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Arbejdsrapport fra Miljøstyrelsen

Alternatives to brominated flame retardants

Screening for environmental and health data

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The Danish Environmental Protection Agency will, when opportunity offers, publish reports and contributions relating to environmental research and development projects financed via the Danish EPA.

Please note that publication does not signify that the contents of the reports necessarily reflect the views of the Danish EPA.

The reports are, however, published because the Danish EPA finds that the studies represent a valuable contribution to the debate on environmental policy in Denmark.

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1 Preamble

The Danish Environmental Protection Agency has requested COWI Consulting Engineers and Planners to screen the readily available literature and databases for information on environmental and health properties for alternatives to brominated flame retardants.

The present project compiles data of environmental and health effects of alternatives to brominated flame retardants. The selected compounds have previously been identified in "Brominated Flame Retardants", Danish Environmental Protection Agency, 1999.

Table 1
Compounds covered by screening for environmental and health data.
Stoffer omfattet af screening for miljø- og sundhedsdata.

Trivial name	CAS no.
Triphenyl Phosphate	115-86-6
Tricresyl Phosphate	1330-78-5
Resorcinol bis(diphenylphosphate)	57583-54-7
Phosphonic acid (dimethyl ester)	20120-33-6
Aluminium Trihydroxide	21645-51-2
Magnesium Hydroxide	1309-42-8
Ammonium Polyphosphate	14728-39-9 and 68333-79-9
Red Phosphorus	7723-14-0
Zinc Borate	1332-07-6
Melamine	108-78-1
Antimontrioxide	1309-64-4
Quinidincarbonate	Not available

The project was carried out by COWI Consulting Engineers and Planners A/S by a project group comprising Frank Stuer-Lauridsen (project manager), Morten Birkved, Sven Havelund and Sonja Mikkelsen.

2 Summary

The Danish Environmental Protection Agency has initiated several projects on flame retardants. The present project is a screening of the reviews, handbooks and readily available literature and databases for information on environmental and health properties for a number of alternatives to brominated flame retardants.

The selected compounds have previously been identified in the project "Brominated Flame Retardants", Danish Environmental Protection Agency, 1999.

Table 2.1
Covered compounds and availability of environmental and health data. Poor, medium and good refers to a (subjective) assessment of the availability of data. It is not an evaluation of the quality of the data, nor whether sufficient data is available for a complete health and environmental assessment.

Trivial name	CAS no.	Physical-chemical	Health	Environment
Triphenyl Phosphate	115-86-6	Good	Good	Good
Tricresyl Phosphate	1330-78-5	Good	Poor (formulation data)	Poor (formulation data
Resorcinol bis(diphenylphosphate)	57583-54-7	Poor	Poor	Poor
Phosphonic acid (dimethyl ester)	20120-33-6	Poor	Poor	Poor
Aluminium Trihydroxide	21645-51-2	Medium	Poor (partly data on aluminium)	Poor (partly data on aluminium)
Magnesium Hydroxide	1309-42-8	Medium	Poor	Poor
Ammonium Polyphosphates	14728-39-9 and 68333-79-9	Poor	Poor	Poor (formulation data)
Red Phosphorus	7723-14-0	Medium	Medium (different allotropic forms)	Medium (different allotropic forms)
Zinc Borate	1332-07-6	Poor	Poor (data for boric acid and zinc)	Poor (data for sodium borate and zinc)
Melamine	108-78-1	Good	Medium	Medium
Antimontrioxide	1309-64-4	Good	Good	Good
Quinidincarbonate	Not available	Poor	Poor	Poor (data from quinidine sulphate)

Data availability

The data availability is very variable among the suggested alternatives for brominated flame retardants. In the screening project information is col-

lected based in the name or CAS number of the suggested compound. Therefore, a precise match of name and number is required and as shown in the table above a poor availability of data is not uncommon. However, if the compound is a slight modification of another compound or belongs to a family of related compounds it is possible that useful information can be obtained by searching for information on such compounds in a more comprehensive project (e.g. in the case of quinidine carbonate).

Several of the inorganic compounds are salts of metals and may dissociate in the hydrosphere. To some extent the lack of data on the selected compounds may be ameliorated by using data on the parent metal. In the case of zinc borate this is, however, somewhat complicated since both zinc and boric acid may contribute to the combined toxicity.

The type of data that are missing varies between compound. Typically missing data on the environment side are biodegradation data and bioaccumulation data. On the health side a less clear pattern is observed.

Triphenyl and tricresyl phosphates, resorcinol

The available data indicate that the triphenyl and tricresyl phosphates may have low impact on health, but are quite toxic in the environment. Poor data availability for the structurally related resorcinol prohibits conclusions regarding the effect pattern.

Phosphonic acid (dimethyl ester)

For this compound only very few data was identified. The phosphonic acid (dimethyl ester) appears acutely toxic at 13 mg/kg bodyweight in rats and mutagenic effects has been reported. A formulation of the compound was lethal to fish (LC_{50}) at approx. 1 ml/l (density unknown).

Aluminium trihydroxide, magnesium hydroxide

The data sets on these compounds are relatively limited. It appears that limited toxic effects can be induced in mammals after exposure to high doses. Aluminium trihydroxide is generally not toxic in the available tests. Both metal-ions play a metabolic role in mammals, but the data for the metal-ions indicates acute toxic levels for Al to fish and crustaceans at <1-10 mg/l and approx. 65 mg/l for crustaceans exposed to Mg.

Red phosphorus

Red phosphorus data are limited and conclusions are unclear. The yellow phosphorus is reportedly acutely toxic to humans (fatal dose 1 mg/kg), but the red allotropic form is described as less toxic. Acute toxic concentrations ($LC_{50\ or}\ EC_{50}$) of unspecified allotropic form in the aquatic environment occurs at 0.009 – 0.012 mg/l for fish and crustaceans.

Zinc borate

There is practically no data on the compound. Based on comparison with sodium borate and boric acid the possible main effects in humans are expected to be irritation of skin, eyes and throat, and harm to the unborn child. In the environment zinc-ion is very toxic to crustaceans.

Melamine

Melamine seems to be only mildly toxic when ingested by animals. The available data does not show evidence of cancer induction by melamine. One experiment indicates that melamine may be harmful to crustaceans, but otherwise the reviewed toxicity data show little aquatic toxicity.

The bioaccumulation of this compound is presumably low in the natural pH range (pH 6-8). The available biodegradation data indicates that this compound is persistent both under aerobic and anaerobic conditions.

Antimony trioxide

Antimony trioxide is in the EU classified as "Harmful (Xn)" and must be labelled with the risk-phrase "Possible risk of irreversible effects" (R40) due

to possible carcinogenicity. The substance is reported as teratogenic. The effects in ecotoxicological test are primarily on algae (ranging from very toxic to harmful), but toxicity in crustaceans or fish is very low.

Quinidine carbonate

No data was identified on quinidine carbonate for health or environmental properties. The toxicity of quinidine carbonate estimated from the toxicity of quinidine sulfate indicates that quinidine carbonate could be harmful to crustaceans, but not to fish.

3 Sammenfatning på dansk

Miljøstyrelsen har igangsat flere projekter vedrørende flammehæmmere og deres alternativer. For 12 kemiske alternativer til bromerede flammehæmmere er der i nærværende projekt gennemført en indsamling af information om stoffernes fysisk-kemiske, sundheds- og miljømæssige egenskaber baseret på oversigtslitteratur, håndbøger, databaser og anden let tilgængelig information.

De valgte stoffer er identificeret i et tidligere projekt "Brominated Flame Retardants", Miljøstyrelsen, 1999.

Tabel 3.1
De omfattede stoffer og tilgængeligheden af fysisk-kemiske, sundheds- og miljømæssige data. Ringe, medium og god henviser til en (subjektiv) vurdering af data tilgængelighed. Det er ikke en vurdering af datakvalitet eller om data er tilstrækkelige til en komplet miljø- og sundhedsvurdering.

Trivial navn	CAS nr.	Fysisk-kemisk	Sundhed	Miljø
Triphenylphosphat	115-86-6	God	God	God
Tricresylphosphat	1330-78-5	God	Ringe (visse data på formulering)	Ringe (data på formulering)
Resorcinol bis(diphenylphosphat)	57583-54-7	Ringe	Ringe	Ringe
Phosphonsyre (dimethyl ester)	20120-33-6	Ringe	Ringe	Ringe
Aluminiumtrihydroxid	21645-51-2	Medium	Ringe (delvist data fra aluminium)	Ringe (delvist data fra aluminium)
Magnesiumhydroxid	1309-42-8	Medium	Ringe	Ringe
Ammoniumpolyphosphater	14728-39-9 og 68333-79-9	Ringe	Ringe	Ringe (data på formulering)
Rød phosphor	7723-14-0	Medium	Medium (forskellige allotrope former)	Medium (forskellige allotrope former)
Zink Borat	1332-07-6	Ringe	Ringe (data for natrium borat og zink)	Ringe (data for natrium borat og zink)
Melamin	108-78-1	God	Medium	Medium
Antimontrioxid	1309-64-4	God	God	God
Quinidinkarbonat	Ikke oplyst	Ringe	Ringe	Ringe (data fra quinidinsulfat)

Datatilgængelighed

Datatilgængelighed er meget varierende blandt de screenede alternativer til bromerede flammehæmmere. I et screeningsprojekt indsamles information

på basis af stoffets navn og CAS nummer. Derfor fremkommer primært informationer, hvor navn eller nummer passer præcist sammen, og som det kan ses i tabellen ovenfor er ringe datatilgængelighed ikke ukendt. Imidlertid er det ofte således, at et andet næsten identisk stof med et ændret navn og nummer findes, og manglende information kan eventuelt kan suppleres fra sådanne stoffer (se f.eks. quinidinkarbonat). Dette kræver dog en mere omfattende informationssøgningsstrategi end det er muligt i et screeningsprojekt.

De uorganiske stoffer er salte af metaller og kan derfor opløses i vandmiljøet som positivt og negativt ladede ioner. I et vist omfang kan manglende data på det valgte stof afhjælpes ved at anvende data indhentet på metalionen. I tilfældet med zinkborat er det dog ikke umiddelbart så simpelt, idet både zinkionen og borsyren formodentlig bidrager til den samlede toksicitet.

Det er ikke samme type data som generelt mangler. Især på sundhedssiden spores ikke noget mønster. På miljøsiden mangler dog oftest data på bionedbrydning og bioakkumulation.

Triphenyl og tricresyl phosphater, resorcinol

De tilgængelige data indikerer, at triphenyl- og tricresylphosphater formodentlig har lille påvirkning af sundheden, men at de er relavitvt giftige i vandmiljøet. Der er så få data på den strukturelt beslægtede resorcinol at der ikke kan drages nogen konklusion vedrørende miljø- og sundhedseffekter.

Phosphonsyre (dimethyl ester)

For dette stof er der kun identificeret få data. Phosphonsyre (dimethyl ester) er akut giftigt ved 13 mg/kg kropsvægt i rotter og mutagene effekter er rapporteret. I en test med et formuleret produkt var dødeligheden for fisk (LC_{50}) ca. 1 ml/l (koncentration og vægtfylde ukendt).

Aluminiumtrihydroxid, magnesiumhydroxid

Der er begrænsede data på disse stoffer. Begrænsede effekter på pattedyr er beskrevet efter eksponering til høje doser. Generelt er aluminiumtrihydroxid er ikke giftigt i de anvendte tests. Begge metalioner har metaboliske roller i pattedyr. Data for metalionerne indikerer akutgiftige niveauer for Al på fisk og krebsdyr ved <1-10 mg/l, og ca. 65 mg/l for krebsdyr ved eksponering til Mg.

Rød phosphor

Rød fosfor er ikke velundersøgt og det er vanskeligt at konkludere på miljø- og sundhedseffekter. Det beslægtede gul fosfor rapporteres akut giftigt for mennesker (dødelig dosis 1 mg/kg), men den røde allotrope form beskrives som mindre giftig. Akut toksiske koncentrationer (LC_{50} eller EC_{50}) for uspecificerede former i det akvatiske miljø ligger mellem 0.009 – 0.012 mg/l for fisk og krebsdyr.

Zink borat

For stoffet findes tilsyneladende meget få data. Ved sammenligning med natrium borat og borsyre forventes hovedeffekterne i mennesker at kunne være irritation af hud, øjne og luftveje, samt mulighed for skade på barnet under graviditeten. I det akvatiske miljø rapporteres zinkionen at være i kategorien meget giftig overfor krebsdyr.

Melamin

Melamin synes kun at være svagt giftig når givet til forsøgsdyr. De tilgængelige data antyder ikke cancerinducering af melamin. I et enkelt eksperiment udviser melamin skadevirkning på krebsdyr (<100 mg/l), men den øvrige litteratur antyder kun lille akvatisk toksicitet.

Biokkumulering af melamin er formodentlig lav i naturligt pH område (pH 6-8). Bionedbrydningsdata antyder, at dette stof er persistent både under aerobe og anaerobe forhold.

Antimontrioxid	Antimontrioxid er klassificeret "Sundhedsskadelig" (Xn) i EU og skal mærkes med risikosætningen "Mulighed for varig skade på helbred" (R40) pga. mulig carcinogenicitet. Stoffet er rapporteret teratogent. Effekterne i økotoksikologiske test er primært fundet i alger (meget giftig til skadelig), mens toksicitet i krebsdyr og fisk er meget ringe.
Quinidinkarbonat	Der er ikke fundet miljø- eller sundhedsdata for quinidinkarbornat. Hvis giftigheden af quinidinkarbonat anslås ved hjælp af giftigheden for quinidinsulfat ville quinidinkarbonat være skadelig for krebsdyr, men ikke for fisk.

4 Approach

4.1 Information search

The following databases have been the primary sources of information: Chemfinder, HSDB, RTECS, Toxline, IUCLID and Ecotox (Aquire). In addition SAX, WHO series and other compilations have been consulted. The scientific literature has only been occasionally included.

The properties of the compound are summarised giving the following data priority.

- Identification data
- Physico-chemical charateristics
- Toxicological data
- Ecotoxicity data
- Environmental fate

4.2 Properties

The screening has comprised the following properties and sub-properties:

Identification of the substance

CAS No.
EINECS No.
EINECS Name
Synonyms
Molecular Formula
Structual Formula
Known Uses
EU Classification on annex 1 in Directive 67/548/EØF and its updates.

Physico-chemical Characteristics

Physical Form
Molecular Weight
Melting Point/range (°C)
Boiling Point/range (°C)
Decomposition Temperature (°C)
Vapour Pressure (mm Hg(°C))
Relative Density
Vapour Density (air=1)
Solubility (water)
Partition Coefficient (log P_{ow})
pK_a
Flammability

Explosivity
Oxidising properties
Mobility

Toxicological Data

Observation in humans

Acute Toxicity

Oral
Dermal
Inhalation
Other Routes
Skin Irritation
Eye Irritation
Irritation of Respiratory Tract
Skin Sensitisation
Sensitisation by Inhalation

Subchronic and Chronic Toxicity

Observation in humans
Oral
Inhalation
Dermal

Genotoxicity and Carcinogenicity

Mutagenicity
Gene Mutation
Chromosome Abnormalities
Other Genotoxic Effects
Cancer review

Reproductive Toxicity, Embryotoxicity and Teratogenicity

Reproductive Toxicity
Teratogenicity
Other Toxicity Studies
Toxicokinetics

Ecotoxicity Data

Algae
Crustacean
Fish
Bacteria

Environmental Fate

BCF
Aerobic biodegradation
Anaerobic biodegradation
Metabolic pathway

Health and Environmental Summary

Attention is drawn to the fact that no assessment of hazard or risk is made, nor is exposure included in the screening.

The references mentioned after each compound screening comprise the consulted literature.

Data quality

Since the screening is based on compiled results in reviews, handbook and databases the data quality is difficult to evaluate. In the selection of data for the screening emphasis has been given to more recent data and studies performed after test guidelines, wherever this could be identified.

Remarks

In the ecotoxicology section the phrases very toxic, toxic and harmful are used according to the classification of effects: < 1 mg/l, 1-10 mg/l and 10-100 mg/l, respectively. Studies with the standard suite of test organisms (algae, crustaceans and fish) have been emphasised.

The bioaccumulation is evaluated by using the bioconcentration factor (BCF). If a BCF of 100 is exceeded, typically from fish studies, the BCF is considered high.

Metals are not evaluated according to BCF, since essential metals (and those co-transported) are transported into organisms against concentration gradients, and steady state concentration factors are not established.

Metals are natural elements and as such biodegradation is not possible. The evaluated metals, however, are metal compounds and may dissociate, be oxidised or reduced to another state in the environment.

A metal is evaluated as the compound (e.g. a certain salt) for which the CAS no. is given. Several of the metal compounds may dissociate in the aquatic environment into the parent metal ion and a salt. Where possible a limited data set on the parent metal or toxic ligand has been given. The concomitant reassociation of the metal-ion with various inorganic or organic compounds (speciation) is not included in the screening, but may affect the environmental bioavailability of the original compounds considerably.

The screening of the alternatives concerning impact on health is based on the references listed within each form. These references have been reviewed. The amount of data has been varying.

In one case (zinc borate) the conclusion is based on the solubility of the substance in water compared to the solubility of sodium borate with know toxicological effects. The effects of sodium borate are extrapolated to zinc borate by using the ratio between the solubility of the compounds.

5 Results of screening

The complete result of the screening for environmental and health data is given in the data sheets presented in the appendix. Each data collection has been based primarily on review literature, handbooks and electronic databases. The first page of each data sheet presents a short summary of the most important findings and if relevant a remark regarding special properties of the compound.

Here a short summary of the most important findings is presented. For each compound a statement on the data availability is also included.

