Sulphur tetrafluoride

(CAS Reg no: 7783-60-0)

Health-based Reassessment of Administrative Occupational Exposure Limits

Committee on Updating of Occupational Exposure Limits,
a committee of the Health Council of the Netherlands

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1 Introduction

The present document contains the assessment of the health hazard of sulphur tetrafluoride by the Committee on updating of Occupational Exposure Limits, a committee of the Health Council of the Netherlands. The first draft of this document was prepared by WK de Raat, Ph.D. and Ir PMJ Bos (TNO Nutrition and Food Research, Zeist, the Netherlands).

The evaluation of the toxicity of sulphur tetrafluoride has been based on the review by ACGIH (ACG91). Where relevant, the original publications were reviewed and evaluated as will be indicated in the text. In addition, literature was retrieved from the online data bases Medline, Cancerlit, Toxline and Chemical Abstracts, covering the the periods 1966 to 30 June 1997 (19970630/UP), 1963 to 18 June 1997 (19970618/ED), 1965 to 21 March 1997 (970321/ED), and 1967 to 1 July 1997 (970701/ED; vol 127, iss 1), respectively, and using the following key words: sulphur tetrafluoride, sulphur fluoride, tetrafluorosulphurane, SF_4, and 7783-60-0. HSDB (no record) and RTECS, databases available from CD-ROM, were consulted as well (NIO98, NLM98). The final literature search has been carried out in July 1997, followed by an additional search in April 2001.

In July 2001, the President of the Health Council released a draft of the document for public review. The committee received no comments.

2 Identity

name	:	sulphur tetrafluoride
synonyms	:	sulfur tetrafluoride; sulphur fluoride, T4; tetrafluorosulphuran
molecular formula	:	SF_4
CAS reg no	:	7783-60-0

Data from ACG91, Lun91.

3 Physical and chemical properties

molecular weight	:	108,07
boiling point	:	-38°C; -40°C
melting point	:	-121°C; -124°C
flash point	:	-
solubility in water	:	violent reaction
Log $P_{octanol/water}$	:	1.65 (estimated)
conversion factors (20°C, 101.3 kPa)	:	1 ppm = 4.5 mg/m 1 mg/m^3 = 0.22 ppm

Data from Bud89, Wea87, http://esc.syres.com

Sulphur tetrafluoride is a colourless gas with an odour resembling that of sulphur dioxide. It is readily hydrolysed by water yielding hydrofluoric acid and thionyl fluoride (SOF_2). The latter compound hydrolyses slowly to hydrofluoric acid and sulphur dioxide.

4 Uses

Sulphur tetrafluoride is used as a selective fluorinating agent, capable of replacing oxygen in many organic, inorganic, and organometallic compounds with fluorine. Moreover, it is used in the production of water- and oil-repellant materials and lubricity improvers (ACG91, Bud89).

5 Biotransformation and kinetics

No information was found on the biotransformation and kinetics of sulphur tetrafluoride. In view of the violent reaction of the compound with water to hydrogen fluoride and thionyl fluoride, exposure to the compound itself will have a local character only. Thionyl fluoride hydrolyses more slowly than its parent

information was found on the stability of thionyl fluoride and the possibility of exposure to this compound at other sites than the site of exposure. After the 2 hydrolysis steps, only sulphur dioxide and hydrogen fluoride remain. The reader is referred to the reports of the Dutch Expert Committee on Occupational

Standards (DECOS) for information on the biotransformation and kinetics of these compounds (DEC85, DEC89).

6 Effects and mechanism of action

Human data

No studies have been located which provide information on the effects of the compound in pure form in humans.

Sulphur tetrafluoride is a breakdown product of sulphur hexafluoride, a gas which is widely used for electrical insulation. Kraut and Lilis described a case of 6 workers, which were accidentally exposed to the breakdown products of the hexafluoride during repair work (Kra90). Air analysis revealed the presence of sulphur tetrafluoride. No other breakdown products were sought for, while the concentrations of the tetrafluoride were not determined. The workers showed symptoms described as chest tightness, shortness of breath, headache, fatigue, nausea, vomiting, intermittent epitaxis (nose bleed), and radiographic changes in the lungs. Most symptoms disappeared in the course of a few weeks, while the workers were symptom-free after one year. The study reveals a clear effect of irritation of the respiratory tract of breakdown products of sulphur hexafluoride. However, no unambiguous link with exposure to sulphur tetrafluoride can be made, as other breakdown products may have added to the observed effects. Moreover, no relation with exposure levels is possible. Thus, due to its descriptive nature, the value of this study is very limited in the present context.

Animal data

The very few available studies with experimental animals showed sulphur tetrafluoride to be a highly acutely toxic gas.

