STAR REFRIGERATION

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Smart Thinking

Topic

F-Gas Conversion

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How F-Gas regulations affects business and what should be considered for the future.

Hydrofluorocarbon (HFC) gases, typically referred to as F-gases, are manmade chemicals developed for use as refrigerants in the HVACR industry. They have been widely used as replacement fluids for ozone depleting gases such as chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) as part of the phased-out programme under the Montreal protocol.

F-Gas Regulation

Although HFCs have no detrimental effect on the ozone layer they contribute towards global warming if released into the atmosphere. Legislation has been introduced at a national and international level in order to combat the effect of F-gases on climate change.

The European F-gas Regulation EC 842/2006 was implemented in 2006 and updated in 2014 (EC 517/2014). It was a landmark ruling that provides a clear path for manufacturers, installers, specifiers and operators of refrigeration, air conditioning and heating equipment to phase down the use of the most environmentally damaging refrigerants and introduce lower global warming potential (GWP) alternatives.

The regulation refers to carbon dioxide (CO2) equivalent as a measure of how much a gas contributes to global warming. This uses CO2 with GWP of 1 as the baseline fluid for comparison. To calculate the CO2 equivalent of a quantity of a refrigerant, the mass of gas is multiplied its global warming potential (GWP). For example, R404A (the widely used HFC refrigerant) has a GWP of 3922. This means that 1kg of R404A contributes the equivalent of 3922 kg of CO2 if released into the atmosphere. A table of commonly used refrigerants and their associate GWPs can be found in figure A.

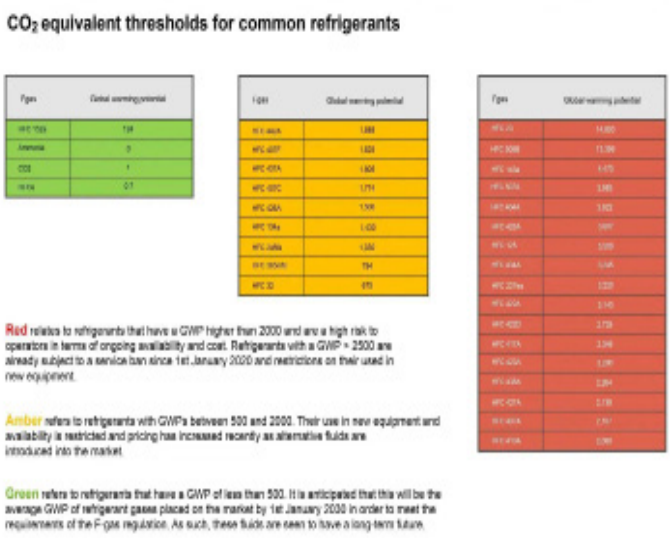

Fig.A Table of commonly used refrigerants and their associate GWPs

To mitigate the potential environmental impact of F-gases, limitations around their use were introduced in the 2006 F-gas Regulation. An update in 2014 added further measures to phase down fluorinated gases with high GWPs in order to achieve a total reduction in equivalent CO2 of 79% by 1st January 2030. This regulation included a ban on the use of newly manufactured HFCs with a GWP greater than 2500 from 1st January 2020 for servicing refrigeration equipment with a CO2 equivalent charge greater than 40 tonnes.

This may appear to be a large figure but in the case of R404A, it relates to a system charge of just over 10kg. In practice terms it means that when this should only be viewed as a temporary solution until a more permanent solution can be implemented.

Drop-in Refrigerant Replacements

When assessing what to do with an existing F-gas refrigeration plant, it is often a requirement to retain the equipment and consider what options are available to allow for continued operation up to 2030 and beyond. One option is conversion of the refrigerant gas to a lower GWP alternative, examples of which can be found in figure B.

