HFOs:
the new generation of F-gases

Greenpeace Position Paper

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With the agreed phase out of CFCs and HCFCs under the Montreal Protocol, governments are now turning their attention to the strong negative impacts of HFCs on the climate and a global discussion is taking place on the alternatives. The chemical industry is promoting new substances it calls 'Hydrofluoroolefins' or HFOs.

Chemically, HFOs are HFCs, but due to the negative connotations that HFCs have acquired, this new class of chemicals has been marketed under a different name. This is part of a marketing strategy to portray these new HFCs as having a low impact on the climate while glossing over their negative environmental effects. As set out below, these new HFCs have real and dangerous environmental and health impacts.

Greenpeace opposes HFOs, the fourth generation of F-gases mainly for these four reasons:

- HFOs present an unnecessary risk to the environment and human health
- HFOs are only a short-term fix
- Natural refrigerants are the best available technology and offer the long-term solution; HFO development will only delay their deployment
- Greenpeace does not want to see history repeating itself; after three subsequent generations of destructive chemical products it is time to opt for the only acceptable alternative: natural refrigerants

Greenpeace seeks the phase out of all F-gases, which present a growing threat to the environment. Greenpeace is not against the development of alternatives, but until our concerns about HFOs can be proven to be unfounded, the precautionary principle should prevail. Safer, cheaper and readily-available alternatives already exist for all applications, and given this fact, we favour the deployment of natural refrigerant and oppose the continuing dependence on synthetic refrigerants.

In order to not lock in the world onto a path towards catastrophic climate change, governments must agree to peak global emissions by 2015 and reduce emissions by at least 80% below 1990 levels by 2050, in accordance with the recommendations of the IPCC[i]. In order to achieve these ambitious objectives Greenpeace will support every sustainable means of doing so, in line with the precautionary principle and therefore without compromising the health and vitality of our planet or future generations. Greenpeace will continuously assess the sustainability of new technologies based on newly available information.

1 HFOs present an unnecessary risk to the environment and human health

1.1 HCFCs[ii] are used to make HFO-1234yf

This means that ozone-depleting and global warming chemicals that are soon going to be banned under the Montreal Protocol are the source of the alleged refrigerants of the future. As opposed to natural refrigerant technology that is tried, tested and open for all to use and develop, the chemical details of HFO-1234yf are shrouded in secrecy. The details that we do know already make it clear that they are dangerous (see point below). Additionally, the substances that are released into the atmosphere as a result of its production, or anything concerning its reproductive toxicity[iii], are still uncertain. Furthermore, the chemical industry is creating HFO blends, which include HFCs that upon atmospheric dissolution will revert to their basic compounds and will make their global warming contributions accordingly.

1.2 HFOs and other HFCs produce toxic by-products upon their production and decomposition

When HFO-1234yf breaks down in the atmosphere it produces trifluoroacetic acid (TFA). In high-enough concentrations, TFA is toxic to aquatic ecosystems.[iv] While TFA is a common by-product when other HFCs break down, HFO-1234yf produces four to five times as much TFA than the same amount of HFC-134a does.[v] This means that if HFO-1234yf (or another HFO) becomes the refrigerant of choice, the concentration of TFA in fresh water bodies around the world could increase dramatically, with unknown effects on ecosystems and human health. TFA concentrations approaching a milligram a litre may be toxic to some aquatic life forms.[vi] To date, no direct evidence has been found for the natural production of TFA even though the existence of a natural source has been the subject of much speculation[vii]. Oceanic waters show varied levels with depth and in different areas and it has been suggested that underwater volcanic vents act as a source of TFA.[viii] While no natural sources have been identified, what is not in doubt is that TFA is a highly persistent chemical.[ix]

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The Scientific Assessment Panel to the Montreal Protocol recently raised several concerns about HFOs, including the possibility of its breakdown products being HFCs with high Global Warming Potential (GWP) or even ozone-depleting substances, and of the potential for tropospheric ozone pollution formation.[x]

The promoters of HFOs argue that if HFO-1234yf were brought into general use this would lead only to an increase of TFA in rainwater. To date, there has been no systematic study of the impacts of TFA on either aquatic or terrestrial systems. Even so, on the basis of what is already known, the precautionary principle should be applied. To continue the mass production of precursors to trifluoroacetic acid as at best irresponsible and production should be prevented until full life cycle studies on the environmental impacts of HFO-1234yf have been carried out.[xi]

1.3 Given that HFO-1234yf is flammable, the combustibility of this chemical is also of concern.

HFC-1234yf is flammable. When it burns, it releases poisonous hydrogen fluoride (HF) substances. HF is very toxic and potentially lethal to humans in unventilated spaces. It would greatly increase the number of casualties from car crashes, particularly in confined and airless areas such as indoor parking lots and tunnels.

