Disulfur decafluoride

(CAS reg no: 5714-22-7)

Health-based Reassessment of Administrative Occupational Exposure Limits

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

No. 2000/15OSH/022, The Hague, 13 November 2001

Preferred citation:
Health Council of the Netherlands: Committee on Updating of Occupational Exposure Limits. Disulfur decafluoride; Health-based Reassessment of Administrative Occupational Exposure Limits. The Hague: Health Council of the Netherlands, 2001; 2000/15OSH/022.

1 Introduction

The present document contains the assessment of the health hazard of disulfur decafluoride 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 MA Maclaine Pont, M.Sc. (Wageningen University, Wageningen, the Netherlands).

The evaluation of the toxicity of disulfur decafluoride has been based on the review by the American Conference of Governmental Industrial Hygienists (ACG99). Where relevant, the original publications were reviewed and evaluated as will be indicated in the text. In addition, literature was retrieved from the data bases Medline, Toxline, and Chemical Abstracts covering the period of 1966 until November 1999, 1981 until July 1999, and 1937 until September 1999, respectively, and using the following key words: sulfur pentafluoride, sulfur decafluoride, disulfurdecafluoride, sulphur pentafluoride, sulphur decafluoride, disulphurdecafluoride, sulfur fluoride (S_2F_{10}), and/or 5714-22-7. The final literature search has been carried out in November 1999.

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

2 Identity

name	:	disulfur decafluoride
synonyms	:	disulphurdecafluoride; sulfurdecafluoride; disulfur decafluoride; sulphurpentafluoride; sulphur pentafluoride; sulfurpentafluoride; sulfur pentafluoride
molecular formula	:	S_2F_{10}
structural formula	:	F_5SSF_5
CAS reg no	:	5714-22-7

Data from How92.

3 Physical and chemical properties

molecular weight	:	254.1
boiling point	:	29°C
melting point	:	-92°C
flash point	:	-
vapour pressure	:	at 20°C: 74.8 kPa
solubility in water	:	insoluble
log $P_{octanol/water}$	:	3.06 (estimated)
conversion factors (20°C, 101.3 kPa)	:	1 mg/m^3 = 0.09 ppm 1 ppm = 10.6 mg/m^3

Data from Che99, Lid96, Lun91, http://esc.syrres.com.

Disulfur decafluoride is a colourless, volatile liquid with a smell similar to that of sulfur dioxide (ACG99, Lun91).

The vapour of disulfur decafluoride is heavier than air. Upon heating above 400°C, it decomposes into toxic and corrosive fumes (among others sulfur oxides, fluor and sulfur fluorides) (Che99). Disulfur decafluoride does not react with water, mercury, copper, or platinum at ambient temperatures (Eib80). It is liberated as a by-product during the synthesis of sulfur hexafluoride; it is one of the minor decomposition products of sulfur hexafluoride upon electrical discharge (ACG99, Gri91).

4 Uses

No commercial uses for this compound have developed although it was once a candidate warfare agent (Gri91).

5 Biotransformation and kinetics

No data have been found.

6 Effects and mechanism of action

Human data

No data have been found.

Animal data

The committee did not find data on the potential skin and eye irritation and sensitisation of disulfur decafluoride.

Some acute lethal toxicity data are listed below.

LC_{50} inhalation during 10 min:		
mouse	:	1000 mg/m^3
rat	:	2000 mg/m^3
dog	:	4000 mg/m^3
rabbit	:	4000 mg/m^3
cat	:	4500 mg/m^3
monkey	:	9000 mg/m^3
LD_{lo} after intravenous injection:		
dog	:	1 mg/kg bw
LD_{50} after intravenous injection:		
rabbit	:	5.79 mg/kg

Data from Lew92, Sau53.

The effects of disulfur decafluoride on the lungs following acute inhalation exposure have been investigated by Greenberg and Lester (Gre50). When one rat was exposed to 18,868 mg/m^3 (1780 ppm), the animal died within 1 hour, showing pulmonary haemorrhages and considerably fluid-filled chest cavity. Exposure to 106 and 10.6 mg/m^3 (10, 1 ppm), for 1 hour, caused diffuse pulmonary haemorrhage and severe pulmonary congestion, respectively, in the rats (n=1/group) killed immediately after ending exposure while no lung lesions were seen in the animals (n=2/group) killed 24 hours later. No effects were observed after 1-hour exposure to 1.1 mg/m^3 (0.1 ppm). Using longer exposure periods, all 6 rats died within 16 hours when exposed to 10.6 mg/m^3 (1 ppm), the lungs being

extensively haemorrhaged and the chest cavities filled with fluid. No mortality was observed in rats (n=6) exposed to 5.3 mg/m^3 (0.5 ppm), for 18 hours. After exposure to 1.1 mg/m^3 (0.1 ppm), for 18 hours, the lungs of the rats (n=6) only showed generalised pinkness indicative of irritation, but there were no microscopic changes. No macro- or microscopic effects were observed after an 18-hour exposure to 0.1 mg/m^3 (0.01 ppm). Greenberg and Lester considered disulfur decafluoride to be more toxic than phosgene. They attributed the pulmonary lesions to products of local hydrolysis of the decafluoride, such as hydrofluoric acid.