Abbreviations used

Abbreviation	Explanation
F	Formulation containing the compound
T	Total concentration (incl. dissociable part)
fw	Fresh water
sw	Salt water
BCF	Bioconcentration factor
BOD	Biological Oxygen Demand
NOEC	No observed effect concentration
EC_{50}	Effect concentration for half population
LC_{50}	Lethal concentration for half population

Marker of important data ♦

The information marked by ♦ in the data sheets of the appendix is used in the summaries.

The list of literature represents the sources of information, which have been consulted. Not necessarily all references are quoted in each table.

5.1 Triphenyl Phosphate (TPP) CAS no. 115-86-6

Health

The available data indicate that TPP has a relatively low impact on health. In rare cases it can induce skin sensitisation and contact dermatitis in humans.

Although TPP is a neurotoxin in animals, recent investigations indicate that TPP is not neurotoxic in humans, but persons with preexisting neuromuscular disorders may be at increased risk.

Environment

The literature reviewed indicates that TPP is very toxic to algae, fish and some crustaceans (typical L(E)C_{50}<1 mg/l). The compound is toxic to *D. magna*. NOEC data available for fish are in the range 0.014 - 0.23 mg/l.

Bioaccumulation of this compound is high (BCF>100).

The biodegradation data available indicates that this compound is readily to inherently biodegradable under aerobic conditions. No data is available for anaerobic degradation.

Mobility of TPP and its primary degradation product in soil is very low.

5.2 Tricresyl Phosphate CAS no. 1330-78-5

Health

The available data indicates that following repeated application tricresyl phosphate is toxic by absorption through the skin.

The reviewed test results do not indicate mutagenic or carcinogenic effects of tricresyl phosphates.

Tricresyl phosphate may cause effects on the reproduction.

The main commercial product is a mixture of various isomers of tricresyl phosphates. Two other tricresyl phosphates (not 1330-78-5) are classified toxic or harmful.

Environment

The available effect data originates from tests performed using either the pure compound or a formulation. The tests performed using the pure compound indicates that tricresyl phosphate are very toxic to fish and toxic to algae and crustaceans ($L(E)C_{50}$ from <1 mg/l to 10 mg/l). Formulations are slightly less toxic, but typically in the 1-10 mg/l. A study of long term acute and chronic effects in fish showed NOECs from 0.0001-0.00032 mg/l for a formulated product.

Tricresyl phosphate bioaccumulates (BCF ranges from 165-281).

Available screening studies suggest that aerobic biodegradation will occur at moderate to rapid rates with half-lives in the order of several days or less.

The mobility in soil is presumably low.

5.3 Resorcinol bis(diphenylphosphate) CAS no. 57583-54-7

Health

The available data is not sufficient to prepare a complete health screening of the substance.

In the reviewed studies there were no adverse effects on reproductive performance or fertility parameters associated with administration of the substance in the diet. In these studies the substance did not result in any biologically significant toxic or teratogenic effect in the fetus.

Environment

No data available.

5.4 Phosphonic acid (dimethyl ester) CAS no. 20120-33-6

Health

The available data is not sufficient to make a health screening of the substance. One study reports an oral-LD50, which may indicate potential adverse acute effects.

Environment

The available data is not sufficient for an environmental screening.

Two data sets are available on the toxicity of a formulation to fish. The indication is that the toxicity of the compound will range from toxic to very toxic to fish.

5.5 Aluminium Trihydroxide CAS no. 21645-51-2

Health

Aluminium hydroxide is often an important source of aluminium in the body. The possible influence of aluminium on the central nervous system, e.g. the development of Alzheimer Syndrome is still at debate.

Oral ingestion of aluminium compounds can lead to deposition of aluminium in bones.

Epidemiological studies indicate that that aluminium compounds may lead to lung injuries.

Most aluminium compounds may cause irritation of eyes and respiratory tract.

Environment

Very few data was found on the compound $Al(OH)_3$. Since the compound may dissociate in the environment, a limited data set on the Al-ion is presented.

The available ecotoxicological data indicates that $Al(OH)_3$ is not toxic to fish, crustacean or bacteria.

The data on aluminium-ion indicates that the ionic form is very toxic to fish and toxic to crustaceans.

5.6 Magnesium Hydroxide CAS no. 1309-42-8

Health

The available data is not sufficient to conduct a health screening of magnesium hydroxide, but indicate that the substance can be regarded as relatively harmless in small quantities as the substance is used as food additive.

Repeated or prolonged human exposure to larger quantities of the substance may imply adverse impact on human health, such as general irritation and malaise.

Environment

Very few data was found on the compound $Mg(OH)_2$. Since the compound may dissociate in the environment, a limited data set on the Mg-ion is presented.

Magnesium is an essential element in many organisms.

One sufficiently documented LC_{50} was identified: 64.7 mg/l, which indicates that magnesium is harmful to crustaceans.

5.7 Ammonium Polyphosphate CAS no. 14728-39-9 and 68333-79-9

Health

No relevant data is available.

Environment

The available data on a formulated product indicates that this substance may be harmful to crustaceans.

5.8 Red Phosphorus CAS no. 7723-14-0

Health

Red phosphorus is often contaminated with white and yellow phosphorus, and information on these two allotropic forms is therefore included.

Pure red phosphorus seems to be less harmful than the two other allotropic forms.

The substance is classified as highly flammable and may explode when exposed to heat or by chemical reaction with oxidisers. Red phosphorus can also react with reducing materials and represent a moderate explosion hazard by chemical reaction or on contact with organic materials.

Large quantities ignite spontaneously and on exposure to oxidising materials. It reacts with oxygen and water vapour to evolve the toxic phosphine.

Environment

No ecotoxicological data on red phosphorus were identified.

The available data on yellow phosphorus indicates that this allotropic form of phosphorus is very toxic to algae and fish.

5.9 Zinc Borate CAS no. 1332-07-6

Health

The health screening on zinc borate show that only few data sets are available.

Boric acid can be formed, if zinc borate gets in contact with water e.g. body fluids.

Based on comparison with sodium borate and boric acid, respectively, the possible main effects are expected to be:
* Irritation of skin, eyes and throat
* Harm to the unborn child.

Environment

No data was found on the compound $ZnO(B_2O_3)_2$. Since the compound may dissociate in the environment, limited data sets on the Zn-ion and Sodium tetraborate are presented. The effect concentrations of zinc borate are estimated from the effect concentrations of disodium tetraborate (CAS no. 1330-43-4). This approach is based on the assumption that the total toxicity of disodium tetraborate and zinc borate originates from the boric acid formed upon dissolution.

Zinc is an essential element for many organisms, however, for crustaceans zinc is very toxic.

5.10 Melamine CAS no. 108-78-1

Health

Melamine seems to be only mildly toxic when ingested by animals. There is not sufficient data to predict acute toxicity from dermal application in humans. The available data does not show evidence of irritation, cancer induction or mutageneity by melamine.

Based on animal tests it seems there is a risk of formation of stones in the urinary bladder.

A risk of inducing dermatitis in humans exposed to melamine among other chemicals in the working environment has been reported, however, the data was obtained in a formaldehyde-rich environment.

The LD50 for application of melamine on rabbit skin is found in one study to be slightly larger than 1 mg/kg (1 mg/kg implicates a high risk of adverse effects on skin of humans).

Environment

One experiment indicates that melamine may be harmful to crustaceans (LC_{100}=56 mg/l), but otherwise the reviewed toxicity data show little aquatic toxicity.

The available BCF and the pK_a values indicate that the bioaccumulation of this compound is low in the natural pH range (pH 6-8).

The available biodegradation data indicates that this compound is persistent both under aerobic and anaerobic conditions.

5.11 Antimony Trioxide CAS no. 1309-64-4

Health

Antimony trioxide is in the EU classified as "Harmful (Xn)" and must be labelled with the risk-phrase "Possible risk of irreversible effects" (R40) due to possible carcinogenicity.

There are epidemiological indications that antimony trioxide causes dermatitis and has an impact on female reproduction. The substance is teratogenic.

Data from animal experiments seem to indicate that females are more sensitive concerning developing lung eoplasms than males.

Environment

The toxicity of the substance to algae ranges from harmful to very toxic (EC_{50} <1 to 67 mg/l). To crustaceans the substance not harmful ($L(E)C_{50}$ >100 mg/l), and weight-of-evidence indicates that the substance is not harmful to fish.

The available data indicates that the substance could be oxidised in the environment.

5.12 Quinidine carbonate CAS no. not available

Health

No relevant data was found on quinidine carbonate.

Environment

No relevant data was found on quinidine carbonate.

If the toxicity of quinidine carbonate is assumed equal (on a molar basis) to data on quinidine sulfate from [1], the following estimates for quinidine carbonate can be given:

Artemia salina (sw): LC_{50}(24 h) = 287 mg/l (Artoxkit M) [1]

Daphina magna:LC_{50}(24 h) = 63 mg/l [1]

The toxicity of quinidine carbonate based on these estimated values indicates that quinidine carbonate could be harmful to crustaceans.

5.13 Appendix

The appendix contains the complete results of the data screening for the following compounds:

Compound	CAS no.	Pages
Triphenyl Phosphate	115-86-6	21-30
Tricresyl Phosphate	1330-78-5	31-38
Resorcinol bis(diphenylphosphate)	57583-54-7	39-44
Phosphonic acid (dimethyl ester)	20120-33-6	45-48
Aluminium Trihydroxide	21645-51-2	49-56
Magnesium Hydroxide	1309-42-8	57-62
Ammonium Polyphosphate	14728-39-9 and 68333-79-9	63-68
Red Phosphorus	7723-14-0	69-76
Zinc Borate	1332-07-6	77-82
Melamine	108-78-1	83-90
Antimontrioxide	1309-64-4	91-98
Quinidine carbonate Only summary page included	No CAS no.	99

Triphenyl Phosphate (TPP)

CAS number: 115-86-6

Data compilation, environmental and health screening

Summary

Health:

The available data indicate that TPP has a relatively low impact on health. In rare cases it can induce skin sensitisation and contact dermatitis in humans.

Although TPP is a neurotoxin in animals, recent investigations indicate that TPP is not neurotoxic in humans, but persons with preexisting neuromuscular disorders may be at increased risk.

Environment:

The literature reviewed indicates that TPP is very toxic to algae, fish and some crustaceans (typical $L(E)C_{50}$<1 mg/l). The compound is toxic to *D. magna*. NOEC data available for fish are in the range 0.014 - 0.23 mg/l.

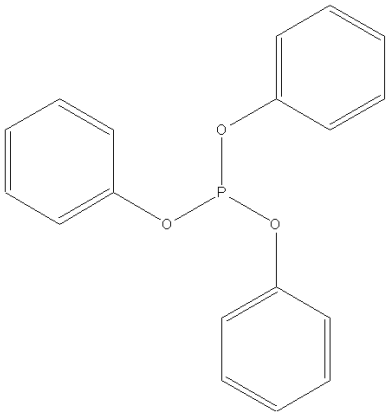
Bioaccumulation of this compound is high (>100).

The available biodegradation data indicates that this compound is readily to inherently biodegradable under aerobic conditions. No data is available for anaerobic degradation.

Mobility of TPP and its primary degradation product in soil is very low.

Triphenyl Phosphate

Identification of the substance

CAS No.	115-86-6
EINECS No.	204-112-2
IUPAC Name	Triphenyl phosphate
Synonyms	Phenyl phosphate; TPP; Phosphoric acid triphenyl ester; triphenyl phosphoric acid ester; celluflex tpp
Molecular Formula	$C_{18}H_{15}O_4P$
Structual Formula	
Known Uses	Fire-retarding agent, plasticizer for cellulose acetate and nitrocellulose
EU	Classification on annex 1 in Directive 67/548/EØF and its revisions: None.

Physico-chemical Characteristics

Physical Form	Colorless or white powder [2].
Molecular Weight (g/mol)	326.28
Melting Point/range (°C)	48 [1], 49-50 [2,3,4], 50 [5]
Boiling Point/range (°C)	370 [1], 220 [3] , 245 [3,4,5,6]
Decomposition Temperature (°C)	No relevant data found
Vapour Pressure (mm Hg(°C))	1 at 193.5 °C [2,6,4]

Density	Specific gravity=1.268 g/cm^3 at 60 °C [5] Specific gravity=1.2055 g/cm^3 at 50 and 4 °C [2]
Vapour Density (air=1)	1.19 [2]
Solubility (water)	1.9 mg/l at 25 °C [2,6,7]
Partition coefficient (log P_{ow})	2.62 [3] 4.59 [2,6,7]
pK_a	Not applicable
Flammability	Nonflammable [2]
Explosivity	No relevant data found
Oxidising properties	No relevant data found

Toxicological Data

Observation in Humans	While a statistically significant reduction in red blood cell cholinesterase has been reported in some workers, there has been no evidence of neurological disease in workers in a TPP-manufacturing plant. There have been no reports of delayed neurotoxicity in cases of TPP poisoning. (10).

Acute Toxicity

Oral	Oral-rat LD50: 3,800 mg/kg [2,4]. Oral-rat LD50: 3,500-10,000 mg/kg bw. [3,6]. Oral-mouse LD50:1,320 mg/kg [2,4,6]. Oral-mouse LD50: 1,300 mg/kg bw. [3]. LD50 White leghorn chicken oral > 5.0 g/kg [2].
Dermal	Concerning dermal application one study indicates that the LD50 for rabbits is higher than 10.000 mg/kg and another that LD0 (no death) is higher than 7,900 mg/kg [2,3,6].
Inhalation	No relevant data found

Other Routes	♦ Several studies concerning subcutaneous acute toxicity have been conducted. Some of the first studies were performed with TPP prepared from coal-tar sources containing neurotoxic impurities. Based on recent experimental data, it is concluded that TPP is not neurotoxic when it is administered subcutaneously [3]. Subcutaneous-monkey LDLo: 500 mg/kg [2,4,6]. Subcutaneous-cat LDLo: 300 mg/kg Subcutaneous-rat LD0: 3,000 mg/kg bw. [3]. Subcutaneous-guinea pig LD0: 3,000 mg/kg bw. [3].
Skin Irritation	Based on 4 studies it is concluded that TPP is not irritating skin [3].
Eye Irritation	100 mg TPP administered directly in the eye of rabbits cause minimal reversible irritation [3].
Irritation of Respiratory Tract	No relevant data found
Skin Sensitisation	♦ Some people have been tested positive in TPP patch-tests [3] and one case of skin sensitisation has been recorded [2]. An allergic reaction in a 67-year old woman to spectacle frames containing triphenyl phosphate was reported. Patch tests with analytical grade triphenyl phosphate in that individual indicated a reaction at concentrations as low as 0.05%. [2].
Sensitisation by Inhalation	No relevant data found

Subchronic and Chronic Toxicity

Observation in Humans	♦ Numerous medical observations have been made on workmen employed for several (2-10) years in the factory where TPP was produced. No abnormal symptoms appear to have been observed, in particular no signs of neurotoxicity. Persons with preexisting neuromuscular disorders may be at increased risk. [2].
Oral	Oral-rat NOAL: 1,900 mg/kg repeated dose [3]. Oral administration for 3 months to rats in doses of 1,800 mg/kg and 380 mg/kg caused no deaths, and it was concluded from the normal growth and cholinesterase activity that these doses have no cumulative toxic effects. [2]. When administered as repeated excessive doses orally, TPP can cause neurotoxic effects such as decreased cholinesterase activity [3]. Concerning neurotoxicity 3 studies have been conducted on hens and chickens with an exposure time of 5-6 days. Only one of these studies indicated signs of decreased colinesterase activity. The two others did not indicate signs of neurotoxicity [2,3].

Inhalation	In workers engaged in the manufacture of aryl phosphates (including TPP and up to 20% triorthocresyl phosphate) and exposed to concentrations of aryl phosphates of 0.2 to 3.4 mg/m^3. There was some inhibition of plasma cholinesterase, but no correlation between this effect and the degree of exposure or minor gastrointestinal or neuromuscular symptoms [2].
Dermal	Contact dermatitis due to TPP has been described [10].

Genotoxicity and Carcinogenicity

Mutagenicity	Triphenyl phosphate was tested for mutagenicity in the Salmonella/microsome preincubation assay using a protocol approved by the National Toxicology Program. Triphenyl phosphate was tested at doses of 0, 100, 333, 1000, 3333 and 10,000 ug/plate in four Salmonella typhimurium strains (TA98, TA100, TA1535, and TA1537) in the presence and absence of Aroclor-induced rat or hamster liver S9. Triphenyl phosphate was negative in these tests, and the highest ineffective dose level tested (not causing the formation of a precipitate) in any Salmonella tester strain was 1000 ug/plate. [2]. ♦4 AMES tests were negative [3] and WHO conclude that TPP is not mutagenic [10].
Gene Mutation	No relevant data found.
Chromosome Abnormalities	No relevant data found.
Other Genotoxic Effects	No relevant data found.
Cancer Review	No IARC evaluation.

Reproductive Toxicity, Embryotoxicity and Teratogenicity

Reproductive Toxicity	One study concludes that TPP is not a development toxicant in rats [3]. The NOAEL on mothers and offspring from a 90-day rat study was terminated at 690 mg/kg per day [10].
Teratogenicity	No relevant data found.
Other Toxicity Studies	No relevant data found.
Toxicokinetics	TPP is poorly absorbed through the intact skin but readily through guinea pig skin [2]. Application of TPP on skin of rats as well as application of TPP in ethanol solution on skin of mice caused no skin irritation which leads to the conclusion that since cholinesterase is not inhibited after application, there is no dermal absorption. [2].

