFCs with a GWP value of over 2500) will be banned from entering the market from 2020. R449A is an interim lower GWP (1397) alternative, with a lower price than R404A. However, while there is no set phase-out date for R449A, again its GWP value is not likely to be low enough to be a long-term replacement for R404A.



NATURAL REFRIGERANTS

Natural refrigerants such as carbon dioxide (R744) and ammonia (R717) have very low GWP values of 1 and 0 respectively, yet they are not suitable for every cooling solution.

Both have negligible environmental impact and are both used in the commercial sector – R744 as a low temperature, large capacity refrigerant and R717 as a large capacity high temperature refrigerant in remote cold store applications. However, both have properties which could have detrimental effects when used in Process and HVAC sites.

At higher industrial temperatures, R744 (CO_2) exhibits very high operating pressures (> 7MPa) resulting in greater leakage potential and heavier gauge system pipe and materials, in addition to its toxicity in high concentrations.

R717 (Ammonia) provides high efficiency and minimal environmental impact, but is very toxic and flammable. In the event of any leak and/or release, its toxicity will have a major impact on the immediate surroundings – even its odour is sufficient to produce adverse reactions in all personnel close by. Ammonia is also highly corrosive to copper which is widely used in refrigeration systems and in electric motor windings - alternative materials and system design are essential in this case.

A2L REFRIGERANTS

Balancing low-GWP vs flammability is key to a safe and sustainable future and is an area where the refrigeration industry is working hard to resolve.

Refrigerants are given safety classifications in line with their toxicity (A = lower toxicity and B = higher toxicity) and with their flammability (1 = non-flammable; 2L = mild flammability; 2 = lower flammability and 3 = higher flammability).

Most HFC refrigerants are classed as “A1”.

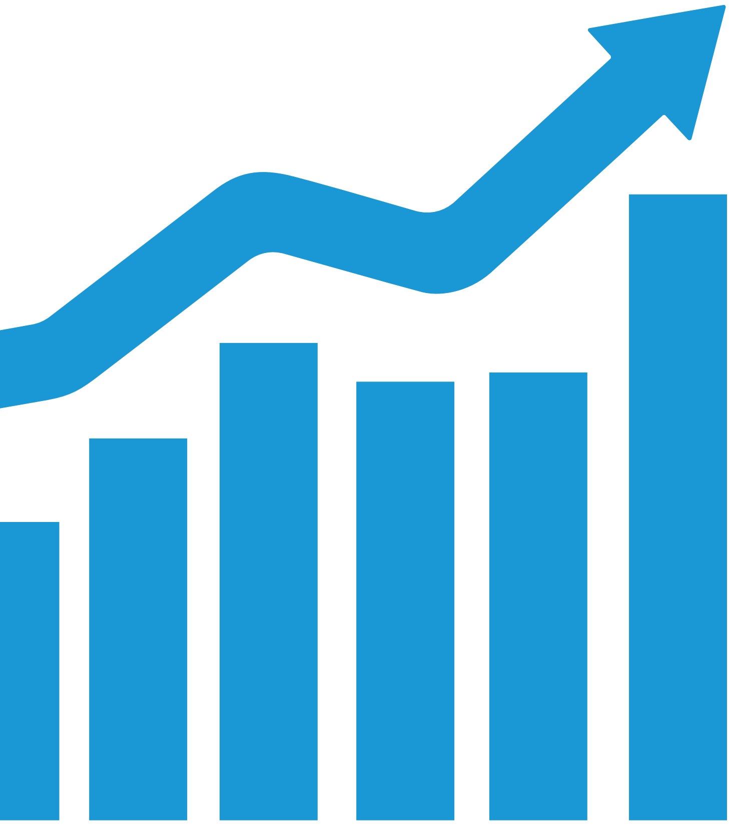
A2L refrigerants such as R32 and R1234ze are classed as “mildly flammable”; they pose certain risks when it comes to transportation, handling and storage. A2L systems need to be designed in line with their siting, installation and functionality and, providing the installation is properly risk assessed (DSEAR), carefully sited and with the appropriate leak detection equipment, there should be only limited cost inflation.

