
Oxygen difluoride

(CAS No: 7783-41-7)

Health-based Reassessment of Administrative Occupational Exposure Limits

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

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1 Introduction

The present document contains the assessment of the health hazard of oxygen difluoride 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 and Research Centre, Wageningen, the Netherlands).

The evaluation of the toxicity of oxygen difluoride has been based on the review by the American Conference of Governmental Industrial Hygienists (ACGIH) (ACG91). Where relevant, the original publications were reviewed and evaluated as will be indicated in the text. In addition, in December 1999, literature was searched in the databases Toxline, Medline, and Chemical Abstracts, starting from 1981, 1966, and 1937, respectively, and using the following key words: oxygen difluoride, fluorine monoxide, oxygen fluoride, fluorine oxide, and 7783-41-7.

In February 2001, the President of the Health Council released a draft of the document for public review. No comments were received.

An additional search in Toxline and Medline in January 2004 did not result in information changing the committee's conclusions.

2 Identity

name	:	oxygen difluoride
synonyms	:	difluorine monoxide; fluorine monoxide; fluorine oxide; oxygen fluoride
molecular formula	:	F ₂ O
CAS number	:	7783-41-7

3 Physical and chemical properties

molecular weight	:	54
boiling point	:	-145°C
melting point	:	-224°C
flash point	:	-
vapour pressure	:	at 20°C: >> 100 kPa
solubility in water	:	slightly soluble
log P _{octanol/water}	:	-1.03 (estimated)
conversion factors	:	at 20°C, 101.3 kPa: 1 mg/m ³ = 0.44 ppm 1 ppm = 2.25 mg/m ³

Data from ACG91, NLM04, <http://esc.syrres.com>.

Oxygen difluoride is an unstable, colourless gas, yellowish-brown when liquid, with a foul odour (ACG91). Odour thresholds of 0.2-1.0 mg/m³ (0.1-4 ppm) have been reported (Amo83, Rut86).

It reacts explosively with even mild reducing agents. Upon decomposition, it forms HF and CO (ACG91).

4 Uses

Oxygen difluoride has been used as an oxidiser for rocket propellants (ACG91).

5 Biotransformation and kinetics

The committee did not find data on the biotransformation and kinetics of oxygen difluoride.

6 Effects and mechanism of action

Human data

Personnel inadvertently exposed to oxygen difluoride during experiments in which animals were exposed to concentrations of 0.2-22 mg/m³ (0.1-10 ppm) suffered from severe headache (no details presented) (ACG91).

Animal data

The committee did not find data from studies on the eye and skin irritation or sensitisation of oxygen difluoride.

One-hour LC₅₀ values were 3.4, 5.9, 58.5, and 58.5 mg/m³ (1.5, 2.6, 26, and 26 ppm) in male rats, male mice, male and female dogs, and male and female monkeys, respectively (Dar72, Dav70, Ver77). Signs of toxicity observed were tachypnoea and muscular weakness in rats and mice and gagging, lachrymation, salivation, dyspnoea, muscular weakness, vomiting, and tetany in dogs and monkeys. Macroscopic changes included massive pulmonary oedema and haemorrhage, as the most characteristic changes, as well as liver, spleen, and kidney congestion at lethal concentrations and slight to moderate lung congestion and oedema at sublethal levels (Dav70). All 10 rats survived exposures to 22.5 mg/m³ (10 ppm) for 5 minutes and to 11.3 mg/m³ (5 ppm) for 15 minutes. Five-minute exposures to 45, 67.5, and 90 mg/m³ (20, 30, and 40 ppm) were lethal to 7/10, 9/10, and 10/10 rats, respectively, while 7/10 and 7/10 rats died following 15-minute exposures to 22.5 and 33.8 mg/m³ (10 and 15 ppm), respectively. Animals generally died within about 10 to 60 hours after exposure. Apart from overt respiratory distress immediately prior to death, Lester and Adams did not observe any evidence of irritation of the external mucosa or any indication of respiratory embarrassment. Gross and microscopic examination only revealed lung injury, mainly concerning the alveolar rather than the bronchiolar or bronchial epithelium. In animals killed 5 minutes to 29 hours after being exposed to 45 mg/m³ (20 ppm) for 5 minutes, lesions of some severity were observed after 7 hours, were distinctive at 14 hours, and included severe diffuse acute pneumonia by 29 hours (Les65).

