PFAS F-gases in Mobile Air-Conditioning: A Neglected Issue with an Easy Fix

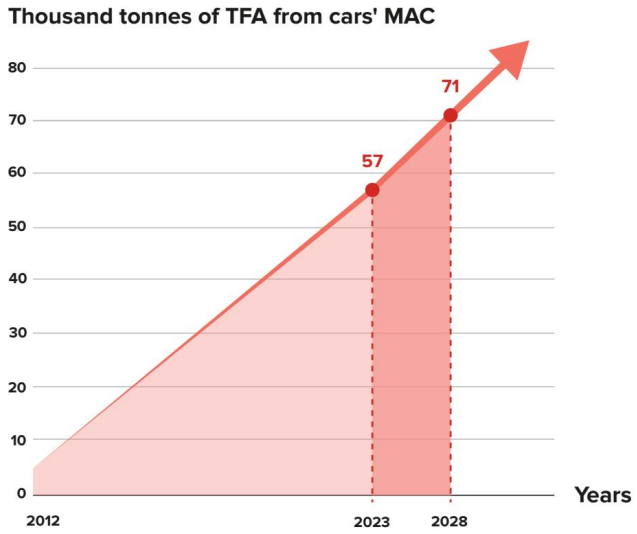
Most of the fluorinated refrigerants used in heating and cooling systems worldwide are considered per- and polyfluoroalkyl substances (PFAS). One of the issues of these substances is their degradation product trifluoroacetic acid (TFA), which forms once fluorinated refrigerants leak into the atmosphere. TFA is harmful to aquatic life and is considered to be very mobile and persistent. Its increasing presence around the world in sources of drinking water and biota is concerning[1] and calls for policy action.[2]

The problem

The use of fluorinated greenhouse gases is considered to be the biggest contributor to PFAS pollution in Europe,[3] and low-GWP f-gases from mobile systems are estimated to be a major source of TFA formation,[4] also due to the penetration of HFO-1234yf in cars breaking down 100% into TFA in around 10 days.

Each year, around 10 million new cars enter the European market,[5] and each car emits on average around 10% of its refrigerant charge per year,[6] exacerbating this issue.

ATMOsphere modelled that around **57 thousand tonnes of TFA**[7] have been emitted from mobile air-conditioning systems alone since 2012. The European Union mobile and air-conditioning Directive (EU MAC Directive),[8] adopted in 2006 and never revised thereafter, imposes a switch to refrigerants below 150 GWP since 2017, resulting in most cars now containing HFO1234yf.

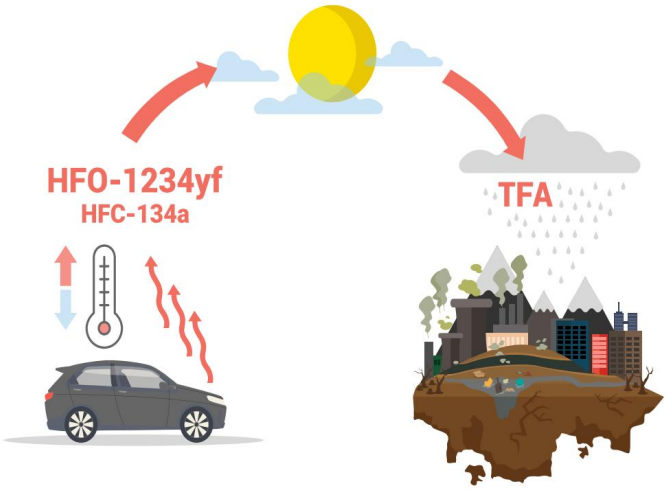


By the time the first restrictions of PFAS and TFA enter into force with the European PFAS Universal Restriction Proposal,[9] ATMOsphere estimates that another **14 thousand tonnes of unnecessary TFA**[7] from car's MAC systems will accumulate in the European environment. Due to the prevalence of systems with HFO-1234yf, in the next years around ¼ of the amount leaked into the environment since 2012 could end up in our environment in the next four years.