Ecotoxicity Data

Algae	*Ankistrodesmus falcatus*: EC_{50} (4h)=0.26 mg/l [3] EC_{50} (28h)=0.260 mg/l (F) [11] *Scenedesmus quadricauda* EC_{50} (4 h)=0.5 mg/l [3] EC_{50} (28 h)=0.5 mg/l (F) [11] *Selenastrum capricornutum:* EC_{50} (96 h)=2.00 mg/l (F) [11]
Crustacean	*Daphnia magna* ♦EC_{50} (48h)=1 mg/l [3] (EPA 660/3-75-009). LC_{50} (48h)=1 mg/l [3]. ♦EC_{50} (48h)=1.35 mg/l [3] (EPA 660/3-75-009). EC_{50} (48h)=1 mg/l [3] (EPA 660/3-75-009). EC_{50} (48h)=1 mg/l (F) [11]. LC_{50} (48h)=1 mg/l (F) [11]. Survival in a 28d test was not affected in concentrations up to (NOEC) 136 µg/l (EPA 660/3-75-009) [3]. *Gammarus pseudolimnaeus:* EC_{50} (96h)=0.25 mg/l [3] *Mysidopsis bahia* : ♦$0.32>LC_{50}$ (96h)>0.18 mg/l [3] (EPA 660/3-75-009).
Fish	*Carassius auratus* (fw): ♦LC_{50} (96h)=0.7 mg/l [3] LC_{50} (1h)=5.0 mg/l (F) [11] LC_{50} (5h)=3.0 mg/l (F) [11] LC_{50} (8h)=1.0 mg/l (F) [11] *Cyprinodon variegatus* (fw): ♦0.32 mg/l$<LC_{50}$ (96h)<0.56 mg/l [3] (EPA 660/3-75-009) *Lepomis macrochirus* (fw): LC_{50} (96h)=0.78 mg/l [3] LC_{50} (96h)=0.290 mg/l [3] LC_{50} values for *Lepomis macrochirus* exposed to water with clay (either adsorption or desorption method) were about double those seen in TPP/water alone (1.56 mg/kg). In the adsorptive soil test, the LC_{50} was about 1.5 times higher than in the water alone (1.2 mg/l) and in the desorptive soil test the LC_{50} was 4 times that in water (3.1 mg/l). Sorption on clay or soil reduced intial bioavailability of TPP to aquatic bluegills [3]. LC_{50} (96h)=290 mg/l (F) [11] *Menidia beryllina* (sw): LC_{50} (96h)=95 mg/l [3]

	Oryzias latipes (fw): LC_{50} (96 h)=1.2 mg/l [3] LC_{50} (24h)=6.4 mg/l at 10 °C (F) [11] LC_{50} (24h)=3.4 mg/l at 20 °C (F) [11] LC_{50} (48h)=0.4 mg/l at 10 °C (F) [11] LC_{50} (48h)=3.4 mg/l at 20 °C (F) [11] *Onchorhynchus mykiis* (fw): ♦LC_{50} (96h)=0.40 mg/l (F) [11] ♦LC_{50} (96h)=0.30 mg/l (F) [11] ♦LC_{50} (96h)=0.36 mg/l (F) [11] *Pimephales promelas* (fw) ♦LC_{50} (96h)=0.66 mg/l (EPA 660/3-75-009) [3] NOEC (30 or 60d)=0.087 mg/l [3] (EPA 660/3-75-009) ♦NOEC (30 or 60 d)=0.23 mg/l (EPA 660/3-75-009) [3] LC_{50} (96h)=0.66 mg/l (F) [11] ♦LC_{50} (96h)=0.87 mg/l (F) [11]
Fish	*Salmo gairdneri* (fw) ♦LC_{50} (96h)=0.36 mg/l [3] ♦LC_{50} (96h)=0.4 mg/l [3] (EPA 660/3-75-009) ♦NOEC (30 or 60d)= 0.014 mg/l [3] (EPA 660/3-75-009) Rainbow trout (fw): Fingerlings: LC_{50} (24h)=0.62 mg/l, EC_{50} (24h)=1.15 mg/l [3] LC_{50} (24h)>0.45 mg/l, EC_{50} (24h)=0.37 mg/l [3] LC_{50} (96h)=0.32 mg/l, EC_{50} (96h)=0.3 mg/l [3] LC_{50} (96h)>0.45 mg/l [3],EC_{50} (96h)=0.27 mg/l [3] Sac-fry: LC_{50} (24h) > 0.45 mg/l, EC_{50} (24h)= 0.295 mg/l [3] LC_{50} (24h)>0.56 mg/l, EC_{50} (24h)=0.31 mg/l [3] LC_{50} (96h)>0.45 mg/l, EC_{50} (96h)=0.24 mg/l [3] Adults: LC_{50} (96h) = 0.85 mg/l (OECD 203) [3]
Other aquatic organisms	*Chironomus tentans* LC_{50} (48h)=1.6 mg/l [3] *Chironomus riparius* ♦EC_{50}=0.36 mg/l [3] EC_{50} (48h)=0.36 mg/l [3]
Bacteria	Not available

Environmental Fate

BCF	*Oryzias latipes* (fw) BCF(18d, conc. 0.009-0.01 mg/l)=84 - 193 [3] BCF(38d, conc. 0.090 mg/l)=61-144 (T) [11] *Phoxinus phoxinus* (fw) Bioaccumulation (4 months, food conc.=100 ug/g)=0.06 [3] *Pimephales promelas* (fw) BCF(105d, mesocosmos, conc. 60 ug/l)=68-160 [3] BCF(1h-1d)=1,743 (F) [11] BCF(1h-1d)=561 (F) [11] BCF(1h-1d)=218 (F) [11] *Salmo gairdneri* (fw): ♦BCF(90d)=271 [3] BCF(112d, conc.=60 ug/l)=43 [3] *Oncorhynchus mykiis* (fw): BCF(1h-1d)=1,368 (F) [11] BCF(1h-1d)=573 (F) [11] BCF(1h-1d)=931 (F) [11] BCF(6h)=2,590 (F) [11] BCF(6h)=18,900 (F) [11]
Aerobic biodegradation	♦Triphenyl phosphate biodegrades under aerobic conditions (half-life of 4 days or less) in water. However, biodegradation in benthic sediments is unclear. If released to soil, biodegradation will be the predominant fate process and aqueous hydrolysis may be important in alkaline soils. Biodegradation is expected to be the dominant fate process of triphenyl phosphate in soil; screening tests exhibited aerobic half-lives of about 4 days or less in natural waters [2]. Half-life in killifish=5h [3]. Half-life in goldfish>100h [3] ♦Percent degraded (20d)=93.8 % (OECD 303A) [3] Percent degraded (48 h)=40 %, sludge inoc. [3] Percent degraded (40 days)=53 %, unknown inoc. [3] ♦Percent degraded (24 h)=96 %, sludge inoc. [3] Percent degraded (2-4 days)=50 %, unknown inoc. [3] ♦Percent degraded (96h)=100 %, sludge inoc. [3] Percent degraded (49-84d)=93-96 %, adap. sludge inoc. [3] BOD_7=61.9% BODth, adap. sludge inoc. [3] BOD_{28}=81.8% BODth, adap. sludge inoc. [3]
Anaerobic biodegradation	No relevant data
Metabolic pathway	No relevant data
Mobility	♦K_{oc}=3,100 [3] K_d (silty clay)=21.52 [3] K_d (loamy sand)=77.72 [3]

	K_d (silty loam)=67.50 [3] ♦Mobility of TPP and its primary degradation product in soil was very low. It was strongly absorbed to the soil [3]. K_p=112 ± 26.8 [3]

Conclusion

Health	The available data indicate that TPP has relatively low impact on health. TPP can induce skin sensitisation and contact demartitis in humans. Based on the available data TPP is not neurotoxic or mutagenic. Persons with preexisting neuromuscular disorders may be at increased risk.
Environment	The literature reviewed indicates that TPP is very toxic to algae, fish and some crustaceans (typical L(E)C_{50}<1 mg/l). The compound is toxic to *D. magna.* NOEC data available for fish are in the range 0.014 - 0.23 mg/l. Bioaccumulation of this compound is high (BCF >100). The biodegradation data available indicates that this compound is readily to inherently biodegradable under aerobic conditions. No data is available for anaerobic degradation. Mobility of TPP and its primary degradation product in soil is very low.

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8 Environmental Fate Database - CHEMFATE (SRC/Procter and Gamble/EPA).
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10 World Health Organization: IPCS Environmental Health Criteria 111 - Triphenyl Phosphate, Geneva, 1991.

11 ECOTOX AQUIRE. ECOTOX database system. United States Environmental Protection Agency. Online search December 1999.:
http://www.epa.gov/ecotox/ecotox_home.htm

Tricresyl Phosphate

CAS number: 1330-78-5

Data compilation, environmental and health screening

Summary

Health:

In the available data there are indications that the investigated tricresyl phosphate is toxic by absorption through the skin. This substances seams not to be mutagenic or carcinogenic.

Tricresyl phosphate might be connected with effects on the reproduction.

This particular tricresyl phosphate has no classification. The main commercial product is a mixture of various isomers of tricresyl phosphates. Two other tricresyl phosphates (not 1330-78-5) are classified toxic or harmful.

Environment:

The available effect data originates from tests performed using either the pure compound or a formulation. The tests performed using the pure compound indicates that tricresyl phosphate are very toxic to fish and toxic to algae and crustaceans ($L(E)C_{50}$ from <1 mg/l to 10 mg/l). Formulations are slightly less toxic, but typically in the 1-10 mg/l range. A study of long term acute and chronic effects in fish showed NOECs from 0.0001-0.00032 mg/l for a formulated product.

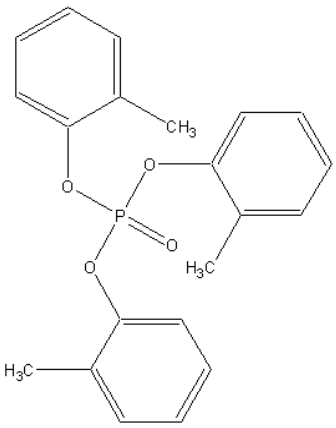
Tricresyl phosphate bioaccumulates (BCF ranges from 165-281).

Available screening studies suggest that aerobic biodegradation will occur at moderate to rapid rates with half-lives in the order of several days or less.

The mobility in soil is presumably low.

Tricresyl Phosphate

Identification of the substance

CAS No.	1330-78-5
EINECS No.	215-548-8
EINECS Name	tris(methylphenyl) phosphate
Synonyms	Celluflex TPP; Disflamoll TP; Phosflex TPP; TPP; Trifenylfosfat (Czech); Triphenyl phosphate; Celluflex 179C; Cresyl phosphate; Disflamoll TKP; Durad; Flexol Plasticizer TCP; Fyrquel 150; IMOL S 140; Kronitex; Lindol; NCI-C61041; Phosflex 179A; Phosphate de tricresyle (French); Tricresilfosfati (Italian); Tricresylfosfaten (Dutch); Tricresyl phosphate; Trikresylfosfat (Czech); Trikresylphosphate (German); Tris(tolyloxy)phosphine oxide; Tritolylfosfat (Czech); Tritolyl phosphate [5]
Molecular Formula	$C_{21}H_{21}O_4P$
Structual Formula	
Known uses	This compound is used as a plasticizer in vinyl plastics manufacturing, a flame-retardant, a solvent for nitrocellulose and in cellulose molding compositions. It is also used as an additive to extreme-pressure lubricants, as a nonflammable fluid in hydraulic systems, as a lead scavenger in gasoline, to sterilize certain surgical instruments, in polystyrene, in waterproofing, in common organic solvents and thinners, in linseed oil, in china wood oil and in castor oil.
EU	♦Classification on annex 1 in Directive 67/548/EØF and its revisions: None, but within the family of tricresyl phosphates, two CAS No. (78-30-8 and 78-32-0) are classified toxic (T, N with R 39/23/24/25-51/53) and harmful (Xn;R21/22 N;R51/53) respectively. ♦Commercial tricresyl phosphates normally contain a mixture of isomers of tricresyl phosphate which can have influence on the final

classification.

Physico-chemical Characteristics

Physical Form	Practically colourless and odourless liquid [4].
Molecular Weight	368.37
Melting Point/range (°C)	-33 [8]
Boiling Point/range (°C)	420 [4], 265 [8]
Decomposition Temperature (°C)	No relevant data found
Vapour Pressure (mm Hg(°C))	6×10^{-7} at 25 °C, estimated [4] 0.1×10^{-3} at 20 °C [8]
Density	Density=1.16 [3], Density=1.162 at 25 °C [4]
Vapour Density (air=1)	Specific gravity= 1.247g/cm^3 12.7 [1]
Solubility (water)	0.36 mg/l [4,8]
Partition Coefficient (log P_{ow})	5.11 [4,8]
pK_a	No relevant data found
Flammability	No relevant data found
Explosivity	May burn, but does not ignite readily
Oxidising properties	No relevant data found

Toxicological Data

Observation in humans	Toxic by ingestion in humans [4].

Acute Toxicity

Oral	Oral-rat LD50: 3,500 mg/kg [5].
	Oral-rat LD50: 5,190 mg/kg [3].
	Oral-muse LD50: 1,320 mg/kg [5].
	Oral-mouse LD50: 3,900 mg/kg [3].
	Oral-dog, adult LDLo: 500 mg/kg [3].
	Oral-rabbit, adult LDLo: 100 mg/kg [3].
Dermal	♦Toxic by skin absorption [4].
	Skin-rabbit LD50: >7,900 mg/kg [5].
	Skin-guinea pig LD50: >4 gm/kg [5].
	Skin-cat, adult LD50: 1,500 mg/kg [3].
Inhalation	No relevant data found
Other Routes	No relevant data found
Skin Irritation	No relevant data found
Eye Irritation	No relevant data found
Irritation of Respiratory Tract	No relevant data found
Skin Sensitisation	No relevant data found
Sensitisation by Inhalation	No relevant data found

Subchronic and Chronic Toxicity

Observation in humans	No relevant data found
Oral	No relevant data found
Inhalation	No relevant data found
Dermal	Repeated dermal application of 128 mg/kg body weight of tricresyl phosphate every other day on up to 83 occasions on pig skin has been shown to produce total, irreversible paresis, but without development of the clinical signs associated with organophosphorus compound poisoning [4].

Genotoxicity and Carcinogenicity

Mutagenicity	♦Tricresyl phosphate was not mutagenic in Salmonella typhimurium strains TA98, TA100, TA1535, or TA1537, nor did it induce chromosomal aberrations or sister chromatid exchanges in cultured Chinese hamster ovary cells. These in vitro assays were all conducted with and without exogenous metabolic activation. [7].
Gene Mutation	No relevant data found
Chromosome Abnormalities	No relevant data found
Other Genotoxic Effects	No relevant data found
Cancer Review	♦In 2-year feeding studies there were no evidence of carcinogenic effects of tricresyl phosphate in male or female F344/N rats treated at 75, 150, or 300 ppm. There was no evidence of carcinogenic activity of tricresyl phosphate in male or female B6C3F1 mice treated at 60, 125, or 250 ppm. [7].

Reproductive Toxicity, Embryotoxicity and Teratogenicity

Reproductive Toxicity	♦The reproductive effects of tricresyl phosphate (TCP) were investigated in Long Evans rats . Twelve male rats/dose group were given 0, 100, or 200 mg/kg TCP in corn oil (10 ml/kg body wt) by gavage once/day, 7 days/wk for 56 days prior to breeding and throughout the 10 day breeding period. Twenty four female rats/dose group received 0, 200, or 400 mg/kg TCP in corn oil (10 ml/kg body wt) for 14 days prior to breeding, and throughout breeding, gestation and lactation until the pups were weaned on day 21.
Reproductive Toxicity cont.	Control groups were given corn oil only. The results show that male rats treated with 200 mg/kg TCP had reduced sperm concentration, motility, and velocity (65, 4, and 5% of control, respectively). There was a dose-dependent increase in abnormal sperm morphology in both the 100 mg/kg and 200 mg/kg treated males. TCP did not have an adverse effect on mean testicular wt, but epididymal weights were reduced in the 200 mg/kg dose group males. The % of sperm-positive females for TCP-exposed pairs was not different from that of controls. [4].
Teratogenicity	No relevant data found
Other Toxicity Studies	No relevant data found
Toxicokinetics	No relevant data found

Ecotoxicity Data

Algae	*Anacystis aeruginosa* EC_{50}(96h)>1 mg/l (F) [10] *Chlorella pyrenoidosa*: EC_{50}(96h)>1 mg/l (F) [10] *Scenedesmus pannonicus*: ♦EC_{50}(96h)=1.3 mg/l (F) [10] EC_{50}(96h)=3.8 mg/l (F) [10] EC_{50}(14d)=1.5 mg/l (F) [10] *Selenastrum capricornutum*: EC_{50}(96h)>1 mg/l (F) [10] *Stephanodiscus hantzschii*: ♦EC_{50}(96h)=0.29 mg/l (F) [10] *Euglena gracilis*: LC_{50}(96h)>1.0 mg/l (F) [10]
Crustacean	*Daphnia magna*: EC_{50}(24h)=9.1 mg/l (F) [10] EC_{50}(24h)>3.2 mg/l (F) [10] ♦EC_{50}(48h)=3.6 mg/l (F) [10] 0.10 <EC_{50}(14d)<0.32 mg/l (F) [10] 0.32 <EC_{50}(14d)< 1.00 mg/l (F) [10] 0.10 <EC_{50}(21d)< 0.32 mg/l (F) [10] 0.32 <EC_{50}(21d)< 1.00 mg/l (F) [10]
Fish	*Brachydanio rerio* (fw): LC_{50}(96h)>1 mg/l (F) [10] LC_{50}(96h)=5.9 mg/l (F) [10] LC_{50}(96h)=0.4 mg/l (F) [10] *Gasterosteus aculeatus* (fw): LC_{50}(24h)>0.87 mg/l (F) [10] LC_{50}(35d)= 0.0017 mg/l (F) [10] LC_{50}(48h)=0.83 mg/l (F) [10] LC_{50}(72h)=0.58 mg/l (F) [10] LC_{50}(72h)=0.44 mg/l (F) [10]

Fish cont.