Referring to a report from 1945, it was stated that exposure to 1.1 mg/m³ (0.5 ppm), 7 hours/day, for 2 days, was lethal to a wide variety of experimental animals (see also below). Besides effects on the respiratory tract, kidney, and internal genitalia injury were reported (no more data presented) (ACG91). Citing the same report, repeated exposure of mice, rats, guinea pigs, rabbits, and dog to 0.23 mg/m³ (0.1 ppm), 7 hours/day, for 30 days, was said to produce no evidence of toxicity. At higher concentrations (4.5-11.3 mg/m³ or 2-5 ppm), there was some variability in toxicity with species and age with older mice being more resistant (no further data presented) (Ano67) [the committee noted that these data were not quoted in ACG91].

Davis studied the induction of oxygen difluoride tolerance in mice by 1-hour pre-exposures to 0.7, 1.1, and 2.3 mg/m³ (0.25, 0.5, and 1.0 ppm) and 1-hour re-exposures to multilethal concentrations at various periods up to 24 days post-

exposure. No significant tolerance was observed at the lower induction concentrations. In mice exposed to 7.9-9.6 mg/m³ (3.5-4.3 ppm) 24 hours, 8 days, or 24 days after exposure to 2.3 mg/m³ (1 ppm), mortality was 60, 10, and 50%, respectively, compared to 100% in animals not pre-exposed, suggesting that tolerance can be produced when the induction concentration is near lethal levels (Dav70).

There are indications that oxygen difluoride does not induce methaemoglobinaemia in rats (Dos68).

The committee did not find data on long-term exposure, mutagenicity, genotoxicity, carcinogenicity, and reproduction toxicity of oxygen difluoride.

7 Existing guidelines

The current administrative occupational exposure limit (MAC) for oxygen difluoride in the Netherlands is 0.1 mg/m³, which is a ceiling value.

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

8 Assessment of health hazard

Oxygen difluoride is a hazard from a chemical and a toxicological point of view. It reacts explosively with even mild reducing agents.

The committee did not find data on the biotransformation and kinetics of oxygen difluoride.

In man, exposure to concentrations of 0.2-22 mg/m³ (0.1-10 ppm) caused severe headache.

In experimental animals, 1-hour LC₅₀ values were 3.4, 5.9, 58.5, and 58.5 mg/m³ (1.5, 2.6, 26, and 26 ppm) in rats, mice, dogs, and monkeys, respectively, death being due to severe pulmonary oedema and haemorrhage.

Exposure to 1.1 mg/m³ (0.5 ppm), 7 hours/day, for 2 days, was lethal to mice, rats, guinea pigs, rabbits, and dog while no effects were seen after exposure to 0.23 mg/m³ (0.1 ppm), for 30 days. However, the committee considers that these very limitedly reported data from a study performed in 1945 cannot be used in deriving a health-based occupational exposure limit.

The committee did not find data on long-term exposure, mutagenicity, genotoxicity, carcinogenicity, and reproduction toxicity of oxygen difluoride.

The committee considers the toxicological database on oxygen difluoride too poor to justify recommendation of a health-based occupational exposure limit.

Since serious pulmonary effects have been found at a 10-fold higher concentration, the committee concludes that the present MAC-value of 0.1 mg/m³, as a ceiling value, is too high.