Greenpeace does not consider the flammability of a refrigerant an inherent impediment to its use. Flammable refrigerants in mobile air conditioners (MACs) are safe when used in equipment designed for their use, such as systems with secondary loops. However, should the MAC industry opt for refrigerants that are flammable, then hydrocarbons are a superior choice over HFO-1234yf. They are already widely used in MACs.[xii] Indeed, since the 1990s the air-conditioning of up to 50 million cars has been changed from HFCs to hydrocarbons, in many countries including Australia, Canada, the US, China, the Philippines and some Caribbean countries. Hydrocarbons are environmentally friendly, more efficient, much cheaper, and immediately available.

2 HFOs are only a short-term fix

2.1 Greenpeace assessment indicates that HFOs - the new generation of HFCs - will not help to achieve the needed peak in greenhouse gas emissions by 2015.

These new chemicals are not yet commercially proven, but what is already known is that potentially they may be very harmful to the environment and in certain conditions to humans as described above. (See 1.3)

2.2 The marketing argument for HFOs is their low climate impact relative to older HFCs. Nevertheless, this does not reflect the economic and social reality

- HFOs can be used as a 'drop-in', which means they can be used in existing technology without fundamental system changes[xiii]
- HFOs are more expensive than the refrigerants that they will replace[xiv]

If used as a drop-in solution, the prohibitive cost would be a problem, especially in developing countries. During maintenance, the systems could easily be retrofitted with cheaper HFCs (e.g. HFC-134a in mobile air conditioning). This would reverse the initial climate benefits of using a low-GWP HFC. Additional safety measures applied to the system to impede such misuse are likely to raise the system costs again.

It is expected that HFOs, such as HFC-1234yf, will be 10 to 20 times more expensive than HFC-134a. High costs will provide incentives for service technicians to revert back to HFC-134a. As HFCs increasingly come under regulatory pressures (for example the EU F-gas Regulations and MAC Directive), the high price of HFO alternatives will fuel an HFC black market.

2.3 We need a long-term approach that prioritizes the real solutions. There is no need for any new chemicals. Natural substances are available and technically and economically feasible.[xv]

There is no need for the continued use of HFCs or HFOs. To highlight this, Greenpeace recently published an updated edition of its *Cool Technologies: Working Without HFCs* report, which documents the existence of natural alternatives with even better technical performance in almost every sector. This report has been confirmed and lauded by a number of refrigeration experts.[xvi]

3 Natural refrigerants are the best available technology and offer the long-term solution; HFO development will only delay their deployment.

3.1 Natural refrigerants are more energy-efficient than new HFCs

As already well established in many sectors, natural refrigerants tend to be more efficient than the new chemicals. The replacement by Coca-Cola, Unilever and others of HFC-units with hydrocarbons, as well as with CO_2, has brought about significant energy gains. Similar efficiency gains have been demonstrated in many supermarkets that have switched to CO_2 systems. For more information, see Greenpeace's *Cool Technologies: Working Without HFCs* report.

In addition to all this, it is well-documented that as a 'drop in' replacement, HFO-1234yf is less efficient than HFC-134a.[xvii,xviii,xix,xx]

3.2 HFOs are taking attention and resources away from cheaper, more efficient and better-understood natural refrigerants.

HFO-1234yf is now the sixth potential replacement to HFC-134a proposed by the chemical industry. Two of the earlier low-GWP HFC products proposed – DP 1 and Fluid H – had to be scrapped due to toxicity concerns, and all other subsequent options were rejected by the car industry. At the same time, outstanding questions and cause for scepticism around HFO-1234yf remain.

HFOs are not currently on the market.

3.3 HFOs should not be allowed to obstruct the real solutions

The marketing of HFOs resulted in the suppression of the market-ready CO_2 systems and undermined the EU's 2011 deadline for the phase-out of HFC-134a for new models vehicles. This means that HFC-134a may dominate the market for many years to come[xxi]. Greenpeace considers hydrocarbons as the most practical, environmentally safest and most efficient solution to replacing HFCs in mobile air-conditioning. Presently there are over 50 million cars in the world that have been safely retrofitted to hydrocarbons from CFCs and HFCs. Such retrofitting is routinely done in Australia, Canada, China, the US and the Philippines. If hydrocarbons can be safely used in retrofits, they could also be safely used in new MACs designed for their use.

4. Greenpeace does not want to see history repeating itself; after three subsequent generations of destructive chemical products it is time to opt for the only acceptable alternative: natural refrigerants

4.1 "Those who cannot remember the past are condemned to repeat it."[xxii]

One of the arguments against this new generation of chemicals is the history of F-gases. This has been characterised by the disregard of their dangerous chemical properties that led firstly to the depletion of the ozone layer, then to the warming of the climate, and will now potentially lead to other areas.

Low GWP and non-ozone damaging properties are not reason enough to support the new generation of HFCs or HFOs. Other serious environmental and human safety risks from these HFOs make them potentially just as dangerous as their HFC cousins. The sorry track record of the chemical industry's marketing of CFCs, HCFCs and HFCs during the last 70 years should be a lesson for not accepting at face value any of the assertions of this sector regarding its new products. This means that governments should not base policies within the Montreal Protocol or the UNFCCC based on industry claims, but on truly independent testing of these products.