Gasterosteus aculeatus (fw):
NOEC(mortality,24h)=0.28 mg/l (F) [10]
NOEC(mortality,48h)=0.28 mg/l (F) [10]
NOEC(mortality,72h)=0.16 mg/l (F) [10]
NOEC(mortality,96h)=0.16 mg/l (F) [10]
NOEC(development,35d)=0.0032 mg/l (F) [10]
NOEC(growth,35d)=0.00032 mg/l (F) [10]
♦NOEC(mortality,35d)=0.0001 mg/l (F) [10]

Ictalurus punctatus (fw):
♦LC_{50}(96h)= 0.803 mg/l [10]

Jordanella floridae (fw):
LC_{50}(48h)=3.1 mg/l (F) [10]
LC_{50}(48h)=6.7 mg/l (F) [10]
LC_{50}(96h)=2.1 mg/l (F) [10]
LC_{50}(96h)=5.0 mg/l (F) [10]
LC_{50}(7d)=0.1 mg/l (F) [10]
0.010<LC_{50}(35d)<0.032 mg/l (F) [10]

Lepomis macrochirus (fw):
LC_{50}(96h)=7,000 mg/l (F) [10]
♦LC_{50}(96h)=0.150 mg/l [10]

Menidia beryllina (fw):
LC_{50}(96h)=8,700 mg/l (F) [10]

Oncorhynchus mykiss (fw):
♦LC_{50}(96h)=0.26 mg/l [10]

Oryzias latipes(fw):
LC_{50}(24h)>1,000 mg/l (F) [10]
LC_{50}(24h)=5.8 mg/l (F) [10]
LC_{50}(48h)=53.0 mg/l (F) [10]
3.2<LC_{50}(48h)<10.0 (F) [10]
LC_{50}(48h)>10,000 mg/l (F) [10]
LC_{50}(48h)>700 mg/l (F) [10]
LC_{50}(96h)=13.0 mg/l (F) [10]
3.2<LC_{50}(96h)<10.0 mg/l
LC_{50}(7d)=0.080 mg/l (F) [10]

Perca flavescens (fw):
♦LC_{50}(96h)=0.520 mg/l [10]

Poecilia reticulata (fw):
LC_{50}(24h)=8.0 mg/l (F) [10]
LC_{50}(24h)=5.7 mg/l (F) [10]
LC_{50}(96h)=5.7 mg/l (F) [10]

Poecilia reticulata (fw) cont.:
LC_{50}(7d)=3.7 mg/l (F) [10]
LC_{50}(7d)=3.5 mg/l (F) [10]
LC_{50}(14d)=2.8 mg/l (F) [10]
LC_{50}(14d)=2.5 mg/l (F) [10]
LC_{50}(28d)=2.6 mg/l (F) [10]
LC_{50}(28d)=2.2 mg/l (F) [10]

Other aquatic organisms	No relevant data found
Bacteria	No relevant data found

Environmental Fate

BCF	♦BCF=165 (F) [10] ♦BCF=281 [8]
Aerobic biodegradation	♦Available screening studies suggest that aerobic biodegradation will occur at moderate to rapid rates with half-lives in the order of several days or less [4]
Anaerobic biodegradation	Biodegradation under anaerobic conditions is unclear [4]
Metabolic pathway	No relevant data found.
Mobility	♦K_{oc}=7,700-79,000, estimated [4] K_{oc}=14,350, estimated [8] ♦K_d=400 [4]

Conclusion

Health	The available data indicate that following repeated application tricresyl phosphate is toxic by absorption through the skin. Available data do not indicate mutagenic or carcinogenic effects of tricresyl phosphates. Tricresyl phosphate may cause effects on the reproduction. This particular tricresyl phosphate has no classification. The main commercial product is a mixture of various isomers of tricresyl phosphates. Two other tricresyl phosphates (not 1330-78-5) are classified toxic or harmful.

Environment	The available effect data originates from tests performed using either the pure compound or a formulation. The tests performed using the pure compound indicates that tricresyl phosphate are very toxic to fish and toxic to algae and crustaceans ($L(E)C_{50}$ from <1 mg/l to 10 mg/l). Formulations are slightly less acutely toxic, but typically in the 1-10 mg/l range. A study of long term acute and chronic effects in fish showed NOECs from 0.0001-0.00032 mg/l for a formulated product. Tricresyl phosphate bioaccumulates (BCF ranges from 165-281). Available screening studies suggest that aerobic biodegradation will occur at moderate to rapid rates with half-lives in the order of several days or less. The mobility in soil is presumably low.

References

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10 ECOTOX AQUIRE. ECOTOX database system. United States Environmental Protection Agency. Online search December 1999.: http://www.epa.gov/ecotox/ecotox_home.htm

Resorcinol bis(diphenyl phosphate)

CAS number: 57583-54-7

Data compilation, environmental and health screening

Summary

Health:

The health screening of the substance show an inadequate data set.

In the reviewed studies there were no adverse effects on reproductive performance or fertility parameters associated with administration of the substance in the diet.

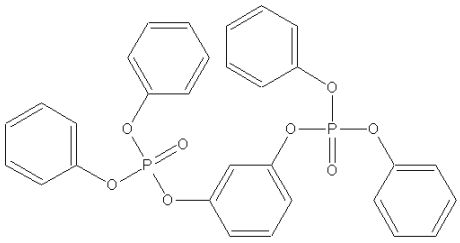
In these studies the substance did not result in any biologically significant toxic or teratogenic effect in the foetuses.

Environment:

No data available.

Resorcinol bis(diphenyl phosphate)

Identification of the substance

CAS No.	57583-54-7
EINECS No.	260-830-6
EINECS Name	tetraphenyl m-phenylene bis(phosphate)
Synonyms	CRR-733S; Fyrolflex RDP; Mark PFK; Oligomeric phosphate ester; m-Phenylenebis(diphenyl phosphate); 1,3-Phenylene tetraphenyl phosphate; PMN 89-234; Resorcinol bis(diphenyl phosphate); Tetraphenylresorcinol diphosphate.
Molecular Formula	
Structual Formula	$C_{30}H_{24}O_8P_2$
Known Uses	The substance is used as a flame retardant and is a component of certain plastics.
EU	Classification on annex 1 in Directive 67/548/EØF and its updates: None

Physico-chemical Characteristics

Physical Form	No relevant data found
Molecular Weight	No relevant data found
Melting Point/range (°C)	No relevant data found
Boiling Point/range (°C)	No relevant data found
Decomposition Temperature (°C)	No relevant data found
Vapour Pressure (mm Hg(°C))	No relevant data found
Relative Density	No relevant data found
Vapour Density (air=1)	No relevant data found

Solubility (water)	No relevant data found
Partition Coefficient (log P_{ow})	No relevant data found
pK_a	No relevant data found
Flammability	No relevant data found
Explosivity	No relevant data found
Oxidising properties	No relevant data found

Toxicological Data

Observation in humans	No relevant data found

Acute Toxicity

Oral	Oral-rat LD50 >5 mg/kg (5).
Dermal	Skin-rat LD50 >2 mg/kg (5).
Inhalation	Inhalation-rat LC50 >4,860 mg/m^3 (5).
Other Routes	No relevant data found.
Skin Irritation	No relevant data found.
Eye Irritation	No relevant data found.
Irritation of Respiratory Tract	No relevant data found.
Skin Sensitisation	No relevant data found.
Sensitisation by Inhalation	No relevant data found.

Subchronic and Chronic Toxicity

Observation in humans	No relevant data found.
Oral	FyrolflexQ RDP administered for more than 13 weeks and up to the entire life span (F1) resulted in increased liver weights with associated periportal hypertrophy. This change was considered an adaptive process associated with RDP metabolism in the liver. (7).
Inhalation	No relevant data found.
Dermal	No relevant data found.

Genotoxicity and Carcinogenicity

Mutagenicity	No relevant data found.
Gene Mutation	No relevant data found.
Chromosome Abnormalities	No relevant data found.
Other Genotoxic Effects	No relevant data found.
Cancer review	No relevant data found.

Reproductive Toxicity, Embryotoxicity and Teratogenicity

Reproductive Toxicity	FyrolflexQ RDP was evaluated in a two-generation reproductive study as part of a program to assess the overall toxicology of this flame retardant. RDP was administered to male and female Sprague-Dawley rats in the diet at concentrations of 1000, 10,000 or 20,000 ppm. The control group was given diet alone. ♦ In conclusion, there were no adverse effects on reproductive performance or fertility parameters associated with RDP administration in the diet. (7).
Teratogenicity	Groups of 27 sperm-positive New Zealand White rabbits (HRP, PA) were administered graded concentrations of 50, 200 or 1000 mg/kg of RDP in corn oil. A vehicle control group of equal size was administered corn oil alone. Rabbits were dosed daily (1.5 mL/kg) on gestation days 6-28 and sacrificed on gestation day 29. The fetuses were removed by cesarian section and examined for gross external, visceral, cephalic and skeletal anomalies. No treatment-related clinical signs of toxicity were observed. No effects on maternal food consumption, body weight, body weight gain, or on uterus, liver, kidney and spleen weights were detected. Fetal viability and body weight, as well as developmental endpoints were unaffected by the treatment. ♦ Accordingly, exposure of pregnant rabbits to doses ranging from 50 to 1000 mg/kg of RDP during the periods of major organogenesis and histogenesis did not result in any biologically significant toxic or teratogenic effect in the dams or fetuses (7).
Other Toxicity Studies	No relevant data found.

Toxicokinetics	No relevant data found.

Ecotoxicity Data

Algae	No relevant data found
Crustacean	No relevant data found
Fish	No relevant data found
Bacteria	No relevant data found
Mobility	No relevant data found

Environmental Fate

BCF	No relevant data found
Aerobic biodegradation	No relevant data found
Anaerobic biodegradation	No relevant data found
Metabolic pathway	No relevant data found

Conclusion

Health	The available data are not sufficient to prepare a health screening of the substance. In the reviewed studies there were no adverse effects on reproductive performance or fertility parameters associated with administration of the substance in the diet. In these studies the substance did not result in any biologically significant toxic or teratogenic effect in the fetuses.
Environment	No data available.

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1 Chemfinder: http://www.chemfinder.com/cgi-win/cfserver.exe/

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Phosphonic acid, (2-((hydroxymethyl)carbanyl)ethyl)- di-methylester

CAS number: 20120-33-6

Data compilation, environmental and health screening

Summary

Health:

The available data are not sufficient to perform a health screening of the substance. One study reports an oral-LD50 which may indicate potential adverse acute effects at a dose of 13 mg/kg.

Environment:

The available data is not sufficient to make an environmental screening.

Two data sets are available on the toxicity of a formulation to fish. The indication is that this compound is toxic to very toxic to fish.

Phosphonic acid, (2-((hydroxymethyl)carbanyl)ethyl)- dimethyl ester

Identification of the substance

CAS No.	20120-33-6
EINECS No.	243-528-9
EINECS Name	dimethyl [3-[(hydroxymethyl)amino]-3-oxopropyl]phosphonate
Synonyms	N-Methylol dimethylphosphonopropionamide; Phosphonic acid, (3-((hydroxymethyl)amino)-3-oxopropyl)-, dimethyl ester (9CI); Phosphonic acid, (2-((hydroxymethyl)carbanyl)ethyl)- dimethyl ester; Pyrovatex [5]
Molecular Formula	$C_6H_{14}NO_5P$ [5]
Structural Formula	No relevant data found.
Known Uses	No relevant data found.
EU	Classification on annex 1 in Directive 67/548/EØF and its revisions: None.

Physico-chemical Characteristics

Physical Form	No relevant data found.
Molecular Weight (g/mol)	211.18
Melting Point/range (°C)	No relevant data found.
Boiling Point/range (°C)	No relevant data found.
Decomposition Temperature (°C)	No relevant data found.
Vapour Pressure (mm Hg(°C))	No relevant data found.
Relative Density	No relevant data found.
Vapour Density (air=1)	No relevant data found.
Solubility (water)	No relevant data found.
Partition Coefficient (log P_{ow})	No relevant data found.
pK_a	No relevant data found.

Flammability	No relevant data found.
Explosivity	No relevant data found.
Oxidising properties	No relevant data found.

Toxicological Data

Observation in Humans	No relevant data found.

Acute Toxicity

Oral	♦Oral-rat LD50: 13 mg/kg (5).
Dermal	No relevant data found.
Inhalation	No relevant data found.
Other Routes	No relevant data found.
Skin Irritation	No relevant data found.
Eye Irritation	No relevant data found.
Irritation of Respiratory Tract	No relevant data found.
Skin Sensitisation	No relevant data found.
Sensitisation by Inhalation	No relevant data found.

Subchronic and Chronic Toxicity

Observation in Humans	No relevant data found.
Oral	No relevant data found.
Inhalation	No relevant data found.
Dermal	No relevant data found.

Genotoxicity and Carcinogenicity

Mutagenicity	One study indicating that the substance has mutagenic effects is reported (5).
Gene Mutation	No relevant data found.

Chromosome Abnormalities	No relevant data found.
Other Genotoxic Effects	No relevant data found.
Cancer Review	No relevant data found.

Reproductive Toxicity, Embryotoxicity and Teratogenicity

Reproductive Toxicity	No relevant data found.
Teratogenicity	No relevant data found.
Other Toxicity Studies	No relevant data found.
Toxicokinetics	No relevant data found.

Ecotoxicity Data

Algae	No relevant data found.
Crustacean	No relevant data found.
Fish	*Oncorhynchus mykiis* (fw): ♦ LC_{50}(48h)=0.56 ml/l (F) [10] ♦ LC_{50}(48h)=1.14 ml/l (F) [10]
Bacteria	No relevant data found.

Environmental Fate

BCF	No relevant data found.
Aerobic biodegradation	No relevant data found.
Anaerobic biodegradation	No relevant data found.
Metabolic pathway	No relevant data found.
Mobility	No relevant data found.

Conclusion

Health	The available data are not sufficient to make a health screening of the substance. One study reports an oral-LD50 which may indicate potential adverse acute effects at a dose of 13 mg/kg.

Environment	The available data is insufficient for an environmental screening. Only data available on the toxicity of a formulation to fish is available(LC_{50} = 0.56-1.14 ml/l). This indicates that the compound is very toxic to fish.

References

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http://www.epa.gov/medecotx/ecotox_home.htm

Aluminium trihydroxide

CAS number: 21645-51-2

Data compilation, environmental and health screening

Summary

Health:

Aluminium hydroxide is often an important source of aluminium in the body.

Aluminium compounds can lead to deposition of aluminium in bones leading to decalcification.

There are indications that aluminium compounds may lead to lung injuries.

Most aluminium compounds may cause irritation of eyes and respiratory tract.

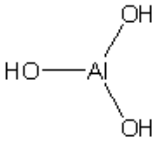
Environment:

Very few data was found on the compound $Al(OH)_3$. Since the compound may dissociate in the environment a limited data set on the Al-ion is presented.

The data on aluminium however indicates that this element is very toxic to fish and toxic to crustaceans.

Aluminium trihydroxide

Identification of the substance

CAS No.	21645-51-2
EINECS No.	244-492-7
EINECS Name	aluminium hydroxide
Synonyms	AF 260; Alcoa 331; Alcoa C 30BF; Alumigel; Alumina hydrated; Alumina trihydrate; alpha-Alumina trihydrate; Aluminic acid; aluminium hydroxide; aluminium hydrate; aluminium(III) hydroxide; aluminium hydroxide gel; aluminium oxide trihydrate; aluminium trihydrate; aluminium trihydroxide; Alusal; Amberol ST 140F; Amphojel; BACO AF 260; British aluminium AF 260; C 31; C 33; C 31C; C 4D; C 31F; C-31-F; C.I. 77002; GHA 331; GHA 332; H 46; Higilite; Higilite H 32; Higilite H 42; Higilite H 31S; Hychol 705; Hydral 705; Hydral 710; Hydrated alumina; Liquigel; Martinal; P 30BF; PGA; Trihydrated alumina; Trihydroxyaluminium [4] Tonerdehydrat, White hydrate [6]
Molecular Formula	$Al(OH)_3$
Structural Formula	
Known uses	Desiccant powder; in packaging materials; chemical intermediate; filler in paper, plastics, rubber, ceramics, in printing inks, lubricating compositions, detergents; iron-free aluminium and aluminium salts and cosmetics; glass additive to increase mechanical strength and resistance to thermal shock; in manufactures of activated alumina; flame retardants, for rubber reinforcing agent, paper coating; adsorbent; emulsifier; ion-exchanger, in chromatography; mordant in dyeing; filtering medium; waterproofing fabrics; used in pharmacy as the gel or dried gel. ♦ Aluminium hydroxide is sometimes used as an antidiarrheal agent, as a slow acting antacid and in protective dermatological pastes
EU	Classification on annex 1 in Directive 67/548/EØF and its revisions: None

Physico-chemical Characteristics

Physical Form	White monoclinic crystals, white powder, pellets or granules [4].