After intravenous injection of single doses into dogs (1-20 mg/kg bw; n=1-3/dose) (see also table above), respiratory, blood pressure, and heart rate effects were found within 40 seconds after injection. Haematocrit values always immediately increased, reaching high levels at death. The cause of death - occurring after 1 to 170 minutes without showing a relationship between dose and onset of death - was fulminant pulmonary oedema. Other histological findings included endothelial damage to the cardiovascular system, thought to be the major effect finally leading to pulmonary oedema, and subtle exudative and proliferative changes in glomeruli resembling early acute glomerulonephritis, thought to be secondary to anoxic anoxia. Repeated intravenous injections of 0.5 and 1.0 mg/kg induced similar but more gradual effects on the circulatory and respiratory system, and, eventually, death. Histological findings were also similar but less severe than those found in singly doses animals (Sau53).

The committee did not find data on the effects of repeated exposure to disulfur decafluoride or on its potential genotoxicity, carcinogenicity or reproduction toxicity.

7 Existing guidelines

The current administrative occupational exposure limit (MAC) for disulfur decafluoride in the Netherlands is 0.1 mg/m^3, 8-hour TWA.

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

8 Assessment of health hazard

The few data available indicate that disulfur decafluoride is a primary lung irritant showing a rather steep dose-response relationship. One-hour exposures to 106

and 10.6 mg/m^3 (10 and 1 ppm) caused lung corrosion and irritation, respectively, while no effects were seen at 1.1 mg/m^3 (0.1 ppm). Sixteen- to 18-hour exposures to 10.6, 5.3, and 1.1 mg/m^3 (1, 0.5, 0.1 ppm) resulted in mortality, severe lung effects, and lung irritation, respectively, while there were no discernible effects at 0.1 mg/m^3 (0.01 ppm).

The committee did not find data on the effects of repeated exposure to disulfur decafluoride or on its potential genotoxicity, carcinogenicity or reproduction toxicity.

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

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

References

ACG99 American Conference of Governmental Industrial Hygienists (ACGIH). Sulfur pentafluoride. In: TLVs® and other occupational exposure values -1999. [CD-ROM]. Cincinnati OH, USA: ACGIH®, Inc, 1999.

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 fysical agents. Biological Exposure Indices. Cincinnati OH, USA: ACGIH®, Inc, 2001: 53.

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; Ordinance AFS 2000/3.

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.

Che99 Chemiekaarten: gegevens voor het veilig werken met chemicaliën/[ed by] Samenwerkingsverband-Chemiekaarten (TNO Arbeid, VNCI). 15th ed. The Hague, the Netherlands: ten Hagen & Stam, 1999.

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: 98 (rep no 37).

Eib80 Eibeck RE, Mears W. Fluorine compounds, inorganic; sulfur: sulfur fluorides. Grayson M, Eckroth D, ed. Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed. New York, USA: J Wiley, 1980; 10: 799-811.

Gre50 Greenberg LA, Lester D. The toxicity of sulfur pentafluoride. Arch Ind Hyg Occup Med 1950; 2: 350-2.

Gri91 Griffin GD, Ryan MS, Kurka K, *et al.* Disulfur decafluoride (S_2F_{10}): a review of the biological properties and experimental studies of the breakdown product of sulfur hexafluoride. Christophorou LG, Sauers I, ed. Gaseous Dielectr VI, Proc Int Symp, 6th. New York, USA: Plenum, 1991: 545-52.

How92 Howard PH, Neil M, ed. Dictionary of chemical names and synonyms. Chelsea MA, USA: Lewis Publishers, 1992.

HSE01 Health and Safety Executive (HSE). EH40/2001. Occupational Exposure Limits 2001. Sudbury (Suffolk), England: HSE Books, 2001: 17.

Lew92 Lewis RJ Sr, ed. Sax's dangerous properties of industrial materials. 8th ed. New York, USA: Van Nostrand Reinhold, 1992: 3167.

Lid96 Lide DR, Frederikse HPR, ed. CRC Handbook of chemistry and physics. 77th ed. Boca Raton FL, USA: CRC Press, 1996; **4**-88.

Lun91 Lundberg P, ed. Consensus report for sulfur fluorides. Arbete och Hälsa 1991; 8: 114-9.

Sau53 Saunders JP, Shoshkes M, De Carlo MR, *et al.* Some physiological effects of disulfur decafluoride (S_2F_{10}) after intravenous injection in dogs. A note on its toxicity to rabbits. AMA Arch Ind Hyg Occup Med 1953; 8: 436-45.

SZW01 Ministerie van Sociale Zaken en Werkgelegenheid (SZW). Nationale MAC-lijst 2001. The Hague, the Netherlands: Sdu, Servicecentrum Uitgevers, 2001: 25.

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

Annex

Occupational exposure limits for disulfur decafluoride 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	0.01	0.1	8 h	administrative		SZW01
Germany						
- AGS	0.025	0.25	15 min			TRG00
- DFG MAK-Kom.	0.025	0.26	8 h	MAK		DFG01
	0.025	0.26	15 min			
Great Britain						
- HSE	0.025	0.26	8 h	OEL		HSE01
	0.075	0.79	15 min	STEL		
Sweden	-	-				Arb00b
Denmark	0.01	0.1	ceiling			Arb00a
USA						
- ACGIH	0.01	-	ceiling	TLV		ACG01
- OSHA	0.025	0.25	8 h	PEL		ACG00
- NIOSH	0.01	0.1	ceiling	REL		ACG00
European Union						
- SCOEL	-	-				CEC00

[a] S = skin notation, which 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