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The Rising Threat of HFOs and TFA to Health and the Environment

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ATMO Report

HFO-1234yf, used widely as a refrigerant by itself and in blends, represents a growing threat to human health and the environment via its atmospheric degradation product, trifluoroacetic acid (TFA).

The report, “The Rising Threat of HFOs and TFA to Health and the Environment,” can be accessed for free here. The report cites a myriad of studies have been conducted, mostly in Europe, on the accumulation of HFO-1234yf and TFA in the environment.

“The writing on the wall – in the form of numerous studies that are cited in this report – strongly points to the steady development of a new environmental and health problem stemming from the use of a fluorinated refrigerant, this time an HFO,” said Marc Chasserot, Founder of ATMOsphere.

The chemical industry’s replacement for HFCs – HFOs (hydrofluoroolefins) – have very low GWP values and thus don’t present a problem for the climate or the ozone layer. But other environmental and health concerns have arisen for HFOs, particularly for HFO-1234yf, a mildly flammable (A2L) refrigerant that is the most widely used HFO, the report notes.

The largest use of HFO-1234yf, beginning in Europe in 2012, has been as a replacement for R134a (100-year GWP of 1,430) in mobile air conditioning. Moreover, HFO blends such as R513A and R449A, which include HFO-1234yf as a key ingredient, are used in thousands of stores globally as well as in industrial facilities, ice rinks and other applications.

When HFO-1234yf leaks into the atmosphere, 100% of it photo-oxidizes, in only 10-14 days, into trifluoroacetic acid (TFA), a short-chain per-fluoroalkylcarboxylic acid (scPFCA). TFA then descends in rainfall to Earth, where, as an extremely durable chemical, it accumulates mostly in water bodies, including rivers, streams, lakes and wetlands.

TFA linked to HFO-1234yf emissions

While not currently regulated, TFA is collecting in the environment, according to a number of recent studies, which largely attribute this to expanding emissions of HFO-1234yf, the report points out.

Even at extremely small concentrations in drinking water, TFA is potentially harmful to human health, says the report, adding that it is difficult to remove from drinking water using conventional methods.

In Germany, where a host of TFA studies have been conducted, the German Environment Agency (UBA) has set a human health "orientation value" limit of 60µg/L for TFA in drinking water and a "precautionary measure" of 10 µg/L. The concentration levels of TFA in the environment have begun to approach – or exceed – those levels in some studies, the report points out.

Long-term exposure to TFA can potentially damage the liver and the thyroid function in humans, according to a report released in 2021 by Refolution Industriekälte, a German consulting and engineering firm focused on sustainable refrigeration.

Both TFA and HFO-1234yf fall under the definition of PFAS (per- and polyfluoroalkyl substances) established by the OECD (Organisation for Economic Co-operation and Development) and used by scientists around the world. PFAS encompass a well-known group of chemicals such as PFOA, PFOS and GenX, that have been linked to effects on the immune system and human development, cancer and other adverse health outcomes.

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