NRF TECHNICAL ARTICLE

REPLACEMENT OF R1234YF WITH R134A

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Since the EU introduced Directive 2006/40/EC on fluorinated greenhouse gases, the discussion in the automotive industry about replacing R134a with R1234yf or CO2 has been heating up the online forums of mechanics and car users.

There is not and probably never will be a winner in this highly emotional discussion any more than there is in, say, politics.

There are strong arguments on each side of the barricade. On the one hand the environmental aspects and on the other the costs that vehicle owners have to pay. Why did the EU and non-EU governments make such a controversial decision?

It has been cursorily calculated that emissions of fluorinated greenhouse gases in 2005 put about 90million tons of CO2 equivalent into the atmosphere.

GWP - Global Warming Potential, was developed to allow comparison of the global warming impact of various gases in terms of emissions of 1 ton of carbon dioxide (CO2). CO2 has a GWP of 1.

R134a otherwise known as HFC134a (HydroFluoroCarbon) is also a fluorinated gas with a very high greenhouse potential GWP=1430. In comparison, R1234yf has GWP=4.

The previous refrigerant R12, which was used until 1994, had GWP=10900 and additionally contained Freon, which directly affected the destruction of the ozone layer. The replacement of R12 with R134a was also fraught with a lot of confusion in the market and similar problems that we are currently facing in the transition to R1234yf.

Feature	R134a	R1234yf
GWP	1430	4
CO2 equivalent /kg	1000	2,8
Decay in the atmosphere	>13 YEARS	<11 DAYS
Boiling point (oC)	-26,4	-29,4
Critical temperature (oC)	101,15	94,7
Critical pressure (bar)	40,64	33,82

Table 1 Selected properties of R134a and R1234yf refrigerants.

Looking at the economic side of withdrawing R134a refrigerant from the automotive market and replacing it with R1234yf, there is tremendous resistance from car owners. Mechanics, wanting to follow the expectations of customers, undertake the substitution of the R1234yf factor for R134a. The procedure of substitution of R1234yf for R134a is most evident in less developed countries where the economic aspect of servicing or repairing the air conditioning system has a huge impact on the home budget of the vehicle owner. On average, the cost of servicing the air conditioning system, in the case of R1234yf refrigerant can be up to 10 times more expensive. The R1234yf refrigerant itself is several times more expensive than R134a.

Is such a popular substitution of R1234yf for R134a legal?

Photo 1. Cylinder with R1234yf refrigerant (photo: NRF)

As of January 01, 2017, all new cars registered in the European Union must have an air conditioning system with a refrigerant whose GWP value does not exceed 150.

The HFO1234yf refrigerant was introduced as a replacement for HFC134a due to its low GWP=4 and very rapid decay in the atmosphere (11 days max.), i.e. much less impact on global warming.

Photo 2. Skoda Kodiaq 2021 nameplate (NRF photo)

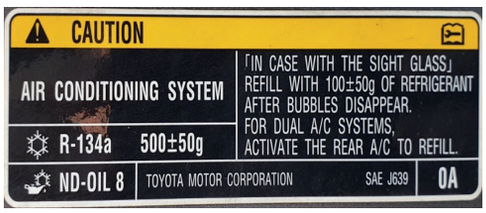

Photo 3. 2015 Toyota RAV4 nameplate (NRF photo)

According to Directive 2008/99/EC, it is an environmental crime to introduce a gas with high greenhouse potential into the environment.
The refrigerant R134a in an automobile air-conditioning system provided for R1234yf is considered an illegal substance according to Directive 2006/40/EC.
This is punishable by a fine and in particularly blatant cases even by imprisonment.
It should be noted at this point that both the workshop and the owner of the vehicle, who actually owns the refrigeration system, are at risk of a fine.

WHAT DANGERS FOR THE A/C SYSTEM RESULT FROM THIS?

From a thermodynamic point of view, the refrigerant R134a and R1234yf are very similar to each other, as shown in part by the pictures of pressure gauges with evaporation and condensation pressures. As you can see on the blue manometer, the evaporation pressure is slightly higher with R1234yf. This causes R1234yf to have a better volumetric efficiency of the compressor, and it will have a lower compression ratio.

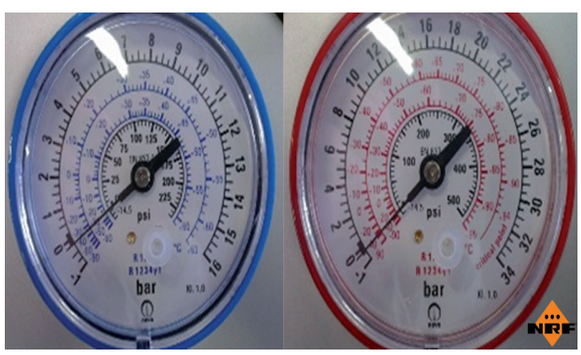

Photo 3 and 4. Low and high pressure gauge for R134a and R1234yf.

However, R1234yf has about 20% less latent heat of vaporization than R134a. R1234yf's cooling capacity is also on average 9% lower than R134a. And the COP (coefficient of perfformance, coefficient of performance) itself is about 7% lower.
Therefore, where we have R1234yf refrigerant used, it is about 20% more than in a similar air conditioner with R134a. And to reduce the difference in COP, internal heat exchangers IHX (Internal Heat Exchanger) are used in systems with R1234yf.

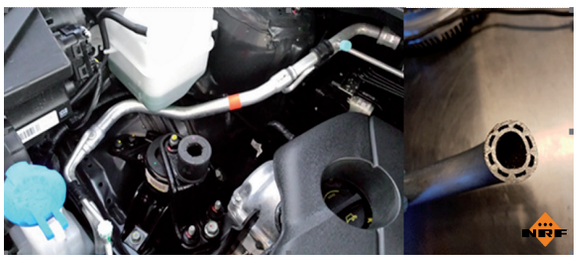

Photo 5. Internal heat exchanger for R1234yf refrigerant (photo: NRF)

As you can see from the above description, R134a and R1234yf refrigerants are not completely identical and their substitution will always result in faster degradation of the A/C system and eventually lead to costly repairs.
Self-car air conditioning systems are precisely tuned with the correct factor and its mass. Any interference will lead to disruption of its operation, even if these deficiencies are not immediately apparent.
Replacing R1234yf with R134a, also raises another important problem. The mixing of different refrigerants in air conditioning systems, which will then be "pulled" to cylinders with very expensive R1234yf.
That is, in order to reduce the cost of A/C maintenance, we will paradoxically be exposing ourselves to expensive servicing of A/C machines and maintenance of gas cylinders.