Perchloryl Fluoride

(CAS reg no: 7616-94-6)

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 perchloryl fluoride 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 perchloryl fluoride 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 Toxline, Medline, and Chemical Abstracts, covering the period of 1981 until July 1999, 1966 until November 1999, and 1937 until September 1999, respectively, using the following key words: perchloryl fluoride, chlorine fluoride oxide, chlorine oxyfluoride, and 7616-94-6. 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	:	perchloryl fluoride
synonyms	:	chlorine fluoride oxide; chlorine oxyfluoride
molecular formula	:	$ClFO_3$
structural formula	:	-
CAS reg no	:	7616-94-6

Data from How92.

3 Physical and chemical properties

molecular weight	:	102.4
boiling point	:	-46.75°C
melting point	:	-147°C
flash point	:	nonflammable
vapour pressure	:	not found
solubility in water	:	at 25°C: 0.06 g/100 mL
Log $P_{octanol/water}$	:	-3.22 (estimated)
conversion factors (20°C, 101.3 kPa)	:	1 mg/m^3 = 0.23 ppm 1 ppm = 4.26 mg/m^3

Data from AGC99, Gre60, Lid96, http://esc.syrres.com.

Perchloryl fluoride is a colourless gas with a sweet odour. It is a noncorrosive, noncombustible gas, usually stored as a liquid under pressure in cylinders (AGC99). Odour thresholds of 43 and 175 mg/m^3 (10 and 40 ppm, resp) have been reported (ACG99, Gre60).

4 Uses

Perchloryl fluoride is used as a fluorinating agent in chemical syntheses and as a liquid oxidant in rocket fuels (AGC99). It can also be used as an insulator for high voltage systems (Bud96).

5 Biotransformation and kinetics

No data have been found.

6 Effects and mechanism of action

Human data

No data have been found.

Animal data

For $ClFO_3$, 4-hour LC_{50} values of 1640 and 2684 mg/m^3 (385, 630 ppm) have been determined for male rats (a derived Wistar strain) and female mice (CF-1), respectively (observation times: 7 and 14 days, resp). In the animals that died, laboured breathing, cyanosis, pronounced gasping, and convulsions were seen. Gross postmortem examination showed moderate discolouration of the blood and the viscera, especially the lungs, while microscopically there was marked congestion of the pulmonary vasculature with occasional small areas of alveolar haemorrhages. These changes were more pronounced in rats than in mice. In dogs (male; Beagle; n=2/group), there was no mortality at 4-hour exposures to 954 and 1810 mg/m^3 (224, 425 ppm). Exposures to 1921 mg/m^3 (451 ppm), for 4 hours, or to 2650 mg/m^3 (622 ppm), for 1.5 hours, were lethal to 1/2 dogs while the other animals survived thanks to a methaemoglobin-counteracting methylene blue therapy. In dogs, essentially the same toxic effects were found as those observed in rats and mice (Gre60).

Exposure to 21,300 mg/m^3 (5000 ppm) of $ClFO_3$ for 15 minutes and to 8520 mg/m^3 (2000 ppm) for 40 minutes was lethal to all rats (male; Sprague-Dawley; number unknown) while no mortality occurred at exposure to 8520 mg/m^3 (2000 ppm) for 25 minutes or to 4260 mg/m^3 1000 ppm for 60 minutes. In all exposed rats, methaemoglobinaemia was detected. In lethal exposures, it exceeded 60% of total haemoglobin (Dos74).

In repeated inhalation studies, exposure to 788 mg/m^3 (185 ppm), 6 hours/day, 5 days/week, for 7 weeks, was lethal to 10/10 guinea pigs (male) after 3 days of exposure, and to 18/20 rats (male; derived Wistar) and 20/39 mice (female; CF-1) after 35 days of exposure. In all animals, dyspnea and cyanosis were observed. In rats, additional changes observed included, amongst others, methaemoglobinaemia, extreme reticylocytosis, fluorosis of incisor teeth, patchy areas of consolidation in the lungs, alveolar oedema developing into bronchopneumonia, increased spleen weight, and splenic, hepatic, and renal haemosiderosis. A similar exposure to 443 mg/m^3 (104 ppm), for 6 weeks, caused mortality in 10/10 guinea pigs and in 1/20 rats after 25 days (mice were not exposed). Cyanosis was the primary sign of toxicity. Other changes observed in rats were similar to those seen at 788 mg/m^3 (185 pm), but less severe. When groups of 10 rats, 20 guinea pigs and 3 dogs (male; Beagle) were exposed to 0 or 102 mg/m^3 (24 ppm), 6 hours/day, 5 days/week, for 26 weeks, all rats and dogs survived. Fourteen of 30 exposed guinea pigs and 1/30 control animals died, but

