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Environment & breakdown products

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Trifluoroacetic Acid and Hydrofluorocarbons (HFCs) or Hydrofluoro-olefines (HFOs).

EFCTC acknowledges the work done by the Environmental Effects Panel of the Montreal Protocol in establishing the environmental context of trifluoroacetic acid (TFA) potentially formed from HFCs (and HFOs) and is pleased to reproduce the whole of the Panel's Briefing Note.

It should be noted, however, that in real life TFA is not a significant terminal degradation product of HFC-125 and HFC-143a.

UNEP Ozone Secretariat
June 2015

Ecological Issues on the feasibility of managing HFCs: Focus on TFA

Inter-sessional informal meeting, 12-13 June 2015

1. Scope of the briefing note

This briefing note focuses on trifluoroacetic acid (TFA) which is one of the main breakdown products for several hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), and hydrofluoroolefins (HFOs). The note summarizes key information pertaining to TFA based on recent reports of the Environmental Effects Assessment Panel and the Scientific Assessment Panel of the Montreal Protocol. The issue of TFA in the environment has been assessed regularly by the EEAP and has also been reviewed by other authors. The EEAP intends to provide an updated review of the topic as part of its 2015 Progress Report.

2. Properties and sources of TFA

TFA is the terminal breakdown product for HCFCs (HCFC-123, HCFC-124), HFCs (HFC-125, HFC-134a, HFC 143a, and HFC-227ea)[1], and HFOs (HFO-1234yf). TFA is a very strong acid, which means that it readily forms salts with minerals in soil. TFA is very resistant to breakdown in the ecosystem. Amounts deposited in flowing surface water will ultimately accumulate in the oceans and salt lakes where water is lost only by evaporation. However, based on estimates of current and future use of HFCs, HCFCs, and HFOs, additional inputs to the global oceans, salt lakes and playas will add only fractionally (estimated to be less than 0.1%) to amounts already present from natural sources such as undersea vents and volcanic activity. TFA is terminal breakdown product of other compounds that not regulated under the Montreal Protocol and is also used and as a reagent in biochemistry. Releases from these other sources are unknown.

TFA is stable in the environment but is water soluble and accumulates in playas, land-locked lakes, and the oceans, where it combines with cations such as sodium, potassium, calcium, and magnesium. More than 95% of the salts of TFA found in the oceans are naturally produced. These salts are inert and not of toxicological or environmental concern in the small concentrations that are present in the oceans, playas, and lakes.

TFA, its chemical precursors, and other breakdown products of HFCs, HCFCs, and HFOs are washed from the atmosphere by precipitation and reach surface waters, along with other chemicals washed from the soil. In locations where there is little or no outflow and the only loss of water is via evaporation (playas and salt lakes), the concentrations of these products are expected to increase over time. However, the effects of increased concentrations of other naturally occurring mineral salts and other materials will be much greater and more biologically significant than the breakdown products of the HFCs and HCFCs.

While it is well established that TFA is a ubiquitous natural component in rivers, lakes, and other surface water bodies, uncertainties remain regarding anthropogenic sources, long-term fate and abundances as these are linked to current and future use and emissions of HFCs, HCFCs, and HFOs. Based on estimates to 2040, increases are predicted to remain relatively low and are therefore not expected to be a significant risk to human health or detrimental to the environment.

[1] In real life TFA is not a significant terminal degradation product of HFC-125 and HFC-143a.