Molecular Weight (g/mol)	77.99
Melting Point/range (°C)	300 [4]
Boiling Point/range (°C)	No relevant data found.
Decomposition Temperature (°C)	Ca. 150-220 °C decomposition to Al_2O_3 and H_2O.
Vapour Pressure (mm Hg(°C))	No relevant data found.
Density	Specific: 2.42 g/cm^3 [4] 2.42 g/cm^3 at 20 °C [6] Relative: 1.01 - 1.25 at 25 °C [6]
Vapour Density (air=1)	No relevant data found.
Solubility (water)	Insoluble in water [4] App. 0015 g/l (20 °C) [6].
Partition Coefficient (log P_{ow})	No relevant data found.
pK_a	No relevant data found.
Flammability	No relevant data found.
Explosivity	Not explosive [6]
Oxidising properties	No oxidising properties [6]

Toxicological Data

Observation in humans	♦ Aluminium hydroxide is one of the main sources to aluminium in the body. The implications of previous reports of elevated aluminium concentration in patients with Alzheimer's disease for the treatment of the disease are disused. At the present time there is no conclusive evidence that active attempts to alter aluminium concentration in diet or medicines produce any beneficial effect in Alzheimer's disease. [4].

Acute Toxicity

Oral	Because aluminium is only sparingly absorbed from the gut, LD50 values for aluminium ingestion are unavailable, since death occurs from intestinal blockage due to precipitated aluminium species rather than systemic aluminium toxicity [4]. The only LD50 value (>5000 mg/kg bw) found supports this [6]. Antacids including aluminium hydroxide may inhibit the gastrointestinal absorption of some beta-blockers [4].
Dermal	No relevant data found.
Inhalation	Animal studies show that aluminium particles, in particular stamped aluminium powder, may cause fibrosis of the lung whereas particles of aluminium compounds appear to be less reactive [4]. ♦On occasion workers chronically exposed to aluminium-containing dusts or fumes have developed severe pulmonary reactions [4].
Other Routes	Aluminium salts are much more toxic intravenously than by mouth to animals [4].
Skin Irritation	Not irritating [6].
Eye Irritation	♦One study indicates that aluminium hydroxide is not an eye irritant [6], but aluminium (dust or powder) is an eye irritant [4].
Irritation of Respiratory Tract	♦Aluminium (dust or powder) is a respiratory irritant [4]. Aluminium compounds appear to be less reactive [4].
Skin Sensitisation	Not sensitising [6].
Sensitisation by Inhalation	No relevant data found.

Subchronic and Chronic Toxicity

Observation in humans	There has been and still is much dispute about aluminium's influence on CNS, e.g. the development of Alzheimer syndrome. Although aluminium is common in nature, and the exposure therefore rather comprehensive, the amount found in humans is rather limited [6].

Oral	Severe aluminium intoxication following oral administration of aluminium hydroxide, chloride, or sulphate to rats is characterised by anorexia or death [4]. The effects of dietary administration of aluminium hydroxide were examined in male Sprague-Dawley rats. Groups of 25 rats were fed a diet containing 14,470 ppm aluminium hydroxide or a control diet for 28 days. The mean daily aluminium dose was calculated as 302 mg/kg body weight/day. Dietary administration of aluminium hydroxide did not induce any signs of toxicity. Clinical observations during the 28-day treatment period and the recovery phase were similar in control and treated rats. There were no significant changes in haematology, clinical chemistry parameters, or organ weights. Histopathological examination of tissues revealed no treatment-related changes. Ingestion of aluminium hydroxide caused no significant deposition of Al in bone samples. [4].
Inhalation	No relevant data found.
Dermal	No relevant data found.

Genotoxicity and Carcinogenicity

Mutagenicity	♦Aluminium compounds have been evaluated as non-mutagenic by most standard methods of mutagenic assays. [4].
Gene Mutation	No relevant data found.
Chromosome Abnormalities	No relevant data found.
Other Genotoxic Effects	No relevant data found.
Cancer review	No relevant data found.

Reproductive Toxicity, Embryotoxicity and Teratogenicity

Reproductive Toxicity	No relevant data found.
Teratogenicity	♦In one study, concentrations of aluminium ranging from 500 to 1,000 ug/g body weight were added to the diets of pregnant rats from day 6 to day 19 of gestation, when the fetuses were removed by Caesarean section. Aluminium in the diet did not affect embryo or fetal mortality rate, litter size, fetal body weight, or length. [4]. ♦5-16 days' exposure of mice did not lead to material toxicity, embryo/fetal toxicity or teratogenicity [6].

Other Toxicity Studies	No relevant data found.
Toxicokinetics	Aluminium salts are absorbed in small amounts from the digestive tract and can be deposited in bones [4]. Aluminium hydroxide or oxide is slowly solubilised in the stomach and reacts with hydrochloric acid to form aluminium chloride and water. About 17-30% of the aluminium chloride formed is absorbed and rapidly excreted by the kidneys in patients with normal renal functions. In vitro studies indicate that aluminium hydroxide binds salts with an affinity and capacity similar to that of cholestyramine. Calcium and aluminium salts decrease the absorption of fluoride from the intestinal tract. In studies of humans, Spencer and co-workers demonstrated that ingestion of antacids containing aluminium hydroxide increased fecal excretion of fluoride by as much as 12 times, resulting in decreased absorption and lowered plasma levels of fluoride. [4]. Adults (with renal failure), who ingested 1.5 to 3.0 g aluminium hydroxide per day for 20 to 32 days, absorbed between 100 and 568 mg aluminium per day (7-19% of the dose). Thus, it is quite clear that the administration of large doses of aluminium result in significant systemic absorption of the metal. [4].
Toxicokinetics	Aluminium hydroxide and aluminium phosphate are some of the least soluble aluminium salts, but both compounds are sources of aluminium exposure. In metabolic studies on six patients, 12% of an oral load of aluminium in the form of a hydroxide was retained, but absorption was not calculated. At least 50% of serum aluminium is bound to proteins, which include both albuminand transferrin. Most of the tissue aluminium stores (about 30-50 mg) reside in bone. Current data indicate that biliary excretion is the major route of excretion, but renal elimination appears more important after large aluminium loads. [4]. Studies have shown that normal persons who consume one of several aluminium salts (eg, hydroxide or carbonate), but not aluminium phosphate readily absorb aluminium from the gastrointestinal tract. [4].

Ecotoxicity Data

Algae	No relevant data found.
Crustacean	*Daphnia magna:* EC_{50}= No effect in tested range DIN 38412 L11 [6] ♦ A search in [10] on Al resulted in several values on *Daphnia magna* and *Daphnia pulex* (range): LC_{50}(24h)=2.6-3.5 mg/l [10]

Fish	*Leuciscus idus* (fw): LC_{50}= No effect in tested range (DIN 38412 L12) [6] ♦A search in [10] on Al resulted in one value on *Oncorhynchus mykiis*: LC_{50}(24h)=0.16 mg/l, F, [10]
Bacteria	♦*Pseudomonas putida*: EC_{50}= No effect (DEV L8, modified) [6]

Environmental Fate

BCF	No relevant data found.
Aerobic biodegradation	Not relevant for metals.
Anaerobic biodegradation	No relevant for metals.
Metabolic pathway	No relevant data found.
Mobility	No relevant data found.

Conclusion

Health	Aluminium hydroxide is often an important source of aluminium in the body. Oral ingestion of aluminium compounds can lead to deposition of aluminium in bones. Epidemiological studies indicate that that aluminium compounds may lead to lung injuries. Most aluminium compounds may cause irritation of eyes and respiratory tract. Aluminium compounds have been evaluated as non-mutagenic by most standard methods of mutagenic assays. Aluminium in the diet did not affect a number of teratogenic parameters in mice or rats (dose 500-1000 ug/g).
Environment	Very few data was found on the compound $Al(OH)_3$. Since the compound may dissociate in the environment, a limited data set on the Al-ion is presented. The data on aluminium indicates that this element is very toxic to fish and toxic to crustaceans.

References

1 Chemfinder: http://www.chemfinder.com/cgi-win/cfserver.exe/

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http://www.epa.gov/ecotox/ecotox_home.htm

Magnesium hydroxide

CAS number: 1309-42-8

Data compilation, environmental and health screening

Summary

Health:

Only few data are reported on the substance (acute oral toxicity in rat and mouse 8,500 mg/kg). Magnesium is used in pharmaceuticals and food, and short term human exposure to the substance in small quantities is assumed not to affect human health adversely.

Repeated or prolonged human exposure to larger quantities of the substance may imply impact on human health, such as malaise and general irritation of skin and respiratory tract.

Effects on the central nerve system (CNS) associated with long term exposure and large doses) can not be excluded.

Repeated or prolonged human exposure to larger quantities of the substance may imply adverse impact on human health, such as general irritation and malaise.

Environment:

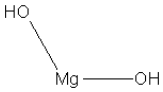
Very few data was found on the compound $Mg(OH)_2$. The compound may dissociate in the environment in Mg-ion and hydroxide.

Magnesium is an essential element in many organisms.

One LC_{50} was identified: 64.7 mg/l, which indicates that magnesium is harmful to crustaceans.

Magnesium hydroxide

Identification of the substance

CAS No.	1309-42-8
EINECS No.	215-170-3
EINECS Name	Magnesium hydroxide
Synonyms	Magnesium hydrate; Milk of magnesia; Magnesia; Magnesium dihydroxide; Gastrobrom; Gastrogel; Mylanta
Molecular Formula	H_2MgO_2
Structural Formula	
Known Uses	Antacid in medicine, alkaline buffer and chemical thickener in food, ingredient in pharmaceuticals, cosmetics, toothpaste, rubber, plastics and adhesives industries. Additive in fuel oil. Chemical intermediate in the production of magnesium chloride and magnesium carbonate. Raw material for the production of magnesium metal. In sugar refining, uranium processing and denetrification.
EU	Classification on annex 1 in Directive 67/548/EØF and its revisions: None. Labelling of metals not developed.

Physico-chemical Characteristics

Physical Form	White powder [3]
Molecular Weight	58.33
Melting Point/range (°C)	350 [4]
Boiling Point/range (°C)	No relevant data found
Decomposition Temperature (°C)	350 [3]
Vapour Pressure (mm Hg(°C))	No relevant data found
Density	Specific gravity=1.573 at 14 °C [4] Specific gravity=1.574 at 20 °C [6]
Vapour Density (air=1)	No relevant data found
Conversion Factor	No relevant data found

Solubility (water)	9 mg/l at 18 °C [3] 40 g/l at 100 °C [3]
Partition coefficient (log P_{ow})	No relevant data found
pK_a	No relevant data found
Flammability	No relevant data found
Explosivity	No relevant data found
Oxidising properties	No relevant data found

Toxicological Data

Observation in Humans	♦ The substance is used for medication mainly as an antacid but also as antidote for poisoning. It is reported that prolonged use rarely cause rectal stones composed of $MgCO_3$ and $Mg(OH)_2$. Absorbed Magnesium is rapidly excreted by kidney but the urine may become alkaline. [4]. ♦ Magnesium hydroxide is a general food additive [10,11].

Acute Toxicity

Oral	Intoxication of humans occurring after oral administration of magnesium salts is rare, but may happen in the face of renal impairment [10]. ♦ Oral-rat LD50: 8.500 mg/kg [5]. ♦ Oral-mouse LD50: 8.500 mg/kg [5]. Human ingestion of quantities above normal content in food may be connected with nausea, vomiting and diarrhoea.
Dermal	Relevant data not found.
Inhalation	No relevant experimental data reported, but according to suppliers of the substance it may irritate the respiratory tract on prolonged or repeated contact [11].
Other Routes	Relevant data not found.
Skin Irritation	♦ No relevant experimental data reported, but according to suppliers of the substance it is indicated that repeated or prolonged contact may cause irritation [11].
Eye Irritation	♦ No relevant experimental data reported, but according to suppliers of the substance it may irritate or injure the eye [11].

Irritation of Respiratory Tract	♦No relevant experimental data reported, but according to suppliers of the substance it may irritate the respiratory tract on prolonged or repeated contact [11].
Skin Sensitisation	Relevant data not found.
Sensitisation by Inhalation	Relevant data not found.

Subchronic and Chronic Toxicity

Observation in humans	Intoxication of humans is rare but may happen in case of renal impairment [10].
Oral	♦Oral administration of large quantities of magnesium salts may cause central nerve system (CNS) depression [12].
Inhalation	♦No relevant experimental data is reported. According to the supplier inhalation of mineral dust over long periods of time may cause industrial bronchitis, reduce breathing capacity and lead to increased susceptibility to other lung diseases [11].
Dermal	No relevant data found.

Genotoxicity and Carcinogenicity

Mutagenicity	No relevant data found.
Gene Mutation	No relevant data found.
Chromosome Abnormalities	No relevant data found.
Other Genotoxic Effects	No relevant data found.
Cancer review	♦No IARC evaluation.

Reproductive Toxicity, Embryotoxicity and Teratogenicity

Reproductive Toxicity	No relevant data found.
Teratogenicity	No relevant data found.
Other Toxicity Studies	No relevant data found.
Toxicokinetics	No relevant data found.

Ecotoxicity Data

Algae	No relevant data found.
Crustacean	No relevant data found. *Gammarus lacustris* (data for Mg) LC_{50}(96h)=64.7 mg/l [13]
Fish	No relevant data found
Bacteria	No relevant data found

Environmental Fate

BCF	Essential element, not relevant
Aerobic biodegradation	Not relevant for inorganic compounds
Anaerobic biodegradation	Not relevant for inorganic compounds
Metabolic pathway	Essential element.
Mobility	No relevant data found

Conclusion

Health	Only few data are reported on the substance (acute oral toxicity in rat and mouse 8,500 mg/kg). Magnesium is used in pharmaceuticals and food, and short term human exposure to the substance in small quantities is assumed not to affect human health adversely. Repeated or prolonged human exposure to larger quantities of the substance may imply impact on human health, such as malaise and general irritation of skin and respiratory tract. Effects on the central nerve system (CNS) associated with long term exposure and large doses) can not be excluded.
Environment	Very few data was found on the compound $Mg(OH)_2$. The compound may dissociate in the environment. Magnesium is an essential element in many organisms. One LC_{50} was identified: 64.7 mg/l, which indicates that magnesium is harmful to crustaceans.

References

1 Chemfinder: http://www.chemfinder.com/cgi-win/cfserver.exe/

2 HAWLEY'S CONDENSED CHEMICAL DICTIONARY. Twelfth Edition. Revised by Richard J. Lewis, Sr. CD-rom. Van Nostrand Reinhold Company, New York, 1994.

3 SAX'S DANGEROUS PROPERTIES OF INDUSTRIAL MATERIALS Eighth Edition on CD-rom. Revised by Richard J. Lewis, Sr. Van Nostrand Reinhold Company, New York, 1994.

4 Hazardous Substance Data Bank (HSDB). HSDB ACCESSION NUMBER: 2648. UPDATE CODE: 199905. SRP REVIEW DATE: Reviewed by SRP on 1/23/1997. Online search December 1999.

5 RTECS. Online search December 1999.

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7 Toxline. Online search December 1999.

8 Environmental Fate Database - CHEMFATE (SRC/Procter and Gamble/EPA).
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9 Environmental Fate Database - BIODEG (SRC/Procter and Gamble/EPA)
Accessed through the web at: http://esc_plaza.syrres.com/efdb.htm

10 Casarett and Doull: TOXICOLOGY - The Basic Science of Poisons, fourth edition, Pergamon Press, New York, 1991.

11 Supplier MSDS:
http://www.sealers.com/msds/thio.htm

12 Supplier MSDS
http://www.jbaker.com/msds/m0160.htm

13 ECOTOX AQUIRE. ECOTOX database system. United States Environmental Protection Agency. Online search December 1999: http://www.epa.gov/ecotox/ecotox_home.htm

Ammonium Polyphosphate

CAS number: 68333-79-9

Data compilation, environmental and health screening

Summary

Health:

No relevant data available.

Environment:

The available data indicates that this substance may be harmful to crustaceans and possibly toxic to algae (the latter is based on a test with a formulated product).

Ammonium Polyphosphate

Identification of the substance

CAS No.	68333-79-9
EINECS No.	269-789-9
EINECS Name	Polyphosphoric acids, ammonium salts
Synonyms	No relevant data found
Molecular Formula	No relevant data found
Structual Formula	No relevant data found
Known Uses	In fire-retardant intumescent paints, mastics, and polymers.
EU	Classification on annex 1 in Directive 67/548/EØF and its revisions: None

Physico-chemical Characteristics

Physical Form	No relevant data found
Molecular Weight	No relevant data found
Melting Point/range (°C)	No relevant data found
Boiling Point/range (°C)	No relevant data found
Decomposition Temperature (°C)	No relevant data found
Vapour Pressure (mm Hg(°C))	No relevant data found
Relative Density	No relevant data found
Vapour Density (air=1)	No relevant data found
Solubility (water)	No relevant data found
Partition Coefficient (log P_{ow})	No relevant data found
pK_a	No relevant data found
Flammability	No relevant data found
Explosivity	No relevant data found

Oxidising properties	No relevant data found

Toxicological Data

Observation in humans	No relevant data found.

Acute Toxicity

Oral	No relevant data found.
Dermal	No relevant data found.
Inhalation	No relevant data found.
Other Routes	No relevant data found.
Skin Irritation	No relevant data found.
Eye Irritation	No relevant data found.
Irritation of Respiratory Tract	No relevant data found.
Skin Sensitisation	No relevant data found.
Sensitisation by Inhalation	No relevant data found.

Subchronic and Chronic Toxicity

Observation in humans	No relevant data found.
Oral	No relevant data found.
Inhalation	No relevant data found.
Dermal	No relevant data found.

Genotoxicity and Carcinogenicity

Mutagenicity	No relevant data found.
Gene Mutation	No relevant data found.
Chromosome Abnormalities	No relevant data found.
Other Genotoxic Effects	No relevant data found.
Cancer review	No relevant data found.

Reproductive Toxicity, Embryotoxicity and Teratogenicity

Reproductive Toxicity	No relevant data found.
Teratogenicity	No relevant data found.
Other Toxicity Studies	No relevant data found.
Toxicokinetics	No relevant data found.

