DISODIUM METASILICATE

This dossier on disodium metasilicate presents the most critical studies pertinent to the risk assessment of disodium metasilicate in its use as a cement additive chemical. It does not represent an exhaustive or critical review of all available data. The information presented in this dossier was obtained from the OECD-SIDS documents on Soluble Silicates, which includes disodium metasilicate (OECD, 2004); and the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch *et al.*, 1997).

Screening Assessment Conclusion – Disodium metasilicate is classified as a **tier 1** chemical and requires a hazard assessment only.

1 BACKGROUND

Disodium metasilicate is a crystalline silicate that is readily solubilized in water. In the solubilized form, it is indistinguishable from solubilized amorphous silicates (e.g., sodium silicate). Upon dissolution in water, disodium metasilicate forms sodium ions (Na^+) and molecular speciation of silicates.

Disodium metasilicate is an inorganic substance and therefore not amenable to biodegradation. It is not expected to bioaccumulate. It is of low toxicity concern to aquatic organisms.

2 CHEMICAL NAME AND IDENTIFICATION

Chemical Name (IUPAC): Disodium oxosilanebis(olate)

CAS RN: 6834-92-0

Molecular formula: Na_2O_3Si

Molecular weight: Not applicable; disodium metasilicate is comprised of infinite chains of Na2O3Si units of variable length.

Molar ratio: 1.0.

Synonyms: Disodium metasilicate; Disodium oxosilanebis(olate); sodium metasilicate; sodium metasilicate anhydrous; silicic acid, disodium salt (anhydrous); sodium metasilicate pentahydrate

3 PHYSICO-CHEMICAL PROPERTIES

Key physical and chemical properties for the substance are shown in Table 1.

Table 1 Overview of the Physico-Chemical Properties of Disodium Metasilicate

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Colourless or white solid	-	ECHA
Melting Point	1089 °C (pressure not indicated)*	2	ECHA
Boiling Point	Not applicable	-	ECHA
Density	2,610 kg/m^3 (temperature not indicated)	2	ECHA
Vapour Pressure	0.00103 kPa @ 1175 °C	2	ECHA
Partition Coefficient (log K_{ow})	Not applicable	-	ECHA
Water Solubility	210 g/L @ 20 °C	2	ECHA
Dissociation Constant (pKa)	9.9, 11.8, 12 @ 30 °C	2	ECHA
Viscosity	Not applicable	-	ECHA

*Anhydrous form of disodium metasilicate

Sodium silicate is produced by fusing high purity quartz sand (SiO_2) and sodium carbonate or soda (Na_2CO_3) at temperatures of 1,300 to 1,500°C. The product that is formed is an amorphous glass that can be dissolved in water to produce silicate solutions. Various products of sodium silicate are obtained by varying the mixing ratio of quartz and soda. Sodium silicates are therefore characterized primarily by the SiO_2 to Na_2O ratio, or molar ratio (MR). Soluble silicates are generally not distinct stoichiometric chemical substances (with a specific chemical formula and molecular weight), but glasses or aqueous solutions of glasses (OECD, 2004).

Disodium metasilicate is a crystalline silicate, produced exclusively in the sodium form, by controlled crystallization of silicate solutions. The MR of disodium silicate is 1.0. Disodium metasilicate can be prepared in anhydrous form, or with water of crystallization as the penta- or nonahydrate (OECD, 2004).

Disodium metasilicate is readily solubilized in water. In the solubilized form, it is indistinguishable from solubilized amorphous silicates (e.g., sodium silicate). Upon dissolution in water, disodium metasilicate forms sodium ions (Na^+) and molecular speciation of silicates. Depending on both pH and concentration the respective solutions contain varying proportions of monomeric tetrahydral ions, oligomeric linear or cyclic silicate ions (OECD, 2004).

4 DOMESTIC AND INTERNATIONAL REGULATORY INFORMATION

A review of international and national environmental regulatory information was undertaken (Table 2). This chemical is listed on the Australian Inventory of Chemical Substances – AICS (Inventory). No conditions for its use were identified. No specific environmental regulatory controls or concerns were identified within Australia and internationally for disodium metasilicate.

