

**ENGLISH TRANSLATION OF ARTICLE IN FRIO-CALOR AIRE  
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## **THE REPLACEMENT OF R-22**

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Following the entry into force of European Regulation No. 2037/2000, from 1 January 2010, the sale & use of virgin R-22, as well as the rest of all newly produced HCFCs, has been banned. This regulation seeks to protect the atmospheric environment by reducing emissions that affect ozone destruction and the greenhouse effect (GWP).

Concerned about the difficulty this will produce in the future, for more than 11 years GAS-SERVEI, SA, has been actively involved in the development, testing and practical application of most of the solutions offered by the chemical industry, the sole purpose of which is to extend the life of refrigerating and air conditioning installations which have been originally designed & manufactured for use with HCFC refrigerants.

This wealth of expertise and practice has resulted in a range of substitutes which are effective & easy to apply.

Consequently, considering that most contractors & users require equivalent cooling, no oil change & a simple retrofit, published in this article is a comparative study of the two most recognized product lines in the market, the RS series & ISCEON range of refrigerants with their own characteristics and benefits. In this article we focus on the substitution of R-22 (HCFC).

Of the comparative properties to take into account when selecting the appropriate refrigerant, it is important to consider the temperature glide because the larger the glide the greater the chance of fractionation during leakage. If the glide is very high, the gas charged in the system needs to be recovered & replaced with a fresh charge of refrigerant.

In addition to the beneficial properties of the refrigerant, selection of which solution to apply will also be determined by the total cost of the retrofit & the time involved.

All refrigerants discussed in this article have an A1 safety classification, that is to say, of low toxicity & nonflammable.

### **DEFINITIVE SOLUTIONS HFC**

Among the possible solutions using HFC substitutes, we find two alternatives:

- Refrigerants which require replacement of mineral oil with POE, called Indirect.
- Refrigerants which can be used with mineral oil, which does not need to be replaced, called Direct.

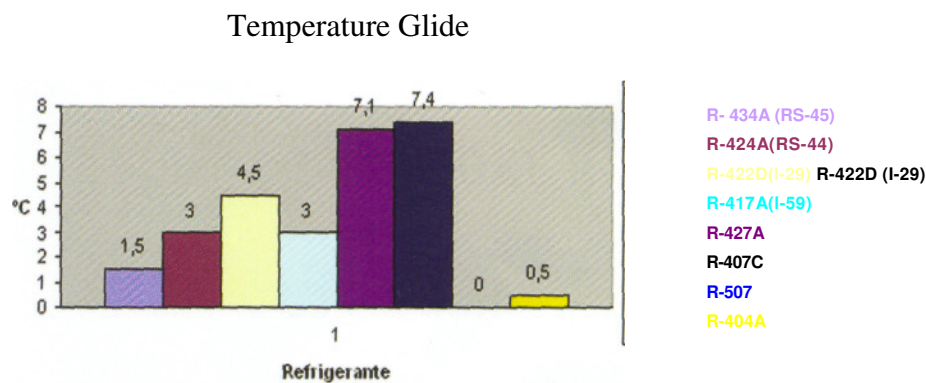
### Refrigerants requiring an oil change to replace R-22, Indirect solutions

In air conditioning applications at average temperatures: R-407C & R-427A.

These refrigerants are very similar in performance, as can be seen in Table I, & both products will fractionate in the case of leakage due to their high temperature glide.

**Table I**

Refrigerant	Components	Composition	GWP
R-507C	R-125:R-143a	50:50	3850
R-404A	R-125:R-143a:R-134a	44:52:4	3784
R-407C	R125:R134a:R32	25:52:23	1523
R-427A	R125:R134a:R32:R143a	25:50:15:10	2013
R-417A	R125:R134a:R600	46.6:50:3.4	2234
R-422D	R125:R134a:R600a	65.1:31.5:3.4	2623
R-424A	R125:R134a:R600a:R600:R601a	50.5:47:0.9:1.0:0.6	2328
R-434A	R125:R143a:R134a:R600a	63.2:18:16:2.8	3131



**Figura 1**

- Refrigeration, medium & low temperatures: R404A & R507.

These refrigerants are ideal for new installations. Amongst other things, for systems operating on R22, there needs to be two or three oil changes, safety valves & pressures checked & the condenser to be oversized.

### Refrigerants which do NOT need an oil change when replacing R22, Direct solutions

- Installations with a fixed orifice or capillary tube at temperatures down to -15C:

R424A (RS-44) & R417 (Isceon 59)

- Installations with an adjustable expansion device at temperatures down to -35C:

R434A (RS-45) & R422D (Isceon 29)

The temperature glides of the various alternatives can be seen in Table 1.

### Advantages of Direct replacements

- Rapid, definitive, simple & economic replacement
- HFCs not harmful to the ozone layer
- No need to change the oil in the majority of cases, compatible with traditional & new lubricants
- Maintains existing equipment
- Test by manufacturer show that R424A & R434A can be mixed with r22 in any proportion
- Discharge temperatures are significantly lower than R-22, which extends compressor life
- The capacity & efficiency of R-22 can be reached in most systems.

To continue we will comment on the differences between the main properties of both sets of replacements for direct substitution of R22.

