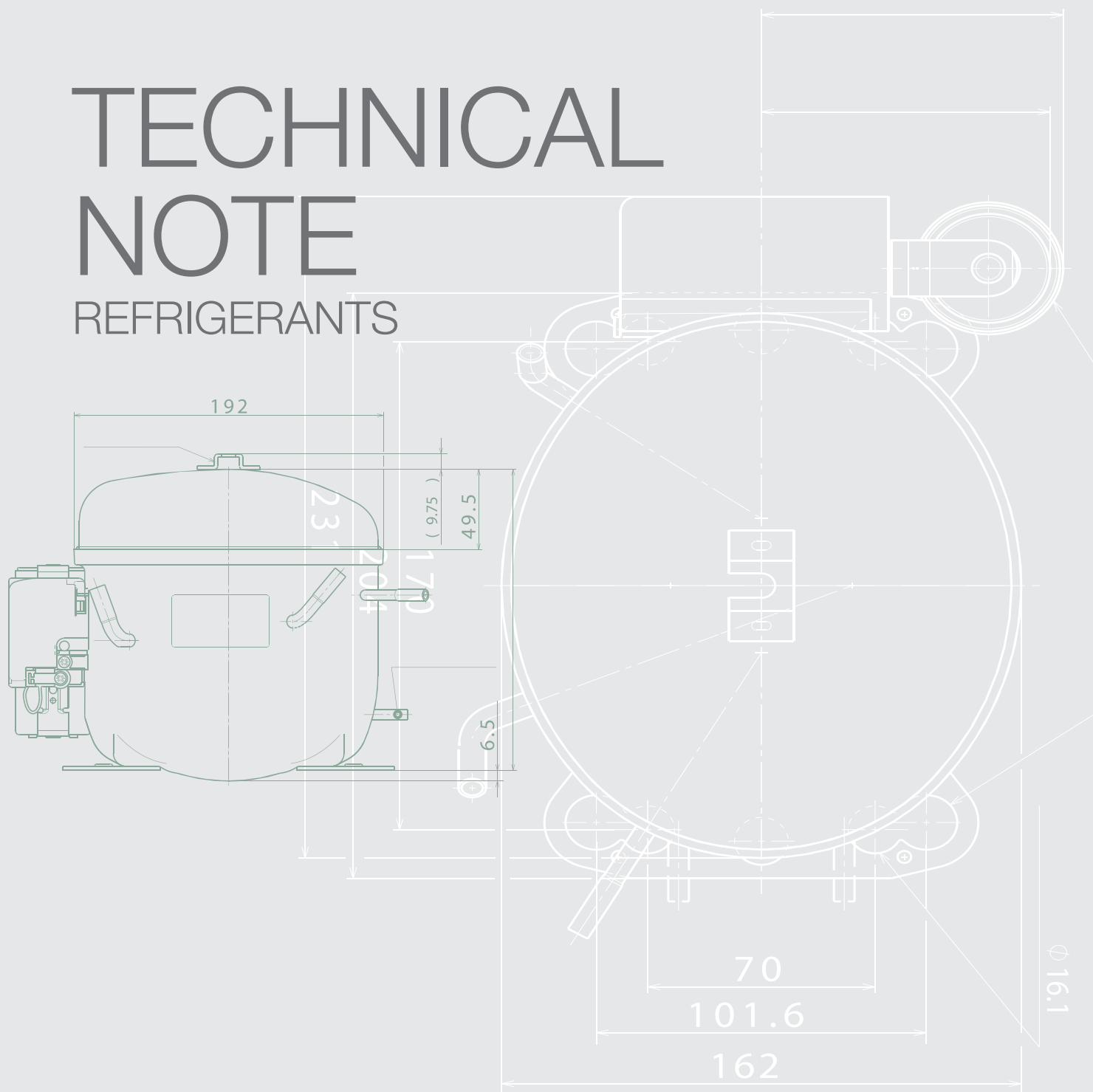


TECHNICAL NOTE

REFRIGERANTS



cubigel[®]
compressors



by
HUAYI
COMPRESSOR
BARCELONA

Refrigeration trend

The first and second generation of refrigerants (CFCs and HCFCs) have been used for a long time. And they have high ozone-depleting and powerful greenhouse gases.