'Drop –in' Refrigerant Replacements

Currently used HFCs	Low GWP alternatives to HFCs	GWP	Safety group
R134a GWP 1430	R450A	604	A1
	R456A	687	A1
	R513A	631	A1
	R515B	293	A1
	R1234yf	4	A2L
	R1234ze(E)	7	A2L
	R444A	92	A2L
	R516A	142	A2L
R404A/R507A GWP 3922/3985 (R22/R407)	R448A	1387	A1
	R449A	1397	A1
	R450B	1352	A1
	R452A	2140	A1
	R452C	2220	A1
	R455A	2103	A1
	R454A	239	A2L
	R454C	251	A2L
	R455A	148	A2L
	R457A	148	A2L
	R459B	144	A2L
	R465A	145	A2
R22/R407C (GWP 1810/1774)	R449C	1251	A1
R410A GWP 2088	R32	675	A2L
	R452B	698	A2L
	R454B	466	A2L
	R459A	460	A2L
	R463A	1494	A1
	R466A	733	A1

Fig.B 'Drop-in' Refrigerant Replacements

As part of any refrigerant conversion work it is important to consider the following:

Replacement of thermostatic expansion valves (TEVs) with electronic expansion valves (EEVs)

Many of the new lower GWP refrigerants are a blend of chemicals that evaporate over a temperature range, often referred to as 'glide'. This may differ from the existing fluid, which is likely to evaporator at a constant temperature. It is recommended to replace traditional TEVs with EEVs to provide better control of refrigeration flow around the system and reduce the risk of liquid passing from evaporators back to the compressor and causing damage. This modification requires replacement of the valve itself, a new control panel or panel modifications to incorporate the new controller(s) and site wiring between the controller(s) and the EEVs. There is an added benefit when using EEVs in terms of improving system efficiency, especially when coupled with floating head pressure control.head pressure control.

Change in cooling capacity and power consumption – When converting to a new refrigerant there is the potential for a change in the system's cooling duty and/or power consumption. This is due to differences in the characteristics of the new refrigerant (e.g. specific heat, mass flow and operating pressures). An assessment should be undertaken when planning the works to ensure there is sufficient capacity and power available after the conversion to meet the existing cooling demand.

Compressor discharge temperature – Introducing a new refrigerant to an existing system can lead to an increase in compressor discharge temperature. This has the potential to damage the compressor itself, add personnel safety concerns due to the elevated temperature and possible problems with oil cooling. A simple assessment can be carried out using the compressor supplier's selection software to ensure that this issue is avoided. This may involve further modifications to the system and avoiding the use of a particular refrigerant.

Assessment of flammability – Many HFC refrigeration systems were not subject to assessments relating to ignition or explosion risk when originally installed. However, a growing number of replacement refrigerants are classified as mildly flammable (A2L)- see Figure B above. This means they are unlikely to be suitable as replacement fluids for existing systems without significant modifications.

The way of minimising a refrigerant's contribution towards global warming is to utilise a natural fluid, such as ammonia or carbon dioxide (CO2). These low cost gases have been used for over a hundred years. Ammonia has a GWP of zero and CO2 has a GWP of one. Neither are subject to the F-gas Regulation and so purchasing of any natural refrigerant equipment can be seen as a long-term investment.

Modifications to refrigerant leak detection – When changing refrigerant, the existing leak detection system should be modified/recalibrated. This could include the replacement of detection system 'heads' and/or the recalibration of the system to account for the new refrigerant characteristics.
Increased operating pressure – A replacement refrigerant may operate with higher working pressures than the gas it's replacing. This may require modifications to system components such as pressure relief valves and even the pipework itself. Assessment of future working pressures is essential to ensure safe operation after conversion and should be carried out before work commences.

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Star Refrigeration's experience

Our experience with converting refrigeration systems from a high to a low GWP fluid stretches back to before the F-gas Regulation was first introduced. Large numbers of conversions from fluids such as R12, R502 and R22 were carried out during the phase out of ozone depleting substances under the Montreal Protocol. Star have performed numerous refrigerant conversions across the country and on a wide-range of equipment, from small single-evaporator condensing units to multi-chamber systems containing tonnes of refrigerant. F-gas conversions are implemented in accordance with industry standards, including EN378. All works include a twelve-month warranty and are performed with minimal disruption to the site operation.

With the introduction of the F-gas Regulation, it has become necessary to monitor refrigeration equipment containing HFC for leakage, to limit the potential environmental impact caused by a release into the atmosphere. The regulation is a positive step in terms of ever-growing environmental awareness but also bring additional responsibilities on end users and contractors who are tasked with ensuring conformance to the regulation. It is hoped that the information provided in this article provides refrigeration plant owners and operators with a greater understanding of how the F-gas Regulation affects their business and what should be considered for the future.

If you require guidance or assistance with any of the topics discussed above, we would be pleased to offer further information and support at **hbedford@star-ref.co.uk.**

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