Ecotoxicity Data

Algae	*Selenastrum capricornutum* (fw) One value is available on a formulation (FIRE-TROL LCG-R, unknown composition) IC_{50}(96h)= 10.00 mg/l [10].
Crustacean	*Daphnia magna* EC_{50}(48h)=90.89 mg/l [10] EC_{50}(48h)=99.74 mg/l [10] Two values are available on a formulation (FIRE-TROL LCG-R) EC_{50}(48h)= 813-848 mg/l [10].
Fish	*Oncorhynchus mykiis* (fw): LC_{50}(96h.)=1,326.0 mg/l at pH 7[10] LC_{50}(96h.)=123.0 mg/l at pH 8 [10] Several values are available on a formulation (FIRE-TROL LCG-R) Low range LC_{50}(96h)= 872-910 mg/l [10].
Bacteria	No relevant data found

Environmental Fate

BCF	No relevant data found
Aerobic biodegradation	No relevant data found
Anaerobic biodegradation	No relevant data found
Metabolic pathway	No relevant data found

Conclusion

Health	The available data are not sufficient to make a health screening.

Environment	The available data indicates that this substance may be harmful to crustaceans and possibly toxic to the algae (the latter is based on a test with a formulated product).
Mobility	No relevant data found

References

1 Chemfinder:
http://www.chemfinder.com/cgi-win/cfserver.exe/

2 HAWLEY'S CONDENSED CHEMICAL DICTIONARY. Twelfth Edition. Revised by Richard J. Lewis, Sr. CD-rom. Van Nostrand Reinhold Company, New York, 1994.

3 SAX'S DANGEROUS PROPERTIES OF INDUSTRIAL MATERIALS Eighth Edition on CD-rom. Revised by Richard J. Lewis, Sr. Van Nostrand Reinhold Company, New York, 1994.

4 Hazardous Substance Data Bank (HSDB). HSDB ACCESSION NUMBER: 2648. UPDATE CODE: 199905. SRP REVIEW DATE: Reviewed by SRP on 1/23/1997. Online search December 1999.

5 RTECS. Online search December 1999.

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10 ECOTOX AQUIRE. ECOTOX database system. United States Environmental Protection Agency. Online search December 1999: http://www.epa.gov/ecotox/ecotox_home.htm

Red Phosphorus

CAS number: 7723-14-0

Data compilation, environmental and health screening

Summary

Remark

Phosphorus exists in many allotropic forms (same molecular structure, different crystal lattice structure). Most data on phosphorus are on the white and yellow forms. Red phosphorus is prepared by heating white phosphorus to 270-300 °C in the absence of air. The red form of phosphorus is much less reactive than the white and presumably also the yellow form.

Health

Red phosphorus is often contaminated with white and yellow phosphorus. Therefore information of the two other allotropic forms included. Red phosphorus is not absorbed very well.

Lethal dose in mammals 1.4 - 4.8 mg/kg bw (allotropic form not specified). Pure red phosphorus is apparently less harmful than the two other allotropic forms. Inhalation of 4.3 mg/l red phosphorus (1h) or 1.5 mg/l (4 h) killed 9 respectively 2 of 10 rats.

The substance is classified as highly flammable and may explode when exposed to heat or by chemical reaction with oxidisers. Red phosphorus can also react with reducing materials and represent a moderate explosion hazard by chemical reaction or on contact with organic materials. It reacts with oxygen and water vapour to produce the toxic phosphine. The abiotic degradation of yellow phosphorus proceeds at ambient temperature.

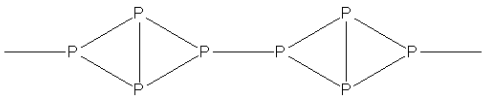
Environment

No ecotoxicological data on red phosphorus were located.

Yellow phosphorus is very toxic to crustaceans and fish in standard tests (L(E)C50 down to 0.011 mg/l and 0.018 mg/l, respectively)

Red Phosphorus

Identification of the substance

CAS No.	7723-14-0 (this CAS No. is covering all allotropic forms of elementary phosphorus: red, yellow, white etc.).
EINECS No.	231-768-7
EINECS Name	Phosphorus
Synonyms	Red phosphorus; Phosphorus, red, amorphous; Phosphorus (yellow); yellow phosphorus; elemental white phosphorus; Exolit-LPKN-WP; Exolit VPK-n 361, Fosforo-Bianco- (Italian), phosphorus, amorphous, red; Rat nip; Bonide Blue Death Rat Killer; White phosphorus; Phosphorus (white); Phosphorus-31; *; *Phosphorus,-white,-molten-, Phosphore-Blanc (French), Phosphorus- (red), Phosphorus (yellow or white); Phosphorus atom; Phosphorous, Yellow/White Black-Phosphorus; *Bonide-Blue-Death-Rat-Killer; Gelber-Phosphor- (German), Rat-Nip, Red-Phosphorus, Tetrafosfor (Dutch), Violet-Phosphorus, Weiss-Phosphor- (German), White-Phosphorus; Yellow-Phosphorus
Molecular Formula	P_4 (chain)
Structual Formula	
Known uses	Manufacture of phosphoric acid and other phosphorus compounds, phosphor bronzes, metallic phosphides, additive to semiconductors, electroluminescent coatings, striking surfaces for matches, fertilizers and as flame retardants in polymers.
EU	Classification on annex 1 in Directive 67/548/EØF and its revisions: F;R11 R16 (Highly flammable; Explosive when mixed with oxidising substances).

Physico-chemical Characteristics

Physical Form	Exists in three main allotropic forms: white, black, and red. The same liquid is obtained from all forms on melting. Colorless or white, transparent, crystalline solid; waxy appearance; darkens on exposure to light. Sometimes called yellow phosphorus; color due to impurities. Two allotropic modifications: alpha-form exists at room temperature; cubic crystals containing P_4 molecules; beta-form hexagonal crystals. Yellow (allotropic form): White to yellow, soft, waxy solid.

Molecular Weight (g/mol)	Depending on crystal structure (number of P_4 in chains) P_4 single=123.90
Melting Point/range (°C)	>590 [6]
Boiling Point/range (°C)	>400 [6]
Decomposition Temperature (°C)	No relevant data found
Vapour Pressure (mm Hg(°C))	0.026 at 20 °C [4]
Density	Density=2.2 g/cm^3 [6]
Vapour Density (air=1)	4.77 [4]
Solubility (water)	5 mg/l at 35 °C [6] Insoluble in water [2]
Partition Coefficient (log P_{ow})	No relevant data found
pK_a	No relevant data found
Flammability	Large quantities of red phosphorus ignite spontaneously and on exposure to oxidising materials [2]
Explosivity	No relevant data found
Oxidising properties	No relevant data found

Toxicological Data

Observation in humans	One case of phosphorus poisoning (effect not specified) in an 18-month old male is reported [4]. ♦The lowest lethal dose referred to in humans is found to be 1.4 mg/kg [6].

Acute Toxicity

Oral	♦LD50 Rat oral 3.03 mg/kg, allotropic form not specified [4, 6]. ♦LD50 Mouse oral 4.82 mg/kg, allotropic form not specified [4, 6]. Elemental red phosphorus is non-volatile, insoluble and thus non-toxic when ingested, unless it is contaminated with traces of yellow phosphorus. Ingestion of such a mixture produces a sensation of warmth or a burning pain in the throat connected to an intense thirst, vomiting, diarrhoea or severe abdominal pain. Worst cases may be severe enough to cause death in 24 to 48 hours, possible because of hepatic failure, central nervous system damage or renal insufficiency [4]. Elemental yellow phosphorus is highly toxic. The acute fatal dose in adults is 15 to 100 mg (1 mg/kg), although survival has occurred after ingestion exceeding 1 g. The fatality rate varies between 20% and 50%. [4]. White phosphorus is extremely poisonous and can cause "phossy jaw", a disease caused by phosphorus fumes that are inhaled or absorbed through cavities in the teeth and then attack and destroy bones, particularly the jaw bone. Phossy jaw is usually fatal. [4].
Oral cont.	The mortality rate of acute phosphorus (allotropic form not specified) poisoning is approximately 25% for victims who had early symptoms of nausea and vomiting, nearly 50% when both gastrointestinal and CNS symptoms were present, and almost 75% when the first manifestation of poisoning was restlessness, irritability, or coma. Most likely this difference in survival rates reflects the interval between time of ingestion and treatment. ♦The toxic dose is 15 mg, and as little as 50 mg may be lethal.
Dermal	♦LD50 for dermal application on rats is found to be 100 mg/kg bw, allotropic form not specified [6]. ♦A skin contact produces painful penetrating of second and third degree burns, which heal slowly [4].

Inhalation	♦9 out of 10 rats died when exposed for 1 hour to 4.3 mg/l red phosphorus, and 2 out of 10 died when exposed to 1.5 mg/l for 4 hours [6]. Inhalation of phosphorus vapour (allotropic form not specified) by rabbits for 30 min daily at a concentration of 150-160 mg/m^3 led to decreased haemoglobin counts [4]. Rabbits and rats were exposed to single doses of smoke from pyrotechnic mixtures containing red phosphorus. The survivors were observed for up to 14 days. Most of the histological changes observed were found in the respiratory tract, including abnormalities in the alveolitis and, in a few cases, frank pneumonia. [4]. Mice and rats were exposed to the smoke produced by ignition of a red phosphorus pyrotechnic composition, 1 hour/day, 5 days/week, at two different dose levels, together with controls. The mice received 180 exposures, while the rats received 200 exposures. Guinea pigs also underwent 200 exposures at the lower concentration, but all animals exposed at the higher concentration died during or immediately after the first dose. Growth of the test groups of mice and rats was depressed during the exposure period. Organ specific toxicity appeared not to be present in rats and was generally confined to the respiratory tract of the mice and the guinea pigs. [4].
Other Routes	Rats injected subcutaneously with 0.05 mg/kg of yellow phosphorus per day developed bone changes after administration of 50 mg. [4]. Subcutaneous injection of 0.2-0.4 mg/kg/day (allotropic form not specified) in dogs caused delayed deaths within a few days [4].
Skin Irritation	The substance (allotropic form not specified) is corrosive [6].
Eye Irritation	The substance (allotropic form not specified) irritates eyes [4].
Irritation of Respiratory Tract	Inhalation of more than 20 ppm phosphorus (allotropic form not specified) vapours by rats (7 hours/day, 5 days/week) resulted in severe respiratory irritation [4].
Skin Sensitisation	No relevant data found.
Sensitisation by Inhalation	No relevant data found.

Subchronic and Chronic Toxicity

Observation in humans	No relevant data found.
Oral	The most important manifestation of chronic phosphorus (allotropic form not specified) poisoning is osteomyelitis of the jaw bones ("phossy jaw"), which commonly begins as a dental disturbance. [4].

Inhalation	One inhalation study with an exposure period of 1-4 days and a dose level from 0 to 5.9 mg/kg bw (allotropic form not specified) showed for highest dose group minor effects on the respiratory system, such as irritation in the nose. [6].
Dermal	No relevant data found.

Genotoxicity and Carcinogenicity

Mutagenicity	No relevant data found.
Gene Mutation	No relevant data found.
Chromosome Abnormalities	No relevant data found.
Other Genotoxic Effects	No relevant data found.
Cancer review	No relevant data found.

Reproductive Toxicity, Embryotoxicity and Teratogenicity

Reproductive Toxicity	No relevant data found.
Teratogenicity	Two studies on oral ingestion of yellow phosphorus in rats showed no signs of teratogenicity [6].
Other Toxicity Studies	No relevant data found.
Toxicokinetics	Elemental yellow phosphorus is well absorbed from the skin and gastrointestinal tract. The lung and gut excrete yellow phosphorus, but little elimination occurs via the kidneys. ♦Red phosphorus is not absorbed very well [4]. In the body, phosphorus (allotropic form not specified) is converted to phosphates. It appears that it is metabolized to hypophosphoric acid via oxidation. [4].

Ecotoxicity Data

Algae	No relevant data found
Crustacean	Yellow phosphorus: *Daphnia magna:* EC_{50}(24h)=0.034-0.050 mg/l (US EPA, 63, 600/3-76/046) [6] EC_{50}(48h)=0.030-0.050 mg/l (US EPA, 63, 600/3-76/046) [6] ♦EC_{50}(48h)=0.011 mg/l (US EPA, 63, 600/3-76/046) [6]

Crustacean cont.	Yellow phosphorus: *Gammarus fasciatus:* EC_{50}(24h)=0.420-0.560 mg/l (US EPA, 63, 600/3-76/046) [6] ♦EC_{50}(48h)=0.012-0.250 mg/l (US EPA, 63, 600/3-76/046) [6] *Chironomus tentans:* EC_{50}(24h)=0.260 mg/l (US EPA, 63, 600/3-76/046) [6] EC_{50}(48h)=0.140 mg/l (US EPA, 63, 600/3-76/046) [6] *Asellus militaris:* EC_{50}(24h)>0.560 mg/l (US EPA, 63, 600/3-76/046) [6] EC_{50}(48h)>0.560 mg/l (US EPA, 63, 600/3-76/046) [6] A search in [9] resulted in several values on crustaceans. The allotropic form of phosphorus was however not specified for any of these values.
Fish	Yellow phosphorus: *Ictalurus punctatus* (fw): LC_{50}(24h)=0.152 mg/l (US EPA, 63, 60013-761046) [6] LC_{50}(48h)=0.087 mg/l (US EPA, 63, 60013-761046) [6] LC_{50}(96h)=0.073 mg/l (US EPA, 63, 60013-761046) [6] LC_{50}(26d)=0.0042 mg/l (Unknown U.S.EPA guideline) [6] LC_{50}(30d)=0.0068 mg/l (Unknown U.S.EPA guideline) [6] *Lepomis macrochirus* (fw): LC_{50}(24h)=0.0024-0.0032 mg/l (US EPA, 63, 60013-761046) [6] LC_{50}(48h)=0.009 mg/l (US EPA, 63, 60013-761046) [6] ♦LC_{50}(96h)= 0.0024-0.086 mg/l (USEPA, 63, 60013-761046) [6] LC_{50}(5d)=0.06 mg/l (US EPA, 63, 60013-761046) [6] *Onchorhynchus mykiis* (fw): LC_{50}(24h)=0.0061 mg/l (US EPA, 63, 60013-761046) [6] LC_{50}(48h)=0.0028 mg/l (US EPA, 63, 60013-761046) [6] ♦LC_{50}(96h)=0.0022 mg/l (US EPA, 63, 60013-761046) [6] *Pimephales promelas* (fw): LC_{50}(24h)=0.0022-0.560 mg/l (US EPA, 63, 60013-761046) [6] LC_{50}(48h)=0.021-0.560 mg/l (US EPA, 63, 60013-761046) [6] ♦LC_{50}(96h)=0.018-0.021 mg/l (US EPA, 63, 60013-761046) [6] LC_{50}(60d)=0.00071 mg/l (Unknown U.S.EPA guideline) [6] LC_{50}(241d)=0.0004-0.00071 mg/l (Unknown U.S.EPA guideline) [6] A search in [9] resulted in several values on fish. The allotropic form of phosphorus was however not specified for any of these values. The data therefore contains no useable information.
Bacteria	No relevant data found

Environmental Fate

BCF	No relevant data found.
Aerobic biodegradation	No relevant data found.

Anaerobic biodegradation	No relevant data found.
Metabolic pathway	No relevant data found.
Abiotic transformation	♦ Yellow phosphorus: $t_{½}$(pH 7)=280h at 0 °C [6] $t_{½}$ (pH 7)=268h at 3 °C [6] $t_{½}$ (pH 7)=11.9h at 93 °C [6]
Mobility	No relevant data found

Conclusion

Health	Red phosphorus is often contaminated with white and yellow phosphorus. Therefore information of the two other allotropic forms included. Red phosphorus is not absorbed very well. Lethal dose in mammals 1.4 - 4.8 mg/kg bw (allotropic form not specified). Pure red phosphorus is apparently less harmful than the two other allotropic forms. Inhalation of 4.3 mg/l red phosphorus (1h) or 1.5 mg/l (4 h) killed 9 respectively 2 of 10 rats. The substance is classified as highly flammable and may explode when exposed to heat or by chemical reaction with oxidisers. Red phosphorus can also react with reducing materials and represent a moderate explosion hazard by chemical reaction or on contact with organic materials. It reacts with oxygen and water vapour to produce the toxic phosphine. The abiotic degradation of yellow phosphorus proceeds at ambient temperature.
Environment	No ecotoxicological data on red phosphorus were located. Yellow phosphorus is very toxic to crustaceans and fish in standard tests (down to 0.011 mg/l and 0.018 mg/l, respectively)

References

1 Chemfinder: http://www.chemfinder.com/cgi-win/cfserver.exe/

2 HAWLEY'S CONDENSED CHEMICAL DICTIONARY. Twelfth Edition. Revised by Richard J. Lewis, Sr. CD-rom. Van Nostrand Reinhold Company, New York, 1994.

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4 Hazardous Substance Data Bank (HSDB). HSDB ACCESSION NUMBER: 2648. UPDATE CODE: 199905. SRP REVIEW DATE: Reviewed by SRP on 1/23/1997. Online search December 1999.

5 RTECS. Online search December 1999.

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7 Environmental Fate Database - CHEMFATE (SRC/Procter and Gamble/EPA).
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8 Environmental Fate Database - BIODEG (SRC/Procter and Gamble/EPA)
Accessed through the web at: http://esc_plaza.syrres.com/efdb.htm

9 ECOTOX AQUIRE. ECOTOX database system. United States Environmental Protection Agency.
Online search December 1999: http://www.epa.gov/ecotox/ecotox_home.htm

Zinc Borate

CAS number: 1332-07-6

Data compilation, environmental and health screening

Summary

Health:

There is not sufficient data to make a complete health screening of zinc borate.

