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

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 (ACGIH91). 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, tetrafluorosulphuran, SF₄, 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 : SF₄
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<sub>octanol/water</sub> : 1.65 (estimated)
conversion factors :
(20°C, 101.3 kPa) 1 ppm = 4.5 mg/m
1 mg/m<sup>3</sup> = 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<sub>2</sub>). 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/m³) caused death in one of 2 exposed rats, while all 2 rats survived a 1-hour exposure to 40 ppm (180 mg/m³). Further, rats repeatedly exposed to 4 ppm (18 mg/m³; 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-response 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 committee 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


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


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### Annex

Occupational exposure limits for sulphur tetrafluoride in various countries.

<table>
<thead>
<tr>
<th>country - organisation</th>
<th>occupational exposure limit</th>
<th>time-weighted average</th>
<th>type of exposure limit</th>
<th>note&lt;sup&gt;a&lt;/sup&gt;</th>
<th>lit ref&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Netherlands - Ministry of Social Affairs and Employment</td>
<td>0.1 ppm, 0.4 mg/m&lt;sup&gt;3&lt;/sup&gt;</td>
<td>ceiling</td>
<td>administrative</td>
<td>Szw01</td>
<td></td>
</tr>
<tr>
<td>Germany - AGS - DFG MAK-Kommission</td>
<td>- ppm, - mg/m&lt;sup&gt;3&lt;/sup&gt;</td>
<td>-</td>
<td>-</td>
<td>TRG00, DFG01</td>
<td></td>
</tr>
<tr>
<td>Great-Britain - HSE</td>
<td>0.1 ppm, 0.45 mg/m&lt;sup&gt;3&lt;/sup&gt;, 0.3 ppm, 1.3 mg/m&lt;sup&gt;3&lt;/sup&gt;</td>
<td>8 h, 15 min</td>
<td>OES</td>
<td>HSE01</td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td>0.1 ppm, 0.4 mg/m&lt;sup&gt;3&lt;/sup&gt;</td>
<td>ceiling</td>
<td></td>
<td>Arb00b</td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>0.1 ppm, 0.4 mg/m&lt;sup&gt;3&lt;/sup&gt;</td>
<td>ceiling</td>
<td></td>
<td>Arb00a</td>
<td></td>
</tr>
<tr>
<td>USA - ACGIH - OSHA - NIOSH</td>
<td>0.1 ppm, 0.4 mg/m&lt;sup&gt;3&lt;/sup&gt;, 0.1 ppm, - mg/m&lt;sup&gt;3&lt;/sup&gt;</td>
<td>ceiling, -</td>
<td>STEL, REL-ceiling</td>
<td>ACG01, ACG00</td>
<td></td>
</tr>
<tr>
<td>European Union - SCOEL</td>
<td>- ppm, - mg/m&lt;sup&gt;3&lt;/sup&gt;</td>
<td>-</td>
<td>-</td>
<td>CEC00</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> S = skin notation; this means that skin absorption may contribute considerably to body burden; sens = substance can cause sensitisation

<sup>b</sup> Reference to the most recent official publication of occupational exposure limits

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