this was attributed to infection by *Bordetella bronchiseptica*. Therefore, the results in the guinea pigs will not be discussed further. Urinary fluoride levels increased fourfold in dogs over the 6-month exposure period. The urinary fluoride levels fell to control values after discontinuation of the exposure. Quantitative data are not given. At the end of the exposure period, the fluoride content of the bone (femur) had increased by about 300% and 50% in rats and dogs, respectively, when compared to control values. The spleens of rats and dogs were congested and contained some iron-bearing pigments. During a 6-week recovery period, there was little decrease in fluoride content of the bones of rats but the spleen changes were no longer present in the rats and dogs. The lungs of these animals showed no effects (Gre60).

The committee did not find data on the potential mutagenicity/genotoxicity, carcinogenicity, or reproduction toxicity of perchloryl fluoride.

7 Existing guidelines

The current administrative occupational exposure limit (MAC) in the Netherlands is 14 mg/m^3, 8-hour TWA.

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

8 Assessment of health hazard

Based on a 4-hour rat LC_{50} of 1640 mg/m^3 (385 ppm), the committee considers perchloryl fluoride as 'toxic by inhalation'. After single inhalation exposure to lethal concentrations of perchloryl fluoride, rats and mice (4-hour LC_{50}: 2684 mg/m^3 or 630 ppm) showed, amongst others, cyanosis and convulsions. In repeated inhalation studies, all guinea pigs died when exposed to 443 or 788 mg/m^3 (104, 185 ppm) after 25 and 3 days of exposure, respectively. Exposure to 788 mg/m^3 *ca*. 50% of the mice while 19/20 rats survived exposure to 433 mg/m^3 (104 ppm) (mice were not exposed). Cyanosis was the primary sign of toxicity. Additional effects observed in rats were methaemoglobinaemia, reticulocytosis, fluorosis of teeth, lung changes (consolidation, oedema), splenomegaly, and haemosiderosis (in spleen, liver, kidneys). Exposure of rats and dogs to 102 mg/m^3 (24 ppm), for 26 weeks, did not induce mortality, but caused persistent increases in fluoride contents of the bone

and transient congestion and haemosiderosis of the spleen. Lung effects were also observed; methaemoglobinaemia was not investigated.

The committee considers the blood to be the target for toxicity.

The committee did not find data on the potential mutagenicity/genotoxicity, carcinogenicity, or reproduction toxicity of perchloryl fluoride.

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

The committee concludes that the present MAC-value of 14 mg/m^3 may be too high considering effects observed in rats and dogs after exposure to 102 mg/m^3 (24 ppm), for 26 weeks.

References

ACG99 American Conference of Governmental Industrial Hygienists (ACGIH). Perchloryl fluoride. 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: 96.

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: 46.

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.

Bud96 Budavari S, O'Neill MJ, Smith A, *et al.* The Merck index. An encyclopedia of chemicals, drugs, and biologicals. 12th ed. Whitehouse Station NJ, USA: Merck & Co, 1996; 1231.

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.

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.

Dos74 Dost FN, Reed DJ, Smith VN, *et al.* Toxic properties of chlorinetrifluoride. Toxicol Appl Pharmacol 1974; 27: 527-36.

Gre60 Greene EA, Colbourne JL, Donati E, *et al.* The inhalation toxicity of perchoryl fluoride. US Army Chem Res Devel Lab, Techn Rep CRDLR 3010; 1960, 24 pp.

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: 23.

Lid96 Lide DR, Frederikse HPR, ed. CRC Handbook of chemistry and physics. 77th ed. Boca Raton FL, USA: CRC Press, 1996; **4**-51.

SZW01 Ministerie van Sociale Zaken en Werkgelegenheid (SZW). Nationale MAC-lijst 2001. The Hague, the Netherlands: Sdu, Servicecentrum Uitgevers, 2001: 37.

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

Annex

Occupational exposure limits for perchloryl fluoride 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	3	14	8 h	administrative		SZW01
Germany						
- AGS	-	-				TRG00
- DFG MAK-Kom.	-	-				DFG01
Great Britain						
- HSE	3	13	8h	OEL		HSE01
	6	26	15 min			
Sweden	-	-				Arb00b
Denmark	3	14	8 h			Arb00a
USA						
- ACGIH	3	-	8 h	TLV		ACG01
	6	-	15 min	STEL		
- OSHA	3	13.5	8 h	PEL		ACG00
- NIOSH	3	14	10 h	REL		ACG00
	6	28	15 min	STEL		
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