Boric acid can be formed, if zinc borate gets in contact with water, e.g. body fluids. By skin contact there is a risk of formation of boric acid which can irritate skin and eyes. Boric acid is suspected of having effects on the unborn child.

Inhalation of zinc borate dust may cause irritation of the respiratory tract.

Environment:

No data was found on the compound $ZnO(B_2O_3)_2$. Using data disodium tetraborate (CAS number:1330-43-4) is not harmful to crustaceans or fish based on a limited data set. The Zn-ion is very toxic in aquatic standard test (acute effects < 1 mg/l).

This approach is based on the assumption that the total toxicity of zinc borate originates from the boric acid and zinc ion formed upon dissolution.

Zinc Borate

Identification of the substance

CAS No.	1332-07-6
EINECS No.	215-566-6
EINECS Name	Boric acid, zinc salt
Synonyms	Borax-2335-, Boric-acid,-zinc-salt-, ZB-112-, ZB-237-, ZN-100-
Molecular Formula	$ZnO(B_2O_3)_2$
Structural Formula	No data
Known Uses	Antimicrobial in cosmetics [10,11]. Fire retardant for PVC, cellulose and unsaturated halogenated polyesters; fireproofing textiles; synergist with antimony oxide and aluminium trihydrate [4].
EU	Classification on annex 1 in Directive 67/548/EØF and its revisions: None. Denmark has proposed to EU that boric acid should be classified as Rep3;R63 - possible risk of harm to the unborn child.

Physico-chemical Characteristics

Physical Form	White, amorphous powder [4]
Molecular Weight	383.41 [4]
Melting Point/range (°C)	980 °C
Boiling Point/range (°C)	No relevant data found
Decomposition Temperature (°C)	No relevant data found
Vapour Pressure (mm Hg(°C))	No relevant data found
Relative Density	3.64 and 4.22 [4]
Vapour Density (air=1)	No relevant data found
Conversion Factor	No relevant data found
Solubility (water)	♦ Slightly soluble in water, 0.3% (3 g/l) in water at 20 °C [4]. The solubility of the Na-salt of boric acid in water at 20°C is 47.1 g/l.
Partition Coefficient (log P_{ow})	No relevant data found

pK_a	No relevant data found
Flammability	May burn, but does not ignite readily
Explosivity	May polymerise explosively when heated.
Oxidising properties	No relevant data found

Toxicological Data

Observation in humans	No relevant data found for Zinc Borate.

Acute Toxicity

Oral	No acute toxicity on Zinc Borate. Zinc toxicity from ingestion is uncommon but gastrointestinal distress and diarrhea have been reported. Human ingestion of 12 g of elemental zinc over a two-day period did not lead to any evidence of hematological, hepatic or renal toxicity [12]. The LD50 for Boric Acid seams be between 2,000- and 3,500 mg/kg. Studies have indicated that the substance may cause effects on the Central Nerve System (CNS).
Dermal	No relevant data found for Zinc Borate.
Inhalation	Inhalation of dust may irritate nose and throat [4].
Other Routes	No relevant data found for Zinc Borate.
Skin Irritation	♦ Contact with skin causes irritation [4].
Eye Irritation	♦ Contact with eyes causes irritation [4].
Irritation of Respiratory Tract	No relevant data found for Zinc Borate.
Skin Sensitisation	No relevant data found for Zinc Borate.
Sensitisation by Inhalation	No relevant data found for Zinc Borate.

Subchronic and Chronic Toxicity

Observation in humans	No relevant data found for Zinc Borate.

Oral	No relevant data found for Zinc Borate.
Inhalation	No relevant data found for Zinc Borate.
Dermal	No relevant data found for Zinc Borate.

Genotoxicity and Carcinogenicity

Mutagenicity	No relevant data found for Zinc Borate.
Gene Mutation	No relevant data found for Zinc Borate.
Chromosome Abnormalities	No relevant data found for Zinc Borate.
Other Genotoxic Effects	No relevant data found for Zinc Borate.
Cancer review	No relevant data found for Zinc Borate.

Reproductive Toxicity, Embryotoxicity and Teratogenicity

Reproductive Toxicity	No relevant data found for Zinc Borate.
Teratogenicity	Boric Acid is proposed to be classified in EU because of a possible risk of harm to the unborn child.
Other Toxicity Studies	No relevant data found for Zinc Borate.
Toxicokinetics	No relevant data found for Zinc Borate but Zinc itself does not accumulate from continued exposure [12].

Ecotoxicity Data

Algae	No relevant data found Zinc: *Selenastrum capricornutum:* EC_{50}(24h)=0.015-0.178 mg/l (T)[13]

Crustacean	Disodium tetraborate: *Daphnia magna*: LC_{50}(48h)=141.0 mg/l [13] Zinc: *Daphnia magna*: LC_{50}(48h)=1.59 mg/l (T)[13] LC_{50}(48h)=0.068 mg/l (T) [13] *Ceriodaphnia dubia:* LC_{50}(48h)=0.070-0.153 mg/l (T) [13] *Ceriodaphnia reticulata* LC_{50}(48h)=0.076-0.264 mg/l (T) [13]
Fish	Disodium tetraborate: *Gambusia affinis* (fw): LC_{50}(24h)=3,460.0 mg/l (F) [13] LC_{50}(48h)=2,360.0 mg/l (F) [13] LC_{50}(96h)=1,040.0 mg/l (F) [13] LC_{50}(6d)=547.0 mg/l (F) [13] *Lepomis macrochirus* (fw): LC_{50}(24h)=15. 0 mg/l (F) [13] Zinc: *Oncorhynchus mykiis* (fw): LC_{50}(48h)=0.79–5.9 mg/l (T) [13] LC_{50}(48h)=0.59–5.3 mg/l (T) [13] LC_{50}(14d)=0.410 mg/l (T) [13] *Pimephales promelas* (fw): LC_{50}(14d)=2.154-2.540 mg/l (T) [13]
Bacteria	No relevant data found
Other aquatic organisms	Disodium tetraborate: *Chironomus decorus*: LC_{50}(48h)=1,376.0 mg/l [13] Zinc: *Thalassiosira guillardii*: LC_{50}(48h)=0.500-20.00 mg/l [13]

Environmental Fate

BCF	No relevant data found
Aerobic biodegradation	No relevant data found
Anaerobic biodegradation	No relevant data found
Metabolic pathway	No relevant data found
Mobility	No relevant data found

Conclusion

Health	There is not sufficient data to make a health screening of zinc borate. Boric acid can be formed, if zinc borate gets in contact with water, e.g. body fluids. The solubility of zinc borate is less than 10% of the solubility of disodium tetraborate. By skin contact there is a risk of formation of boric acid which can irritate skin and eyes. Boric acid is suspected of having effects on the unborn child. Inhalation of zinc borate dust may cause irritation of the respiratory tract.
Environment	No data was found on the compound $ZnO(B_2O_3)_2$. Disodium tetraborate (CAS number 1330-43-4) is not harmful to crustaceans or fish based on a limited data set. The Zn-ion is toxic to very toxic standard test with crustaceans and fish (acute effects 10 to < 1 mg/l). This approach is based on the assumption that the total toxicity of zinc borate originates from the boric acid and zinc ion formed upon dissolution.

References

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3 SAX'S DANGEROUS PROPERTIES OF INDUSTRIAL MATERIALS Eighth Edition on CD-rom. Revised by Richard J. Lewis, Sr. Van Nostrand Reinhold Company, New York, 1994.

4 Hazardous Substance Data Bank (HSDB). HSDB ACCESSION NUMBER: 2648. UPDATE CODE: 199905. SRP REVIEW DATE: Reviewed by SRP on 1/23/1997. Online search December 1999.

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Melamine

CAS number: 108-78-1

Data compilation, environmental and health screening

Summary

Health:

Melamine seems to be only mildly toxic if ingested by animals. There is not sufficient data to predict acute toxicity from dermal application in humans. The available test data do not show evidence of irritation, cancer induction or mutageneity by melamine.

Based on animal tests it seems there is a risk of formation of stones in the urinary bladder.

Dermatitis has been reported from melamine formaldehyde resins and glues. Probably these cases were chiefly due to formaldehyde or intermediate reaction products of formaldehyde.

The LD50 for application of melamine on rabbit skin is found in one study to be slightly larger than 1 mg/kg (1 mg/kg implicates a high risk of adverse effects on skin of humans).

Environment:

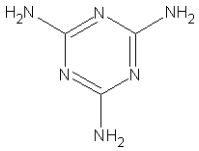
The reviewed limited toxicity data show little aquatic toxicity of melamine. A 96h algae EC_{50} is 940 mg/l, a 21d NOEC for Daphnia 18 mg/l.

The available BCF and the pK_a values indicate that the bioaccumulation of this compound is low in the natural pH range (pH 6-8).

The available biodegradation data indicates that this compound is persistent both under aerobic and anaerobic conditions.

Melamine

Identification of the substance

CAS No.	108-78-1
EINECS No.	203-615-4
EINECS Name	Melamine
Synonyms	Cymel; 1,3,5-Triazine-2,4,6-triamine; cyanuramide; cyanuric triamide; triaminotriazine; 2,4,6-triamino-1,3,5-triazine; cyanurotriamide; cyanurotriamine; 2,4,6-triamino-s-triazine; s-triaminotriazine; 1,3,5-triazine-2,4,6(1H,3H,5H)triimine; 2,4,6-triamino sym-triazine; AERO; hicophor pr; isomelamine; teoharn; theoharn; virset 656-4; Sym Triaminotriazine
Molecular Formula	$C_3H_6N_6$
Structural Formula	
Known Uses	Melamine resins, organic synthesis, leather tanning, melamine resin [2,6]. Food additive [3,4]. Production of high pressure laminate resins, moulding compounds, surface coating, textile and paper treating resins, adhesive resins for gluing lumber and as a flame retardant [4,6]. Production of paint and lacquers [6].
IUCLID	No data (will reportedly be included in new IUCLID version)
EU	Classification on annex 1 in Directive 67/548/EØF and its revisions: None.

Physico-chemical Characteristics

Physical Form	Monoclinic prisms, colourless or white crystals [4].
Molecular Weight (g/mole)	126.13
Melting Point/range (°C)	345 [1], 354 [2], 350 [6]
Boiling Point/range (°C)	Sublimes [1,3]

Decomposition Temperature (°C)	No relevant data found
Vapour Pressure (mm Hg at °C)	50 at 315°C [3,4] and $3.6x10^{-10}$ at 20 °C [4]
Density	Specific gravity=1.573 g/cm^3at 14 °C [1] Specific gravity=1.573 g/cm^3 at 4 °C [2] Specific gravity=1.574 g/cm^3 at 20 °C [6]
Vapour Density (air=1)	No relevant data found
Solubility (water)	3.2 g/l at 20 °C [6]
Partition Coefficient (log P_{ow})	-1.14 at 25 °C (OECD 107) [6].
pK_a	pK_a≈5.00 [5,8] ♦pK_a=5.16 at 20 °C [8]
Flammability	Not flammable [6]
Explosivity	Not explosive [6]
Oxidising Properties	No oxidising properties [6]

Toxicological Data

Observation in Humans	It is reported that: ♦Workers engaged in the production of melamine-formaldehyde products had dermatoses. This effect is assessed to be due to irritation [6]. ♦Workers engaged in the production of melamine and dicyanidiamide showed symptoms of allergic dermatitis [6]. ♦ Some workers suffered dermatitis on areas of exposed skin in production of fiber-resin composite by impregnation of cellulose fibers with phenol-formaldehyde and melamine-formaldehyde resins [7].

Acute Toxicity

Oral	No data are available on the acute effects of melamine in humans [7]. Oral-rat LD50: 3,100-3,800 mg/kg [6]. Oral-rat (male) LD50: 3,200 mg/kg [3,4]. Oral-rat (female) LD50: 3,800 mg/kg [4]. Oral-mouse LD50: 4,550 mg/kg [6]. Oral-mouse (male) LD50: 3,296 mg/kg [3,4,6]. Oral-mouse (female) LD50: 7,000 mg/kg [4,6].
Dermal	♦One study has found a very low value for "Skin-rabbit LD50". This value is just above >1mg/kg. [5].
Inhalation	Without specifying the time of exposure inhalation-rat LC50 is referred to be 3,248 mg/m^3 [5].
Other Routes	No relevant data found.
Skin Irritation	Melamine is not irritating in Guinea Pigs at solutions of 1% in water [6].
Eye Irritation	Eyes-rabbit, adult 500 mg/24h [5]. Not irritating [6].
Irritation of Respiratory Tract	No relevant data found.
Skin Sensitisation	Not a sensitiser [6].
Sensitisation by Inhalation	No relevant data found.

Subchronic and Chronic Toxicity

Observation in humans	No data are available on the subchronic effects of melamine in humans [7].

Oral	Chronic feeding tests have been carried out on rats over a period of 2 years at a dietary level of 1,000 ppm and on dogs for 1 year at a level of 30,000 ppm. Throughout the study, the general health was not significantly different from that of the controls. At these levels microscopic examination of the tissues revealed no abnormality attributable to the feeding of Melamine. [4]. Body weight gain was depressed in males receiving 6,000 and 12,000 ppm but not in females [6]. When rats where fed with Melamine at a 1.0% level (10,000 ppm) over their life-span, bladder stones with benign papillomata were found in about 1/3 of the animals. These papillomata are interpreted as a typical response of the rat's bladder mucosa to the presence of a foreign body. No disturbance of the nutrition or the general healthy appearance of these animals was noted. [4]. In 2 studies on B6C3F mice and 2 on Fischer 344/N rats effects on bladder after 14 days exposure have been studied. In these studies stones were found in the urinary bladders of most male rats, as a dose-related incidence, and in the bladders of some female rats receiving 15,000 mg/kg or more. Bladder stones were observed in both male and female mice receiving 12,000 mg/kg or more [4,6].
Inhalation	No relevant data found.
Dermal	♦Dermatitis has been reported from melamine formaldehyde resins and glues. Probably these cases were chiefly due to formaldehyde or intermediate reaction products of formaldehyde.

Genotoxicity and Carcinogenicity

Mutagenicity	Oral-rat TDLo: 195 g/kg/2Y [3,5]. Melamine (tested up to 5,550 µg/plate) was not mutagenic to Salmonella typhimurium TA1535, TA1537, TA98 or TA100 in the presence or absence of a metabolic system (S9) from the liver of Aroclor-induced rats or hamsters. [4].
Gene Mutation	4 Ames test studies were negative in Salmonella typhimurium at concentrations of 0.1-5,000 µg/plate [6].
Chromosome Abnormalities	No relevant data found.
Other Genotoxic Effects	No relevant data found.
Cancer Review	Inadequate evidence of carcinogenicity in animals. ♦IARC Cancer Review: Group 3: No data available in humans. The agent is not classifiable as to its carcinogenicity to humans [3,4].

Reproductive Toxicity, Embryotoxicity and Teratogenicity

Reproductive Toxicity	No relevant data found.
Teratogenicity	No toxic effect or gross malformation was found in fetuses of pregnant rats injected intraperitoneally with 70 mg/kg bw melamine on gestation days 5 and 6, 8 and 9 or 12 and 13 [4].
Other Toxicity Studies	No relevant data found.
Toxicokinetics	No relevant data found.

Ecotoxicity Data

Algae	*Scenedesmus pannonicus*: ♦EC_{50}(96h)=940 mg/l [6]. NOEC(96h) = 320 mg/l [6].
Crustacean	*Daphnia magna*: EC_{50} (48h)>2000 mg/l [6] ♦LC_{100}(21d)=56 mg/l, NOEC(21d)=18 mg/l [6] NOEC(21d)=18 mg/l [6]
Fish	*Leuciscus idus* (fw): LC_{50}(48h.)>500 mg/l [6] LC_{50}(48h.)>50 mg/l (DIN 38.412 L-20) [6] *Poecilia reticulata* (fw): LC_{10}(96h)<4400 mg/l [6] LC_{50}(96h)>3000 mg/l [6] *Jordanella floridae* (fw): NOEC(35d)>10000 mg/l [6]
Bacteria	*Nitrosomonas sp.* (inhib. of ammonium-oxidation): EC_0(2h)>100 mg/l [6] *Pseudomonas putida* (DIN 38412, part 27): EC_{50} (30 min)>10000 mg/l [6], EC_{10} (30 min)>10000 mg/l [6]. Sludge (ISO 8192) EC_{10} (30 min)>1992 [6]

Environmental Fate

BCF	♦BCF ≈ 15, pH unknown) [6] BCF=0.05, estimated value, pH unknown [5] ♦BCF=6.45, estimated value, pH unknown [8]

Aerobic biodegradation	BOD_5 (20 °C)=0% BODTh, inoc. unknown [6] BOD_5<1 % BODTh, adap. unknown inoc. [6] ♦ Percent degraded (14 d)<30 %, MITI test [6] Percent degraded (20 d)<20 % TOC, adap. sludge inoc. [6]. ♦ A standard 5 days BOD test of melamine resulted in almost no biochemical oxygen demand. Based on the five day BOD data the author considered melamine to be non-biodegradable [5].
Anaerobic biodegradation	♦ After up to 28 weeks incubation a nitrification of 0-8.9 % was observed in field study in silty clay loam at a test compound concentration of 0.2 mg/g at 32 °C [6].
Metabolic pathway	Pure culture studies of 3 mM melamine samples indicated the degradation pathway of melamine involves the conversion of melamine to ammeline and eventually cyanuric acid. [5]
Mobility	K_{oc}=51 , estimated value, pH unknown [8] Adsorption of melamine to suspended clay sediment was reported from pH 1 to 6.5, with a maximum absorption of 5.00×10^{-4} mols/g at pH 4.0 [4].