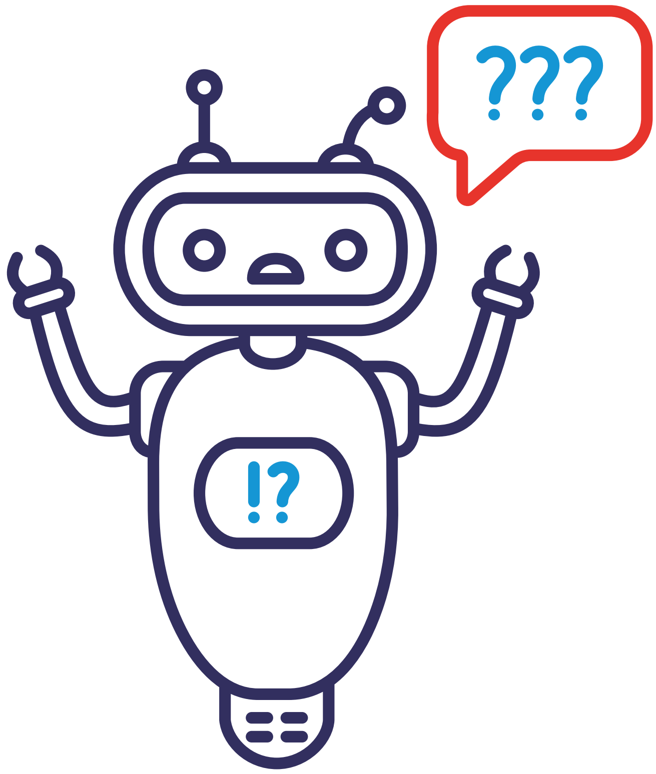
REFRIGERANTS PRICE RISES

Over the past two years or so, end-users will have noticed that some refrigerant prices have sharply risen. This is reportedly due to a combination of several factors:

- The reduced availability and increased price of Fluorspar, a vital ingredient in many HFC refrigerants
- A worldwide shortage of R125, a component in many popular refrigerants
- A reduction of quotas available in the EU
- The combined stockpiling of refrigerants in the years 2014 – 2017
- The end, or limitation, of the manufacturing of some high-GWP refrigerants
- The increased use of HFCs by Far Eastern markets, limiting availability in the West

While prices seem to have stabilised in recent months, as the HFC phase-down continues to bite, it is likely that prices may rise in the future. The HFO refrigerant prices are still relatively high, but HFC/HFO blend prices appear to be returning to more reasonable levels.





LOOKING TO THE FUTURE?

There is a continuous push to research and develop new refrigerants, however they need to be subjected to thorough safety and stability testing, as well as extensive operational trials before they can be placed on the market.

There are some interim low-GWP blend alternatives which are already available, which will allow end-users to run a reduced GWP operation until a very low-GWP alternative is available.

However, many of the very low-GWP – and even some of the medium-GWP – variations are 'mildly flammable' and require some professional attention during installation and operation.

For end-users keen to find a long-term refrigerant solution which will lessen their impact on the environment, and help keep applications running safely and efficiently, get in touch with ICS Cool Energy's technical team today, on:
0800 774 7426 or email info@icscoolenergy.com.

WHAT REFRIGERANT DO WE USE?

ICS Cool Energy is concentrating its search on lower GWP and high-efficiency HFCs, HFOs and HFC/HFO blends.

R134a (1430) is used in all of the company's screw and centrifugal compressor models, providing the higher efficiencies and large vapour volumes needed for these applications, whilst keeping the operating pressures much lower than alternatives such as R407C.

Although R134a has a comparatively low-GWP value, ICS Cool Energy is also able to offer selected screw compressor models charged with R513A (631) and some models – including those with centrifugal compressors – charged with R1234ze (<7).

Both R513A and R1234ze offer much reduced GWP figures whilst maintaining high comparative efficiency levels.

R410A (2088) is used in all of ICS Cool Energy's scroll compressor units and gives perfect operating performances and efficiency levels with a GWP which is almost 50% lower than R404A.

At present there are a few alternatives available for R410A, none of which are 'drop-in' options and all of those alternatives which are currently available are all 'mildly flammable'.

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