### R424A (RS-44) & R417A (Isceon 59)

Both products will have a slight loss of capacity which will depend upon the design of the equipment. Because R424A contains a little more R125 in its formulation, the loss of capacity will be less than when using R417A. Both products have a temperature glide of 3<sup>o</sup>C, so that the charge does not need to be replaced in the event of a leak,

The different studies recommend if required the possibility of recharging a leakage of R-22 with R-434A (RS-45), which provides a quick & economic solution.

### R434A (RS-45) & R422D (Isceon 29)

It is important to use both of these refrigerants with adjustable expansion devices in order to set the correct superheat. It is advisable not to use these products with capillary tubes because they are more dense than R22 with a higher mass flow. There are 2 important differences between these products:

- Temperature glide: R422D has a glide of 4.5<sup>0</sup>C which compares with 1.5<sup>0</sup>C for R434A.
- Refrigerating capacity: R434A has the same capacity as R22. On the other hand, R422D can show a reduction of 5<sup>0</sup>C when evaporating at 7<sup>0</sup>C, & this lack of capacity increases to 9<sup>0</sup>C at -35<sup>0</sup>C evap.

**Table II: Comparative performances of alternatives in refrigeration**

<b>-35<sup>0</sup>C Evaporating -35<sup>0</sup>C Condensing</b>	<b>R-22</b>	<b>R-434A</b>	<b>R-422D</b>	<b>R-404A</b>	<b>R507</b>
Discharge pressure (bar)	14.07	15.55	14.26	16.78	17.22
Discharge temp ( <sup>0</sup> C)	197.0	119.06	120	123.5	121.6
Cooling capacity Kj/m <sup>3</sup>	619	632	562	705	729
% of R-22	100	102	91	114	117
COP	1.27	1.28	1.29	1.27	1.26
Compression ratio	11.4	11.4	12.3	10.7	10.5
Temperature glide ( <sup>0</sup> C)	0	1.50	4.5	0.5	0
Flow rate	5.67	7.92	7.88	7.57	7.79
Mineral oil	Yes	Yes	Yes	No	No
POE	Yes	Yes	Yes	Yes	Yes

**Table III: Comparative performances of alternatives in airconditioning**

<b>+7<sup>0</sup>C Evaporating +45<sup>0</sup>C Condensing</b>	<b>R-22</b>	<b>R-424A</b>	<b>R-434A</b>	<b>R-422D</b>	<b>R-417A</b>	<b>R-407C</b>	<b>R-427A</b>
Discharge pressure (bar)	17.91	16.25	19.81	18.24	15.74	19.3	18.63
Discharge temp ( <sup>0</sup> C)	111.4	83.9	81.9	81.5	84.0	97.7	93.7
Cooling capacity Kj/m <sup>3</sup>	3062	2654	3115	2912	2500	3189	3065
% of R-22		87	102	95	85	104	100
COP	3.20	3.23	3.12	3.17	3.25	3.19	3.2
Compression ratio	3.00	3.21	3.00	3.11	3.21	3.20	3.18
Temperature glide ( <sup>0</sup> C)	0	3.0	1.5	4.5	3.0	7.4	7.1
Boiling point ( <sup>0</sup> C)	-40.80	-38.70	-44.90	-45.70	-38.40	-43.70	-42.70
Mineral oil	Yes	Yes	Yes	Yes	Yes	No	No
POE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

### What do these differences imply?

R422D, evaporating at positive temperatures, has some loss of capacity which, although bearable, is not found with R434A.

In regard to refrigeration applications, many installation contractors have not been considering R422D as a possible replacement for R22 due to the lack of refrigerating capacity & are resorting to R404A & R507 as the only solutions.

With no lack of capacity, R434A is the only possible direct solution on the market for the range of temperatures and especially in high performance equipment, such as flooded evaporators.

The different studies recommend if required the possibility of recharging a leakage of R-22 with R-434A (RS-45), which provides a quick & economic solution.

### What problems are there with direct replacements?

- Oil return depends on certain conditions of design & operation of equipment. In some systems with long and complex pipelines, flooded evaporators, operating at low temperatures or containing a low pressure received, we recommend the replacement of whole or part (approx. 25%) of the existing oil with POE.

- The orifice of the refrigerant expansion device may require changing to the equivalent of R-404A or replacing with a new valve able to accommodate the higher flow rate of R-404A.

### **What problems can be found in solutions of direct and indirect substitution?**

\* Depending on the age & condition of the installation, it may be required to replace all gaskets. Some elastomeric seals are not compatible with HFCs. The plastics (teflon, viton, HNBR, etc.) are appropriate. Looking at Tables II and III, all data is taken from manufacturers' information, the latest edition of Refrigerant Report 15th edition by Bitzer and the software programme Refprop,

### **CONCLUSIONS**

We are aware that indirect solutions for retrofitting, especially for replacing R22 in refrigeration, tend to be expensive, slow, and can result in problems such as leakage, the effect of POE oils on old facilities.

As we experience difficult economic times, many users still have not made any decision to replace R22, and summer is already in full swing. Therefore, there will not be any other solution than direct substitutes.

The RS series, due to their excellent performance and low temperature glide, are the perfect products, together with Series 9 (ISCEON) to meet the urgent situation which has arisen due to the lack of reclaimed R-22 in order to maintain equipment in service.

Only small amounts of reclaimed R22 available will remain on the market in July.