1. Garry, M. (2022). The rising threat of HFOs and TFA to health and the environment. ATMOsphere. Available online at: https://atmosphere.cool/atmosphere-report-examines-rising-threat-of-hfos-and-tfa-to-health-and-the-environment/
2. Norwegian Environment Agency (2023). PFAS restriction proposal in the EU - Main provisions targeting fluorinated refrigerants. Available online at: https://ozone.unep.org/system/files/documents/MP%20side-event_Heggelund.pdf
3. See Table 4. Tonnages and emissions of major use sectors and manufacture for 2020 (sorted by tonnage range) in the ANNEX XV RESTRICTION REPORT – Per- and polyfluoroalkyl substances (PFASs). Available online at: https://echa.europa.eu/documents/10162/1c480180-ece9-1bdd-1eb8-0f3f8e7c0c49
4. See Figure S 4. European (EU-28) emissions of important HFCs, u-HFCs and u-HCFCs in refrigerants and blowing agents, and resulting trifluoroacetic acid (TFA) quantities in kilotonnes by sector for the years 2000 to 2050 in 10-year steps, in the German Environment Agency report "Persistent degradation products of halogenated refrigerants and blowing agents in the environment: type, environmental concentrations, and fate with particular regard to new halogenated substitutes with low global warming potential". Available online at: https://www.umweltbundesamt.de/sites/default/files/medien/5750/publikationen/2021-05-06_texte_73-2021_persistent_degradation_products.pdf
5. Data taken from new passenger car registrations in the EU, ACEA 2023. Available online at: https://www.acea.auto/figure/new-passenger-car-registrations-in-eu/
6. See Table 43: AnaFgas sector sheet for the baseline scenario: Mobile AC - Passenger cars, in Support Contract for an Evaluation and Impact Assessment for amending Regulation (EU) No 517/2014 on fluorinated greenhouse gases. Available online at: https://climate.ec.europa.eu/system/files/2022-04/f-gases_external_preparatory_study_annexes_en.pdf
7. The data are modelled for the European Economic Area, plus Switzerland and the United Kingdom.
8. See European Commission dedicated website here: https://single-market-economy.ec.europa.eu/sectors/automotive-industry/environmental-protection/mobile-air-conditioning-systems-macs_en
9. Estimated in 2028.

The solutions – natural refrigerants

HFO-1234yf, as well as other fluorinated refrigerants, are **not essential** to the functioning of mobile air-conditioning systems, whether in internal combustion engines or electric vehicles. In fact, natural refrigerants such as R744 and R290 can work safely and efficiently. Mobile air-conditioning systems with R744 are already deployed on European roads, and R290-based are progressing quickly.[10] Some OEMs are already taking action to switch models to natural heat carriers in the coming years.[11]



Key Asks

ATMOsphere calls on European policymakers to revise the MAC Directive in the next Commission's political cycle, and in any case, before the finalisation of the EU Universal PFAS Restriction Proposal. ATMOsphere believes the revision of the MAC Directive can have a direct and immediate effect on the issue of TFA. ATMOsphere also notes that the legally mandated review in the MAC Directive Article 8 was never published.

→ **Revise the MAC Directive in the next European policy cycle**

Deliver the legally mandated review

ATMOsphere calls on European policymakers to proceed swiftly and steadily on the European Universal PFAS Restriction Proposal, especially with regards to fluorinated gases as they are considered a low-hanging fruit due to the availability of alternatives.

→ **Prioritise the finalisation of bans on PFAS in the EU Universal Restriction Proposal where alternatives are available, such as f-gases in mobile air-conditioning systems in cars, and HVAC&R systems in general**

ATMOsphere calls on the Commission to deliver as soon as possible the report mandated in Article 35(3) of the revised EU F-gas Regulation. In fact "cost-effective, technically feasible, energy-efficient and reliable alternatives" to fluorinated refrigerants exist today, allowing the addition of mobile air-conditioning and transport refrigeration systems to Annex IV Bans of the EU F-gas Regulation.

→ **Deliver the legally mandated report by 2027 as established by the revised EU F-gas Regulation**

Add fluorinated refrigerants in mobile air-conditioning systems to the list of bans in Annex IV of the Regulation

10. See, for instance, Koegelenberg, I. (2022). Volkswagen Cites Efficiency Gains from CO2 Heat Pump in First Electric SUV Coupe. R744.com. Available online at: https://r744.com/volkswagen-cites-efficiency-gains-from-co2-heat-pump-in-first-electric-suv-coupe/, and Haroldsen, J. (2023). German Concept Electric Vehicle Features Propane Heat Pump. Hydrocarbons21.com. Available online at: https://hydrocarbons21.com/german-concept-electric-vehicle-features-propane-heat-pump/
11. Trevisan, T. (2024). Volkswagen Plans to Convert All Battery Electric Vehicles to R744 by 2030. R744.com. Available online at: https://r744.com/volkswagen-plans-to-convert-all-bev-models-to-r744-by-2030/