With the implementation of the Montreal Protocol and the phasing out of CFCs and HCFCs it was necessary to search for refrigerants that would be more ozone friendly, with less global warming potential (GWP) and ozone-depleting potential (ODP), such as hydrofluorocarbons (HFC).

Nowadays the importance of protecting the environment is clear, the effects of refrigerant leakages on global warming and climate change have become more evident and for this reason the fourth generation of refrigerants is necessary.

Due to the high GWP of the HFCs, whose emissions are controlled under the Kyoto Protocol, hydrocarbons (HCs) are increasingly being used, such as R290 (propane) and R600a (isobutene), both of which have zero ODP and a GWP of 3.

Huayi Compressor Barcelona follows the refrigerant trends (see fig. 1) and is committed to alternatives to refrigerants with high global warming potential, such as natural refrigerants (R290 and R600a).

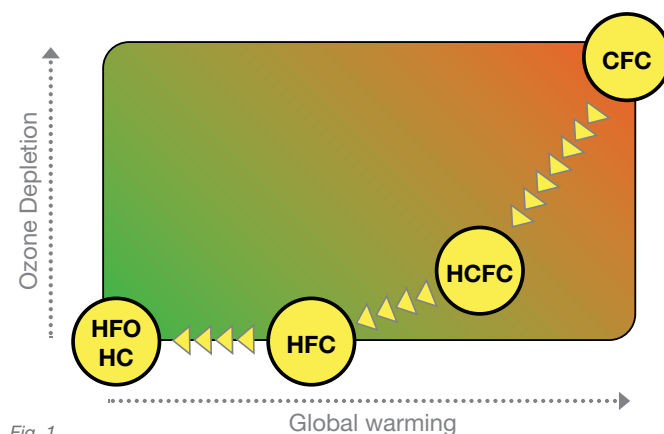


Fig. 1

F-gas regulation

F-gases are used in several types of products and appliances as substitutes for ozone-depleting substances such as chloro-fluorocarbons CFCs or HFCs.

The European Union has therefore taken action to control F-gases as part of its policy to combat climate change. F-gases are used in several types of products and appliances, mainly as substitutes for ozone-depleting substances such as chloro-fluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs) and halons which are being phased out under the Montreal Protocol and EU legislation.

The European F-Gas Regulation (842/2006), passed in July 2006, has the purpose of reducing the environmental impact of fluorinated gases with high global warming potential covered by the Kyoto Protocol. In 2012 the European Commission (Council and Parliament) made two proposals to strengthen this, in order to cut F-gas emissions by 2030.

In December 2013, representatives of the European Parliament and Council agreed on a slightly amended text based on the Commission's proposal. The revision of the F-gas Regulation is now subject to formal approval by the Parliament and Council (see fig. 2).

F-GAS REGULATION

HFC new equipment ban

	Date
Domestic fridges and freezers	1/1/2015
Hermetically sealed fridges and freezers	
HFC's > 2500 GWP	1/1/2020
HFC's > 150 GWP	1/1/2022
Hermetically sealed moveable a/c systems	1/1/2020

Service & maintenance

	Date
HFCs >2500 GWP in systems with charge size equivalent to or greater than 40 tonnes CO ₂	1/1/2020
In effect, this exempts small transport & commercial systems	
Use of reclaimed HFCs allowed	1/1/2030

Fig. 2

Propane R290: The most optimum solution for light Commercial Refrigeration

Other temporary alternatives to R404A: The new R407F and R442A

According to these proposals, the pressure on controlling and reducing HFCs is clear and it is even possible that eventually HFCs will be taxed according to their GWP.

R404A is at the high end of direct global warming for HFCs and is, therefore, vulnerable to early replacement provided a suitable alternative can be found (see fig. 3).