In a review on fluorocarbons, Clayton also mentioned some data on sulphur tetrafluoride without providing the original sources and data. It is stated that single exposures to sulphur tetrafluoride at sublethal concentrations are largely without effect on the upper respiratory tract. Four hours of respiratory exposure to 19 ppm (86 mg/m^3) caused death in one of 2 exposed rats, while all 2 rats survived a 1-hour exposure to 40 ppm (180 mg/m^3). Further, rats repeatedly exposed to 4 ppm (18 mg/m^3; 4 hours/day for 10 days over a 12-day period) showed signs of 'respiratory embarrassment'. Two rats sacrificed immediately after the 10th exposure, showed pulmonary damage, while rats allowed to recover

for 14 days showed no clinical and anatomical lesion (Clay62). No data on, *e.g.*, number of rats exposed, sex, a dose-respons relation, and endpoints investigated are provided. Therefore, the committee is of the opinion that these data cannot be used for the derivation of a health-based recommended occupational exposure limit.

The commiteee did not find data on the toxicity of sulphur tetrafluoride following intermittent long-term repeated exposure by inhalation including carcinogenicity, on mutagenicity and genotoxicity, and on reproduction toxicity.

7 Existing guidelines

The current administrative occupational exposure limit (MAC) for sulphur tetrafluoride in the Netherlands is 0.1 ppm (0.4 mg/m^3), as a ceiling limit.

Existing occupational exposure limits for sulphur tetrafluoride in some European countries and in the USA are summarised in the annex.

8 Assessment of health hazard

The toxicological information available for sulphur tetrafluoride is very scanty. It allows the conclusion that the compound exerts severe local effects upon inhalation at rather low exposure levels, most probably due to respiratory tract irritation. Moreover, eye-irritating properties are suggested by a case study, in which workers were exposed to the breakdown products of sulphur hexafluoride.

ACGIH based its ceiling value on the review by Clayton (Cla62) in which it was reported that local effects in the respiratory tract were found in a rat study at 4 ppm (18 mg/m^3). However, no reference was made to an original source in this review paper. Furthermore, the ACGIH provides more details than Clayton.

The committee did not find other (animal) data on the toxicity of sulphur tetrafluoride following intermittent long-term repeated exposure by inhalation including carcinogenicity, and on reproduction toxicity. Neither data on mutagenicity and genotoxicity were found.

In view of the violent reaction of sulphur tetrafluoride with water, systemic exposure to this compound itself may be deemed negligible. Systemic exposure to hydrogen fluoride, sulphur dioxide, and thionyl dioxide - hydrolysis products - will, however, occur. It may be considered to evaluate the systemic toxic potential for sulphur tetrafluoride in relation to these metabolites, assuming maximal (worst case) hydrolysis first to thionyl dioxide and subsequently to hydrogen fluoride and sulphur dioxide. The first compound has been reviewed

by the committee (see Hea01), the latter two compounds by DECOS (DEC85, DEC89). However, since the latter two evaluations are dated, an update of the relevant literature should be performed.

With respect to thionyl fluoride, hardly anything is known about its toxicological properties (see Hea01). Its chemical reactivity with water appears to be less than that of sulphur tetrafluoride, which points to the possibility of systemic exposure. Ultimately, it will decompose to hydrogen fluoride and sulphur dioxide. However, before this decomposition is complete, thionyl-fluoride-specific systemic effects might arise. The health hazard of occupational sulphur tetrafluoride exposure can as yet not be assessed on this point.

The committee considers the toxicological data base on sulphur tetrafluoride too poor to justify recommendation of a health-based occupational limit.

The committee concludes that there is insufficient information to comment on the level of the present MAC-value.

References

ACG91 American Conference of Governmental Industrial Hygienists (ACGIH). Sulphur tetrafluoride. In: Documentation of the Threshold Limit Values and Biological Exposure Indices 6th ed. Cincinnati OH, USA: ACGIH, 1991: 1468-9.

ACG00 American Conference of Governmental Industrial Hygienists (ACGIH). Guide to occupational exposure values - 2000. Cincinnati OH, USA: ACGIH®, Inc, 2000: 114.

ACG01 American Conference of Governmental Industrial Hygienists (ACGIH). 2001 TLVs® and BEIs®. Threshold Limit Values for chemical substances and physical agents. Biological Exposure Indices. Cincinnati OH, USA: ACGIH®, Inc, 2001: 54.

Arb00a Arbejdstilsynet. Grænseværdier for stoffer og materialer. Copenhagen, Denmark: Arbejdstilsynet, 2000; (At-vejledning C.0.1).

Arb00b Arbetarskyddstyrelsen. Hygieniska gränsvärden och åtgärder mot luftföroreningar. Solna, Sweden: National Board of Occupational Safety and Health, 2000: 60; (Ordinance AFS 2000/3).

