

Sulfuryl Fluoride

Sulfuryl fluoride (sulfuric oxyfluoride), commercially known as Vikane® or ProFume®, is an insecticide and rodenticide fumigant registered in the United States for use in pesticides since 1959. It is used to fumigate commodities and to control infestations of pests in residential structures, processed-food and pet food facilities, warehouses, and shipping containers. Sulfuryl fluoride, an odorless gas at ambient temperatures, but marketed as a liquefied gas in pressurized steel cylinders, is non-corrosive, non-flammable, and not very reactive. (Stewart, 1957) It is hydrolyzed by sodium hydroxide but not water. It breaks down into sulfate and fluoride anions. (U.S. EPA, 2008) The fluoride ion is considered the active metabolite, which inhibits lipase and other enzymes in the glycolysis cycle and increases oxygen uptake in treated termites. The termite dies when protein and amino acids, as energy sources, are depleted. (Meikle et al., 1963)

In humans, acute inhalation exposure to high concentrations of sulfuryl fluoride results in respiratory irritation, pulmonary edema, nausea, abdominal pain, central nervous system depression, numbness in the extremities, muscle twitching, seizures, and death (U.S. EPA, 1999). The fluoride ion may affect muscle activity (muscle twitching, seizures) by binding to calcium (Scheuerman, 1985). Other effects may be attributed to its binding to potassium and magnesium ions. Direct contact with concentrated sulfuryl fluoride as a liquid causes tissue damage to eyes, mucous membranes, or skin (U.S. EPA, 1985). At lethal concentrations, sulfuryl fluoride would be expected to disrupt carbohydrate and lipid metabolism of humans similar to its action in termites. EPA list sulfuryl fluoride as “not likely to be carcinogenic to humans”. (U.S. EPA, 2004a and b)

Sulfuryl fluoride can be a source of stratospheric sulfur (Crutzen, 1976) and a greenhouse gas. (California EPA, 2006a) However, it is practically non-reactive in the atmosphere, therefore it is not expected to deplete ozone. A European Union report (Swedish Chemicals Agency, 2005) estimates that more than 88% of sulfuryl fluoride emitted to the atmosphere, more than 1.62 Gg per year, results from fumigant use and that the atmospheric lifetime of sulfuryl fluoride is at most 4.5 years. The atmospheric history of sulfuryl fluoride in both hemispheres was reconstructed from in situ measurements and archived air, showing that sulfuryl fluoride has been accumulating in the global atmosphere with growth rates of $5 \pm 1\%$ per year since 1978. (Möhle et al., 2009)

Sulfuryl fluoride (<https://www.epa.gov/aegl/sulfuryl-fluoride-results-aegl-program>), in comparison to other typical fumigants, is more toxic than methyl bromide (<https://www.epa.gov/aegl/methyl-bromide-results-aegl-program>) and less toxic than phosphine (<https://www.epa.gov/aegl/phosphine-results-aeglprogram>). Sulfuryl Fluoride is listed as a Toxic Air Contaminant under the California Code of Regulations (Title 3), Pesticides and Pest Control Operations (Division 6), Environmental Protection (Chapter 4), Air (Subchapter 2), Toxic Air

Contaminants (Article 1), Toxic Air Contaminants List (6860(a)).

<http://www.cdpr.ca.gov/docs/legbills/calcode/040201.htm#a6860> As per the criteria to list a chemical as a Toxic Air Contaminant, California EPA determined the following reference concentrations for residents/bystanders: 1) acute - 510 $\mu\text{g}/\text{m}^3$, averaging time of 24 hours; and 2) Long-Term or Chronic – 10 $\mu\text{g}/\text{m}^3$. (California EPA, 2006b) It should be noted that the 24- hour sulfuranyl fluoride reference concentration is currently being reevaluated. As a result of this reevaluation, California is using a 1,700 $\mu\text{g}/\text{m}^3$ as the 24-hour acute exposure reference concentration. However, this may be modified as additional information and data is generated and considered. (California EPA, 2017)

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