References

- ACG91 American Conference of Governmental Industrial Hygienists (ACGIH). Oxygen difluoride. In: Documentation of the threshold limit values and biological exposure indices. 6th ed. Cincinnati, Ohio, USA: ACGIH®, 1991: 1153-4.
- ACG03 American Conference of Governmental Industrial Hygienists (ACGIH). Guide to occupational exposure values - 2003. Cincinnati OH, USA: ACGIH®, 2003: 102.
- ACG04 American Conference of Governmental Industrial Hygienists (ACGIH). 2004 TLVs® and BEIs® based on the documentation of the Threshold Limit Values for chemical substances and physical agents & Biological Exposure Indices. Cincinnati OH, USA: ACGIH®, 2004: 43.
- Amo83 Amoores JE, Hautala E. Odor as an aid to chemical safety: odor thresholds compared with Threshold Limit Values and volatilities for 214 industrial chemicals in air and water dilution. *J Appl Toxicol* 1983; 3: 272-90.
- Ano67 Anonymous. Hygienic guide series. Oxygen difluoride (fluorine monoxide). *Am Ind Hyg Assoc J* 1967; 28: 194-6.
- Arb02 Arbejdstilsynet. Grænseværdier for stoffer og materialer. Copenhagen, Denmark: Arbejdstilsynet, 2002: 23 (At-vejledning C.0.1).
- Dar72 Darmer KI Jr, Haun CC, MacEwen JD. The acute inhalation toxicology of chlorine pentafluoride. *Am Ind Hyg Assoc J* 1972; 33: 661-8.
- Dav70 Davis HV. Acute toxicity of oxygen difluoride. Wright-Patterson Air Force Base OH, USA: Aerospace Medical Research Laboratory, 1970; rep no AMRL-TR-70-102, paper no 21 (In: Proceedings of the 1st Annual Conference on Environmental Toxicology, Fairborne OH, USA, September 9-11, 1970: 329-40).
- DFG03 Deutsche Forschungsgemeinschaft (DFG): Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area. List of MAK and BAT values 2003. Maximum concentrations and biological tolerance values at the workplace. Weinheim, FRG: Wiley-VCH Verlag & Co. KGaA, 2003; rep no 39.
- Dos68 Dost FN, Reed DJ, Wang CH. The mechanism of methemoglobin formation in nitrogen trifluoride intoxication (abstract). *Fed Proc* 1968; 27: 466.
- EC04 European Commission: Directorate General of Employment and Social Affairs. Occupational exposure limits (OELs); http://europe.eu.int/comm/employment_social/health_safety/areas/oels_en.htm.
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- HSE02 Health and Safety Executive (HSE). EH40/2002. Occupational Exposure Limits 2002. Sudbury (Suffolk), England: HSE Books, 2002.
- Les65 Lester D, Adams WR. The inhalational toxicity of oxygen difluoride. *Am Ind Hyg Assoc J* 1965; 26: 562-7.
- NLM04 US National Library of Medicine (NLM), ed. Fluorine monoxide. In: The Hazardous Substances Data Bank (HSDB) (last revision data fluorine monoxide file: January 2003; last review date: January 1998); <http://toxnet.nlm.nih.gov>.
- Rut86 Ruth JH. Odor thresholds and irritation levels of several chemical substances: a review. *Am Ind Hyg Assoc J* 1986; 47: A142-51.
- Swe00 Swedish National Board of Occupational Safety and Health. Occupational exposure limit values and measures against air contaminants. Solna, Sweden: National Board of Occupational Safety and Health, 2000; Ordinance AFS 2000:3.
- SZW04 Ministerie van Sociale Zaken en Werkgelegenheid (SZW). Nationale MAC-lijst 2004. The Hague, the Netherlands: Sdu Uitgevers, 2004: 44.
- TRG03 TRGS 900. Grenzwerte in der Luft am Arbeitsplatz; Technische Regeln für Gefahrstoffe. BArBl 2003; (9).
- Ver77 Vernot EH, MacEwen JD, Haun CC, et al. Acute toxicity and skin corrosion data for some organic and inorganic compounds and aqueous solutions. *Toxicol Appl Pharmacol* 1977; 42: 417-23.
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Annex

Occupational exposure limits for oxygen difluoride in various countries.

country - organisation	occupational exposure limit		time-weighted average	type of exposure limit	note ^a	reference ^b
	ppm	mg/m ³				
the Netherlands - Ministry of Social Affairs and Employment	0.05	0.1	ceiling	administrative		SZW04
Germany - AGS	-	-				TRG03
- DFG MAK-Kommission	-	-				DFG03
Great Britain - HSE	-	-				HSE00
Sweden - HSE	-	-				Swe00
Denmark - HSE	0.05	0.1	ceiling			Arb02
USA - ACGIH	0.05	-	ceiling	TLV		ACG04
- OSHA	0.05	0.1	8 h	PEL		ACG03
- NIOSH	0.05	0.1	ceiling	REL		ACG03
European Union - SCOEL	-	-				EC04

^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.