4.2 HFOs are just the beginning

There is a whole family of these gases waiting to be rolled out, with unknown environmental and health effects. New F-gases potentially containing chlorine (which is responsible for most of the ozone depletion in the stratosphere) are being tested. While scientists indicate that because of their short lifetime, these new chemicals wouldn't reach the stratosphere, there are certain to be unanticipated environmental impacts from increased chlorine in the atmosphere.

4.3 Greenpeace does not support countries providing public financial support to HFO at the expense of funding natural refrigerants development and investment.

References

[i] The Intergovernmental Panel on Climate Change (IPCC) concluded in its 4th Assessment Report, published in 2007, that reaching the lowest range in concentration stabilisation levels assessed (445 to 490 ppm of CO_2-equivalent, leading in the long term to a temperature increase between 2 and 2.4°C), would require global CO_2 emissions to peak before 2015.

[ii] HCFC-225 ca (20-year GWP: 550, ODP: 0.07) and HCFC-225 cb (20-year GWP: 1700, ODP: 0.03) – US patent no. 7,470,828 B2 (December 30, 2008). Available from http://www.freepatentsonline.com/7470828.html

[iii] REACH evaluation – HFO-1234yf.

[iv] Boutonnet et al. (1999). Environmental risk assessment of trifluoroacetic acid. Human and Ecological Risk Assessment, 5(1), 59–124.

[v] EPA Proposed Ruling on HFO 1234yf (2009). p. 11-12. Available at www.epa.gov/ozone/downloads/NPRMHFO1234yf.pdf

[vi] IPCC/TEAP Special Report on Ozone and Climate, Chapter 2, p.22

[vii] Nielsen OJ, Scott BF, Spencer C, Wallington TJ & Ball JC (2001). Trifluoroacetic acid in ancient freshwater. Atmospheric Environment 35: 2799-2801

[viii] Frank H, Christoph EH, Holm-Hansen O & Bullister JL (2002). Trifluoroacetate in Ocean Waters. Environmental Science and Technology 36: 12-15

[ix] Scott BF, Macdonald RW, Kannan K, Fisk A, Witter A, Yamashita N, Durham L, Spencer C & Muir DCG (2005). Trifluoracetate profiles in the Arctic, Atlantic and Pacific Oceans. Environmental Science and Technology 39 (17): 6555-6560

[x] Newman et al. (2009). HCFCs and HFCs: An Update from the Scientific Assessment Panel.

[xi] NOÉ21(2010). HFO-1234yf in the environment by Félix Dalang, Dr in Chemistry EPF-Z, 8-6-2010

[xii] The Australian company HyChill (www.hychill.com.au) and American company OZ technology (www.oztechnologyinc.com) provide hydrocarbon refrigerants for mobile air conditioning.

[xiii] Thierry Vanlancker, DuPont Fluorocarbons Manager, Personal communication to Greenpeace, Berlin, 10 March 2009.

[xiv] Refrigerant costs of HFO-1234y could be more than 10 times higher than those of R134a- Report from the German Environment Ministry comparing costs of R744 vs. R1234yf: "Proposal for supporting Mobile Air Conditioning (MAC) for Cars with a very low GWP" (2008).

[xv] Colbourne D (2009). Opportunities for the application of Natural Refrigerants, in the GTZ publication Natural Refrigerants; Pachai AC et al. (2009). Achieving the green dream by the use of natural refrigerants.

[xvi] Daniel Colbourne (Refrigerants, Naturally! Secretariat), Alexander Cohr Pachai (Johnson Controls), Per Henrik Pedersen (Danish Technological Institute).

[xvii] Monforte R, Rose B & L'Huillier J-M (2008). Updated situation about alternative refrigerant evaluation. Fiat Group Automobiles, PSA Peugeot Citroen, Renault. Presentation prepared for SAE 2008 Alternative Refrigerant Systems Symposium, 10-12 June, 2008, Phoenix, AZ.

[xviii] Meyer J (2008). R-1234yf System Enhancements and Comparison of R134a; Visteon. Presentation prepared for SAE 2008 Alternative Refrigerant Systems Symposium, 10-12 June, 2008, Phoenix, AZ.

[xix] Benouali J, Karl S & Petitjean C (2008). A/C System Control Strategies for Major Refrigerant Options; Valeo. Presentation prepared for SAE 2008 Alternative Refrigerant Systems Symposium, 10-12 June, 2008, Phoenix, AZ.

[xx] Ikegami T, Iguchi M, Aoki K & Iijima K (2008). New Refrigerants Evaluation Results. Toyota, Honda, Nissan, Valeo joint presentation prepared for the VDA Alternative Refrigerant Winter Meeting, 13-14 February, 2008, Saalfelden, Austria.

[xxi] Goldstein M (2009). Car makers fight EU ban on climate change chemicals. Reuters. Jun 23, 2009. Accessed at http://www.reuters.com/article/rbssConsumerGoodsAndRetailNews/idUSLN24261420090623

[xxii] George Santayana, The Life of Reason or The Phases of Human Progress: Reason in Common Sense.

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