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Created: October 2013

Updated: March 2021

Fluoride in the Atmosphere: A very small contribution from HFCs

Fluorine, in the form of fluoride ion, is found in many rocks and minerals and most soils. It comprises 0.06% of the Earth's crust (which, although it does not seem much, is actually about twice the known amount of fossil fuel carbon). Fluorides are released into the environment naturally through the weathering and dissolution of minerals, in emissions from volcanoes and in marine aerosols. Estimates of the annual global release of hydrogen fluoride from volcanic sources through passive degassing and eruptions range from 0.06 to 6 million tonnes/year. The wide distribution in soils means that there is significant natural movement of fluoride through the atmosphere on wind-borne dust particles (estimates vary from 1 to 10 million tonnes/year). However, human activity can add to this flux.

Airborne fluoride exists in gaseous and particulate forms and is deposited in the general vicinity of an emission source, although some particulates may react with other atmospheric constituents. In areas not in the direct vicinity of emission sources, the mean concentrations of fluoride in ambient air are generally less than $0.1 \mu\text{g}/\text{m}^3$. However, in areas of China [1], where fluoride-rich coal is used as a source of fuel, reported concentrations of fluoride in ambient air have reached $6 \mu\text{g}/\text{m}^3$.

This has been highlighted in a Chinese paper that examines the consequence of burning coal in electrical power generating stations. The 140 million tonnes/year of coal burnt is estimated to result in 160,000 tonnes/year of fluoride being emitted into the atmosphere there. This will significantly augment the natural fluoride present in the atmosphere of Eastern Asia [2].

Natural decomposition of HFCs (hydrofluorocarbons) emitted from leaking refrigeration and air conditioning systems constitutes a much smaller source of fluoride in the global atmosphere. The emissions reported by countries to the United Nations database for year 2011 [3] indicate that some 15,000 tonnes/year of fluoride could be formed in the global atmosphere in this way (or about one tenth of the flux from burning just Chinese coal).

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EU Transparency Register n° 64879142323-90

A sector group of Cefic 
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Sources:

1. Fluorides, Environmental Health Criteria 227, World Health Organization, Geneva, 2002
2. Jian Chen, Guijian Liu, Yu Kang, Bin Wu, Ruoyu Sun, Chuncai Zhou, Dun Wu, Atmospheric emissions of F, As, Se, Hg, and Sb from coal-fired power and heat generation in China, Chemosphere 90 (2013) 1925–1932.
3. United Nations Framework Convention on Climate Change (UNFCCC), Greenhouse Gas Inventories 2013 (at unfccc.int)