Bud89 Budavari S, O'Neil MJ, Smith A, *et al*, eds. The Merck Index. An encyclopedia of chemicals, drugs, and biologicals. 11th ed. Rahway NJ, USA: Merck & Co, Inc, 1989: 1414.

CEC00 Commission of the European Communities (CEC). Commission Directive 2000/39/EC of 8 June 2000 establishing a first list of indicative occupational exposure limit values in implementation of Council Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work. Official Journal of the European Communities 2000; L142 (16/06/2000): 47-50.

Cla62 Clayton JW. The toxicity of fluorocarbons with special reference to chemical constitution. J Occup Med 1962; 4: 262-273.

DEC85 Dutch Expert Committee on Occupational Standards (DECOS). Sulphur dioxide. The Hague, The Netherlands: Sdu, Servicecentrum Uitgevers, 1985; rep no RA4/85.

DEC89 Dutch Expert Committee on Occupational Standards (DECOS). Health-based recommended occupational exposure limits for fluorine, hydrogenfluoride and inorganic fluoride compounds.The Hague, The Netherlands: Sdu, Servicecentrum Uitgevers, 1989; rep no RA1/89.

DFG01 Deutsche Forschungsgemeinschaft (DFG): Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area. List of MAK and BAT values 2001.Maximum concentrations and biological tolerance values at the workplace. Weinheim, FRG: Wiley-VCH, 2001; (rep no 37).

Gri84 Griffin GD, Easterly CE, Sauers I, *et al.* Cytotoxic activity of spark-decomposed sulphur hexafluoride and analysis of cytotoxic contributions of individual spark decomposition products. Toxicol Environ Chem 1984; 9: 139-66.

Hea01 Health Council of the Netherlands: Committee on Updating of Occupational Exposure Limits. Health-based reassessment of administrative occupational exposure limits: thionyl chloride. The Hague, the Netherlands: Health Council of the Netherlands, 2001; rep no 2000/15OSH/028.

HSE01 Health and Safety Executive (HSE). EH40/2001. Occupational Exposure Limits 2001. Sudbury (Suffolk), England: HSE Books, 2001: 26.

Kra90 Kraut A, Lilis R. Pulmonary effects of acute exposure to degradation products of sulphur hexafluoride during electrical cable repair work. Br J Ind Med 1990; 47: 829-32.

Lun91 Lundberg P, ed. Consensus report for sulphur fluorides. In: Scientific basis for Swedish Occupational Standards XI. Arbete och Hälsa 1991; (8): 114-9.

NIO98 National Institute of Occupational Safety and Health (NIOSH). Sulfur tetrafluoride. In: Registry of Toxic Effects of Chemical Substances (RTECS) [CD-ROM], issue April 1998. SilverPlatter International, 1998 (last update sulphur tetrafluoride file: December 1997).

NLM98 US National Library of Medicine (NLM). Hazardous Substances Data Bank (HSDB) [CD-ROM], issue April 1998. SilverPlatter International.

SZW01 Ministerie van Sociale Zaken en Werkgelegenheid (SZW). Nationale MAC-lijst 2001. The Hague, The Netherlands: Sdu, Servicecentrum Uitgevers, 2001: 44.

TRG00 TRGS 900: Grenzwerte in der Luft am Arbeitsplatz; Technische Regeln für Gefahrstoffe. BArbBl 2000; 2.

Wea87 Weast RC, ed. CRC handbook of chemistry and physics. Boca Raton FL, USA: CRC Press, Inc, 1987: B-135.

Annex

Occupational exposure limits for sulphur tetrafluoride in various countries.

country -organisation	occupational exposure limit		time-weighted average	type of exposure limit	note[a]	lit ref[b]
	ppm	mg/m^3				
The Netherlands						
-Ministry of Social Affairs and Employment	0.1	0.4	ceiling	administrative		SZW01
Germany						
-AGS	-	-				TRG00
-DFG MAK-Kommission	-	-				DFG01
Great-Britain						
-HSE	0.1	0.45	8 h	OES		HSE01
	0.3	1.3	15 min			
Sweden	0,1	0,4	ceiling			Arb00b
Denmark	0,1	0,4	ceiling			Arb00a
USA						
-ACGIH	0.1	0.4	ceiling	STEL		ACG01
-OSHA	-					ACG00
-NIOSH	0.1	0.4	ceiling	REL-ceiling		ACG00
European Union						
-SCOEL	-	-				CEC00

[a] S = skin notation; this means that skin absorption may contribute considerably to body burden; sens = substance can cause sensitisation

[b] Reference to the most recent official publication of occupational exposure limits