Characteristic	R744	R134a	R404A/R507	R407F	R442A	R290	R600a	R1234yf	R1234ze
Group Name	C02	HFC	HFC	HFC	HFC	HC	HC	HFO	HFO
GWP	1	1300	3260	1824	1888	3	3	4	6
ODP	0	0	0	0	0	0	0	0	0
Inherent COP	Medium	Medium	Medium	Medium	Medium	High	High	Medium	Low
T (1 bar) °C	-79	-26.1	-46.5	-45.5	-46.5	-42.1	-11.7	-29	-20
T (25 bar) °C	-12	77	54	58	-	68	112	79	-
P (-35°C) Bar	12.05	0.67	1.66	1.7	-	1.36	0.37	0.79	-
P (-10°C) Bar	26.5	2	4.33	4.4	-	3.42	1.09	2.2	-
P (45°C) Bar	73.83	11.6	20.45	21.4	-	15.31	6.1	11.54	-
P (60°C) Bar	73.83	16.81	28.7	29.5	-	21.18	8.79	16.42	-
Critical Point	31°C 73,83 Bar	101°C 40,67 Bar	72°C 37,31 Bar	82,6°C 47,54 Bar	82,4°C 47,6 Bar	97°C 42,36 Bar	136°C 36,84 Bar	94°C 33,82 Bar	79°C 36,32 Bar
Flammable (*)	No	No	No	No	No	Yes	Yes	Yes	Yes
Oils	MINERAL	POE	POE	POE	POE	MINERAL POE	MINERAL	POE	POE

(*) If Flammable, there is charge limitation

Fig. 3

Huayi Compressor Barcelona follows the refrigeration market trends, and it is for this reason that the search for alternatives for R404A is necessary.

R442A and R407F could be alternatives for R404A with low GWP in refrigeration systems and further for retrofitting of existing refrigeration systems. The following table (see fig. 4) shows the results obtained in Huayi Compressor Barcelona laboratories with these two alternatives for R404A.

	Cooling Capacity (kcal/h)			COP (W/W)			Consumption (W)			Current (A)		
	55°C			55°C			55°C			55°C		
	-25	-10	7.2	-25	-10	7.2	-25	-10	7.2	-25	-10	7.2
R404A	515	1014	1900	1.03	1.53	2.21	579	770	1001	2.68	3.56	4.62
R442A	446	947	1882	0.97	1.51	2.28	537	729	960	2.49	3.37	4.43
R407F	441	942	1878	0.96	1.51	2.28	535	727	958	2.48	3.35	4.42
R404A vs R442A	15.44%	7.14%	0.93%	6.97%	1.44%	-3.17%	7.90%	5.57%	4.25%	7.77%	5.54%	4.21%
R404A vs R407F	16.90%	7.65%	1.14%	8.01%	1.55%	-3.25%	8.23%	6.00%	4.55%	8.06%	6.17%	4.45%
R442A vs R407F	1.26%	0.47%	0.20%	0.97%	0.11%	-0.07%	0.31%	0.41%	0.28%	0.27%	0.60%	0.23%

Fig. 4

Conclusion

According to the Council's and Parliament's proposed F-gas regulation, the refrigerants R442A and R407F are only temporary solutions. It is true that these refrigerants decrease significantly the GWP of the current HFCs but they remain too high for the F-gas regulation and would be out of use by 2020 in new equipment; for this reason the necessity of finding other solutions is clear.

Huayi Compressor Barcelona is committed to natural refrigerants (R290 and R600a) as a future solution. HCs are an environ-

mentally friendly, non-toxic, non-ozone-depleting replacement for chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs). From a chemical point of view, hydrocarbon is the simplest organic compound, consisting entirely of hydrogen and carbon. Hydrocarbons are safe, with proper handling. Since hydrocarbons are flammable, some basic safety rules need to be respected by manufacturers, installers and users, which may differ slightly, depending on the application.



**HUAYI
COMPRESSOR
BARCELONA**

Huayi Compressor Barcelona, S.L.

Antoni Forrellad, 2 · 08192

Sant Quirze del Vallès · BCN · Spain

Phone: +34 93 710 60 08

Fax +34 93 710 69 58

www.huayicompressor.es