Aluminium alkyl compounds

(CAS No: 97-93-8, 100-99-2, 96-10-6, 563-43-9)

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 aluminium alkyl compounds 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 AAE Wibowo, Ph.D. (Coronel Institute of the Academic Medical Centre, Amsterdam, the Netherlands).

Literature was retrieved from the databases Medline, Chemical Abstracts, and Embase (starting from 1966, 1970, and 1988, respectively), and Poltox (Toxline, Cambridge Sc Abst, FSTA; from 1994 backwards), HSEline, and NIOSHTIC (from 1997 backwards), using the following key words: trialkylaluminum, alkylaluminum, triethylaluminum, triisobutylaluminum, chlorodiethylaluminum, dichloroethylaluminum. The final literature search was carried out in December 1997.

In February 1999, the President of the Health Council released a draft of the document for public review. The committee received no comments.

An additional literature search in May 2002 did not result in information changing the committee's conclusions.

2 Identity

The group of aluminium alkyl compounds includes trialkylaluminium compounds (R_3Al), alkylaluminium halides ($[R_nAlX_{3-n}]_2$, n=1, 2), and alkylaluminium sesquihalides ($R_3Al_2X_3$).

The industrially most important compounds are:

name	formula	CAS number
triethylaluminium	$(C_2H_5)_3Al$	97-93-8
triisobutylaluminium	$[(CH_3)_2CHCH_2]_3Al$	100-99-2
chlorodiethylaluminium (synonym: diethylaluminium chloride)	$(C_2H_5)_2$-AlCl	96-10-6
dichloroethylaluminium (synonym: ethylaluminium dichloride)	$C_2H_5AlCl_2$	563-43-9

Data from Bud89.

3 Physical and chemical properties

The following physical and chemical properties are reported (Bud89):

compounds	molecular weight	boiling point (°C)	melting point (°C)
triethylaluminium	114.17	194	-
triisobutylaluminium	198.33	at 1.3 kPa: 86	6
chlorodiethylaluminium	120.56	at 6.5 kPa: 127	-
dichloroethylaluminium	126.95	at 6.5 kPa: 113	32

The partition coefficients (log $P_{octanol/water}$) of these compounds are not known.

At room temperature, the trialkylaluminium compounds are colourless liquids; the triethyl derivative exists as a dimer, the triisobutyl derivative primarily as a monomer. Chlorodiethyl- and dichloroethylaluminium are a colourless volatile liquid and a solid, respectively, strongly associated forming dimers, held together by bridging halogen bonds. The aluminium alkyl compounds are highly reactive compounds. They react violently with water and are sensitive to oxidation and hydrolysis in air. The compounds ignite spontaneously in air (Bud89). Miura et al. reported that the vapour of triethylaluminium ignites at less than the freezing point at concentrations of more than 0.15 ppm in air (Miu72).

4 Uses

Aluminium alkyl compounds are used as catalysts, with compounds of early transition metals as Ziegler-Natta polymerisation catalysts and as intermediates in organic synthesis.

5 Biotransformation and kinetics

The committee did not find data on the (toxico)kinetics of aluminium alkyl compounds.

6 Effects and mechanism of action

Human data

The committee did not find data on effects in humans due to exposure to aluminium alkyl compounds.

Animal data

There is only one paper available describing inhalation experiments with triethylaluminium in mice, rats, and rabbits (Miu72). However, the results can not be used for determining a health-based occupational exposure limit because the administered vapour consisted of various unknown combustion products of triethylaluminium due to the reactivity of the compound.

The committee did not find data from repeated-dose toxicity studies, including carcinogenicity and reproduction toxicity, or on genotoxicity or mutagenicity studies on aluminium alkyl compounds.

7 Existing guidelines

The current administrative occupational exposure limit (MAC) of aluminium alkyl compounds in the Netherlands is 2 mg/m^3 as Al, 8-hour TWA.

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

8 Assessment of health hazard

There are no human data and the only animal study performed can not be used for recommending a health-based occupational exposure limit due to the presence of unknown combustion products of triethylaluminium.

In fact, the committee is of the opinion that an occupational exposure limit for aluminium alkyl compounds is irrelevant because, in practice, there will be no exposure to airborne aluminium alkyl compounds. These compounds are so highly reactive that they ignite spontaneously in air. Therefore, aluminium alkyl compounds are stored in airless, inert, and stable atmospheres, and are not kept in open air. In case of instigating an air monitoring program, the committee

recommends to measure aluminium oxide levels in air which is the product of ignition.

The committee considers the toxicological database on aluminium alkyl compounds 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

ACG02a American Conference of Governmental Industrial Hygienists (ACGIH). Guide to occupational exposure values - 2002. Cincinnati OH, USA: ACGIH®, Inc, 2002: 5.

ACG02b American Conference of Governmental Industrial Hygienists (ACGIH). 2002 TLVs® and BEIs®. Threshold Limit Values for chemical substances and fysical agents. Biological Exposure Indices. Cincinnati OH, USA: ACGIH®, Inc, 2002: 14.

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

Arb00b Arbetarskyddsstyrelsen. Hygieniska gränsvärden och åtgärder mot luftföroreningar. Solna, Sweden: Arbetarskyddsstyrelsen, 2000; Ordinance AFS 2000:3.

Bud89 Budavari S, O'Neil MJ, Smith A, et al, eds. In: The Merck Index. An encyclopedia of chemicals, drugs, and biologicals. Rahway NJ, USA: Merck & Co, Inc, 1989: 54-5.

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.

DFG02 Deutsche Forschungsgemeinschaft (DFG): Senatskommission zur Prüfung gesundheitsschädlicher Arbeitsstoffe. MAK- und BAT-Werte-Liste 2002. Maximale Arbeitsplatzkonzentrationen und Biologische Arbeitsstofftoleranzwerte. Weinheim, FRG: Wiley-VCH, 2002; rep no 38.

HSE02 Health and Safety Executive (HSE). EH40/2002. Occupational exposure limits 2001. Sudbury (Suffolk), England: HSE Books, 2002.

Miu72 Miura T, Nakajima T, Hara I, et al. Studies on the toxicity of triethylaluminum (TEA). Intern Arch Arbeitsmed 1972; 29: 189-200.

SZW02 Ministerie van Sociale Zaken en Werkgelegenheid (SZW). Nationale MAC-lijst 2002. The Hague, the Netherlands: Sdu, Servicecentrum Uitgevers, 2002: 16.

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

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Annex

Occupational exposure limits for aluminium alkyl compounds in various countries.

country -organisation	occupational exposure limit[a]		time-weighted average	type of exposure limit	note[b]	reference[c]
	ppm	mg/m^3				
the Netherlands						
-Ministry of Social Affairs and Employment	-	2	8 h	administrative		SZW02
Germany						
-AGS	-	-				TRG00
-DFG MAK-Kommission	-	-				DFG02
Great-Britain						
-HSE	-	2	8 h	OES		HSE02
Sweden	-	-				Arb00b
Denmark	-	2	8 h			Arb00a
USA						
-ACGIH	-	2	8 h	TLV		ACG02b
-OSHA	-	-				ACG02a
-NIOSH	-	2	10 h	REL		ACG02a
European Union						CEC00
-SCOEL	-	-				

[a] In all cases, exposures are measured as Al.

[b] S = skin notation; which mean that skin absorption may contribute considerably to body burden; sens = substance can cause sensitisation.

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