Conclusion

Health	The available data lead to the conclusion that melamine seems to be only mild toxic ingested by animals (LD50 >3,000 mg/kg). There is not sufficient data to predict acute toxicity from dermal application in humans. The available data does not show evidence of cancer induction by melamine. Based on animal tests it seems that there is a risk of formation of stones in the urinary bladder. Dermatitis has been reported from melamine formaldehyde resins and glues. Probably these cases were chiefly due to formaldehyde or intermediate reaction products of formaldehyde. The LD50 for application of melamine on rabbit skin is found in one study to be slightly larger than 1 mg/kg (1 mg/kg implicates a high risk of adverse effects on skin of humans).

Environment	The reviewed literature indicates that show little aquatic toxicity. A 96h algae EC_{50} is 940 mg/l, a 21d NOEC for Daphnia 18 mg/l. From the available BCF and the pK_a values indications are available that the bioaccumulation of this compound is low in the natural pH range (pH 6-8). The biodegradation data available indicates that this compound is persistent both under aerobic and anaerobic conditions.

References

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9 Environmental Fate Database - BIODEG (SRC/Procter and Gamble/EPA)
Accessed through the web at: http://esc_plaza.syrres.com/efdb.htm

Antimony trioxide

CAS number: 1309-64-4

Data compilation, environmental and health screening

Summary

Remark:

Antimony trioxide is used in combination with other flame retardants.

Health:

Antimony trioxide is in the EU classified as "Harmful (Xn)" and must be labelled with the risk-phrase "Possible risk of irreversible effects" (R40) as a possible carcinogen.

There are epidemiological indications that antimony trioxide causes dermatitis and has an impact on reproduction in female workers. The substance is reportedly teratogenic in rats.

Data from animal experiments seem to indicate that females are more sensitive concerning developing lung eoplasms than males.

The overall evaluation from IARC is: ‘Antimony trioxide is probably carcinogenic to humans’.

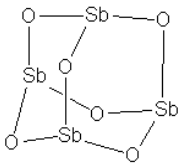
Environment:

The toxicity of the substance to algae ranges from harmful to very toxic (EC_{50} <1 to 67 mg/l). The majority of data is < 1 mg/l.

To crustaceans the substance is harmful (EC_{50} <100 mg/l). Weight-of-evidence indicates that the substance is not harmful to fish.

Antimony trioxide

Identification of the substance

CAS No.	1309-64-4
EINECS No.	215-175-0
EINECS Name	Diantimony trioxide
Synonyms	Antimony (III) oxide; antimony white; bianitmony trioxide; flowers of antimony; antimonius oxide; antimony peroxide; antimony sesquioxide; antimony oxide; diantimony trioxide; senarmontite; exitelite; weisspiessglanz; A1530; A1582; a1588 lp; AP 50; chemetron fire shield; ci 77052; ci pigment white 11; dechlorane a-o; nyacol a 1530; thermoguard b; thermoguard s; timonox
Molecular formula	Sb_4O_6
Structual Formula	
Known uses	Flameproofing of textiles, paper, and plastics (polyvinyl chloride); paint pigments; ceramic opacifier; catalyst; intermediate; staining iron and copper; phosphors; mordant; glass decolorizer [2].
EU	Classification on annex 1 in Directive 67/548/EØF and its revisions: Carc3;R40 (labelling: Xn; R40)

Physico-chemical Characteristics

Physical Form	White, odourless, crystalline powder [2], white cubes [3]
Molecular Weight (g/mol)	583.04
Melting Point/range (°C)	655 [2], 655 [4], 656 [5],
Boiling Point/range (°C)	1,425 °C [4], 1,550 °C at 1,000 hPa [6], 1,550 °C [3].
Decomposition Temperature (°C)	No relevant data found
Vapour Pressure (mm Hg(°C))	1 at 574 °C [4]
Density	Specific gravity=5.2 g/cm^3 (Senarmonite) [2] Specific gravity=5.67 g/cm^3 (Valenite) [2] Specific gravity=5.67 g/cm^3 [4] Specific gravity=5.2 g/cm^3 at 20 °C [3]

Vapour Density (air=1)	No relevant data found
Solubility (water)	Insoluble in water [3], Slightly soluble in water [4], < 0.0287 g/l at 20 °C [6]
Partition Coefficient (log P_{ow})	No relevant data found
pK_a	No relevant data found
Flammability	Flammable when exposed to heat or flame [3].
Explosivity	Moderately explosive when shocked [3]
Oxidising properties	No relevant data found

Toxicological Data

Observation in humans	Fifty-one workers (ages 31-54, mean 45.23 years) in an antimony melting plant (worked 9-31 years, mean 17.91 years), were exposed to airborne dust containing up to 88% antimony trioxide and the remainder, antimony pentoxide. Pneumoconiotic changes were seen in the lungs after 1 decade of employment. No systemic changes were seen except for "antimony dermatosis". No massive lung fibrosis was noted. 32 of the 51 exposed developed antimony dermatosis. 35% developed upper airway inflammation, 37% developed chronic bronchitis. [4]. ♦Female workers exposed to antimony aerosols in an antimony plant experienced a greater incidence of spontaneous abortions than did a control group of unexposed working women. There were higher rates of spontaneous late abortions (12.5 versus 4.1 percent), premature births (3.4 versus 1.2 percent), and gynaecological problems (77.5 versus 56 percent) among female metallurgical workers exposed to antimony aerosols. Antimony concentrations were not specified, but air samples reportedly contained metallic dust, antimony trioxide, and pentasulfide. Weights of the offspring began to lag behind those of control babies at 3 months, and were significantly reduced at 1 year. Blood antimony levels were 10 times those of a corresponding unexposed group of women, and average urinary antimony levels ranged from 2.1 to 2.9 mg versus none detected in the controls. Some values among the 318 tested reached 18.2 mg. Antimony in breast milk was 3.3 +/- 2 mg/l; in placentaltissue, 3.2 to 12.6 mg; in amniotic fluid, 6.2 +/ - 2.8 mg; and in blood 6.3 +/- 3 mg. [4]. Heavy exposure resulted in symptoms such as abdominal cramps, nausea, vomiting, diarrhea, metallic taste, and dyspnea. [4]. Ingestion in humans can cause irritation of the mouth, nose, stomach, and intestines; vomiting, purging with bloody stools; slow pulse, and low blood pressure; slow, shallow breathing; coma, and convulsions sometimes followed by death [4].

Acute Toxicity

Oral	LD_{50} Rat oral larger than 34,600 mg/kg [4,5,6]. LD_{50} Rabbit percutaneous larger than 2,000 mg/kg [4]. Rabbits fed daily up to 150 mg/kg for 4 weeks showed no pathologic changes [4].
Dermal	Skin-rabbit LDLo: 2 mg/kg.
Inhalation	Inhalation in humans causes inflammation of upper and lower respiratory tract [4]. Rats and rabbits exposed to antimony trioxide (90-125 mg antimony trioxide/m^3 during 100 h/month) for periods of up to 14 months, developed in addition to pneumonitis, also lipoid pneumonia, fibrous thickening of alveolar walls, and focal fibrosis. Rabbits appeared to be more susceptible than rats. [4]. Guinea pigs exposed to a dust concentration of antimony trioxide of 45.4 mg/m^3 of air, for 2 h daily 7 days a week for the first 3 weeks, later for 3 h daily; which corresponded to an estimated daily retention of 1.6 mg. All the animals showed extensive interstitial pneumonitis, and 4 died during the period of exposure. No cardiac lesions, as evidenced by the electrocardiogram, were observed. Fatty degeneration of the liver in 11 out of 15 guinea pigs having 138 or more hours of exposure was recorded. The blood picture showed a decrease in total white cells. [4].
Other Routes	No relevant data found
Skin Irritation	Contact with skin caused dermatitis [4], and the substance is regarded as moderately irritating [6].
Eye Irritation	Contact with eyes causes conjunctivitis [4].
Irritation of Respiratory Tract	Ingestion can cause irritation of the mouth and nose [4].
Skin Sensitisation	No relevant data found
Sensitisation by Inhalation	No relevant data found

Subchronic and Chronic Toxicity

Observation in humans	No relevant data found
Oral	No relevant data found

Inhalation	Three groups of 8 month old Wistar derived rats (90 males and 90 females per group) were exposed by inhalation to either antimony trioxide (time-weighted average (TWA) 45 mg/m^3), antimony ore concentrate (TWA 36 +40 mg/m^3), or filtered air (controls) for 7 h/day, 5 day/wk, for up to 52 weeks and sacrificed 20 weeks after terminating exposures. The concentration of antimony (Sb) in the lung of male rats (38,300 ug Sb/g) exposed to antimony trioxide was significantly larger than that in female rats (25,000 ug/g) exposed to antimony trioxide. The lung of both male and female rats exposed to antimony trioxide contained significantly more Sb than the lungs of males and females exposed to Sb ore (approximately 5 times larger). ♦The most significant findings were the presence of lung neoplasms in 27% of females exposed to antimony trioxide and 25% of females exposed to Sb ore concentrate. None of the male rats in any group or the female controls developed lung eoplasms. [4].
Dermal	No relevant data found

Genotoxicity and Carcinogenicity

Mutagenicity	Antimony trioxide produced differential killing in DNA repair-proficient compared to repair-deficient strains of Bacillus subtilis. In a spot test it was not mutagenic to Escherichia coli B/rWP2 or to Salmonella typhimurium TA1535, TA1537, TA1538, TA98 or TA100 (details not given). [4]. In general the substance is less mutagenic than many other metals such as As, Cr and Ni [7].
Gene Mutation	No relevant data found
Chromosome Abnormalities	No relevant data found
Other Genotoxic Effects	Antimony trioxide is not genotoxic in vivo and does not present a genotoxic hazard to humans [7].
Cancer review	♦There is inadequate evidence for the carcinogenicity of antimony trioxide in humans. There is sufficient evidence for the carcinogenicity of antimony trioxide in experimental animals. The overall evaluation is therefore: ‘Antimony trioxide is probably carcinogenic to humans’ (IARC: Group 2B)". [4].

Reproductive Toxicity, Embryotoxicity and Teratogenicity

Reproductive Toxicity	Female rats were exposed by inhalation for 4 hours per day for 1.5-2 months to 0 or 250 mg/m^3 antimony trioxide. They were then mated, and exposure continued until days 3-5 before expected delivery. Pregnancy was obtained in 16/24 treated females and in 10/10 controls. Litter size and weight of offspring at birth and weaning were not altered by exposure to antimony trioxide. [4].

Teratogenicity	♦Pregnant female rats (six to seven per group) were exposed by inhalation to 0, 0.027, 0.082 or 0.27 mg/m^3 antimony trioxide for 24 hours per day for 21 days. Fetal growth and viability were assessed at the end of gestation. Maternal body weight gain was not affected by exposure, but at the high-dose level increased pre- and postimplantation death of embryos was observed. At the mid-dose level, preimplantation loss and fetal growth retardation were evident. [4].
Other Toxicity Studies	No relevant data found
Toxicokinetics	There is no particular difference in tissue distribution between rabbit and rat, when the animals were fed with 2 percent Sb_2O_3 in a casein diet. Mean amounts of the antimony ranged from 6.7 to 88 ug/g of tissue in seven samples analyzed. The largest amounts were in the thyroid and adrenal glands, spleen, liver, lung, heart, and kidney. [4]. When rats were administered single oral doses of 200 mg antimony trioxide in 5 ml of water, only 3.24% of the dose was eliminated in the urine. Levels in the feces were not measured. After administration of antimony trioxide in the diet at a concentration of 2% for 8 months, antimony excretion in the feces was much larger than in the urine. [4]. After administration of 2% antimony trioxide to rats in the diet for eight months, very high levels were found in the thyroid, while retention was much lower (in decreasing order) in the liver, spleen, kidney, heart and lungs. After administration of 1% antimony trioxide to rats in the diet for 12 weeks, the highest antimony concentrations were found (in decreasing order) in the blood, spleen, lungs, kidneys, hair, liver and heart; 12 weeks after the end of treatment, levels in the blood, lungs and kidneys had decreased to about 50%, but the spleen still contained about 75% of the concentration observed at the termination of exposure. [4]. Part of the intravenously administered antimony salts is absorbed by erythrocytes, and the rest is distributed to other tissues, predominantly the liver, adrenals, spleen, and thyroid. In rats, trivalent antimony is absorbed by erythrocytes, distributed to other tissues, and retained in the liver for a short time before it is gradually excreted in feces. [4].

Ecotoxicity Data

Algae	*Selenastrum capricornutum*: EC_{50}(24h)>1.00 mg/l (T) [10] EC_{50}(48h)=0.74 mg/l (T) [10] ♦EC_{50}(72h)=0.73 mg/l (T) [10] ♦EC_{50}(72h)=67 mg/l (OECD 201) [6] EC_{50}(96h)=0.74 mg/l (T) [10] EC_{50}(96h)=0.76 mg/l (T) [10] NOEC(96h)=0.20 mg/l (T) [10]

Crustacean	*Daphnia magna*: ♦ EC_{50}(24h)=555.26 mg/l (T) [10] EC_{50}(48h)>1,000 mg/l (OECD 202) [6] ♦ EC_{50}(48h)=423.45 mg/l (T) [10] LC_{50}(24h)>530 mg/l (T) [10] LC_{50}(48h)>530 mg/l (T) [10]
Fish	*Brachydanio rerio* (fw): LC50(96h)>1,000.0 mg/l (OECD 203) [6] *Fundulus heteroclitus* (sw): LC_{50}(24h)>1,000.0 mg/l (T) [10] LC_{50}(48h)>1,000.0 mg/l (T) [10] LC_{50}(72h)>1,000.0 mg/l (T) [10] LC_{50}(96h)>1,000.0 mg/l (T) [10] *Lepomis macrochirus* (fw): LC_{50}(24h)>440.0 mg/l (T) [10] LC_{50}(96h)>440.0 mg/l (T) [10] *Pimephales promelas* (fw): LC_{50}(96h)>80.0 mg/l (T) [10]
Other aquatic organisms	*Tubifex tubifex* (fw): ♦ EC_{50}(24h)=108.0 mg/l (T) [10] ♦ EC_{50}(48h)=920.0 mg/l (T) [10] ♦ EC_{50}(96h)=678.0 mg/l (T) [10]
Bacteria	*Pseudomonas putida:* EC_{50}(7h)>3.5 mg/l (DIN 38412-L8) [6]

Environmental Fate

BCF	Antimony is possibly an essential element [1]
Aerobic biodegradation	Not relevant, inorganic compound
Anaerobic biodegradation	Not relevant, inorganic compound
Metabolic pathway	No relevant data found
Other biotic transformation	Pure cultural study using *Stibiobacter senarmontii*, an autotrophic bacterium isolated from antimony ore samples, demonstrated that biological transformation of antimony oxides in the environment could be possible. The bacteria were grown in a mineral medium containing antimony trioxide and oxidised the chemical (antimony trioxide) at rates of 45.5-51.6 mg/month for senarmonite (cubic) and 13.5-19.3 mg/month for valentinite (rhombic). Little antimony trioxide oxidation occurred in the sterile medium. [4]
Mobility	No relevant data found

Conclusion

Health	The overall evaluation from IARC is: 'Antimony trioxide is probably carcinogenic to humans'. Dermatitis and teratogenic effects are observed in animal experiments. Animal experiments also indicate that females are more sensitive with respect to developing lung neoplasms than males.
Environment	The toxicity of the substance to algae ranges from harmful to very toxic (EC_{50} <1 to 67 mg/l). The majority of data is < 1 mg/l. The available data on crustaceans indicates that the substance is harmful to crustaceans. Weight-of-evidence indicates that the substance is not harmful to fish.

References

1 Chemfinder: http://www.chemfinder.com/cgi-win/cfserver.exe/

2 HAWLEY'S CONDENSED CHEMICAL DICTIONARY. Twelfth Edition. Revised by Richard J. Lewis, Sr. CD-rom. Van Nostrand Reinhold Company, New York, 1994.

3 SAX'S DANGEROUS PROPERTIES OF INDUSTRIAL MATERIALS Eighth Edition on CD-rom. Revised by Richard J. Lewis, Sr. Van Nostrand Reinhold Company, New York, 1994.

4 Hazardous Substance Data Bank (HSDB). HSDB ACCESSION NUMBER: 2648. UPDATE CODE: 199905. SRP REVIEW DATE: Reviewed by SRP on 1/23/1997. Online search December 1999.

5 RTECS. Online search December 1999.

6 IUCLID CD rom, European Commission, C 1996.

7 Toxline. Online search December 1999.

8 Environmental Fate Database - CHEMFATE (SRC/Procter and Gamble/EPA). Accessed through the web at: http://esc_plaza.syrres.com/efdb.htm

9 Environmental Fate Database - BIODEG (SRC/Procter and Gamble/EPA) Accessed through the web at: http://esc_plaza.syrres.com/efdb.htm

10 U.S. EPA ECOTOX Database system. AQUIRE On line search December 1999. http://www.epa.gov/medecotx/ecotox_home.htm

Quinidine carbonate

CAS number: not available

Data compilation, environmental and health screening

Summary

Remark

The lack of data on the compound selected for screening led to the tentative use of available quinidine sulfate test data for the estimation of the toxicity of the quinidine carbonate. Only the summary page is presented.

Health
No relevant data was found on quinidine carbonate.

Environment
No relevant data was found on quinidine carbonate.

The toxicity of quinidine carbonate may tentatively be estimated from the following data on quinidine sulfate:
Artemia salina (sw):
LC_{50}(24 h) = 287 mg/l (Artoxkit M) [1]

Daphina magna:
LC_{50}(24 h) = 63 mg/l [1]

The toxicity of quinidine carbonate estimated from the toxicity of quinidine sulfate indicates that quinidine carbonate could be harmful to crustaceans.