NICNAS has assessed disodium metasilicate in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment[1] .

Table 2 Existing International Controls

Convention, Protocol or other international control	Listed Yes or No?
Montreal Protocol	No
Synthetic Greenhouse Gases (SGG)	No
Rotterdam Convention	No
Stockholm Convention	No
REACH (Substances of Very High Concern)	No
United States Endocrine Disrupter Screening Program	No
European Commission Endocrine Disruptors Strategy	No

5 ENVIRONMENTAL FATE SUMMARY

Disodium metasilicate readily dissolves in water to sodium ions (Na^+) and molecular speciation of silicates. Dissolved silica from commercial soluble silicates is indistinguishable from natural dissolved silica. Silica (SiO_2) represents about 59% of the elemental composition of the earth's crust. Similar percentages are obtained for many sediments and soils (Jackson, 1964). Compounds of silicon and oxygen are ubiquitous in the environment; it is present in inorganic matter, like minerals and soils and in organic matter.

Silica is found in all natural waters and the median values in the U.S. were reported to be 17 mg SiO_2/L for ground waters and 14 mg SiO_2/L for streams (Davis, 1964). The world-wide concentration in rivers is 13 mg SiO_2/L (Edwards and Liss, 1973).

Disodium metasilicate is an inorganic substance and therefore not amenable to biodegradation. It is not expected to bioaccumulate.

6 ENVIRONMENTAL EFFECTS SUMMARY

A. Summary

Disodium metasilicate is of low toxicity concern to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on disodium metasilicate.

[1] https://www.industrialchemicals.gov.au/chemical-information/search-assessments?assessmentcasnumber=6834-92-0

Table 3 Acute Aquatic Toxicity Studies on Disodium Metasilicate and Sodium Silicate

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Danio rario (previous name Brachydanio rerio)	96-hr LC_{50}	210	2	ECHA; OECD, 2004
Brachydanio rerio	96-hour LC_{50}	1,108*	2	ECHA; OECD, 2004
Oncorhynchus mykiss	96-hour LC_{50}	260 – 310*	2	ECHA; OECD, 2004
Daphnia magna	48-hour EC_{50}	1,700*	2	ECHA; OECD, 2004
Scenedesmus subspicatus	72-hour EC_{50}	207 (biomass)* >345.4 (growth rate)*	2	ECHA; OECD, 2004

*sodium silicate (CAS No. 1344-09-8)

Chronic Studies

No chronic studies are available.

C. Terrestrial Toxicity

There are no studies on disodium metasilicate or sodium silicate. A honeybee acute contact toxicity study according to (USEPA, 2012) has been conducted on AgSil™ 25 potassium silicate solution (29.1% potassium silicate in water). The 48-hr LD_0 was 25 µg/animal and the 48-hr LD_{50} was 25 µg/animal (ECHA).

7 CATEGORISATION AND OTHER CHARACTERISTICS OF CONCERN

A. PBT Categorisation

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2008).

Disodium metasilicate is an inorganic compound that dissociates completely to sodium and silicate ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions; both sodium and silicate ions are also ubiquitous and are present in most water, soil and sediment. For the purposes of this PBT assessment, the persistent criteria are not considered applicable to this inorganic compound.

Sodium and silicate ions are essential to all living organisms and is ubiquitous in the environment. Therefore, disodium metasilicate is not expected to bioaccumulate.

No chronic toxicity data exist on disodium metasilicate; however, the acute E(L)C50 values for disodium metasilicate and read-across substance sodium silicate are >1 mg/L in fish, invertebrates and algae. Therefore, disodium metasilicate does not meet the screening criteria for toxicity.

The overall conclusion is that disodium metasilicate is not a PBT substance.

B. Other Characteristics of Concern

No other characteristics of concern were identified for disodium metasilicate.

8 SCREENING ASSESSMENT

Chemical Name	CAS No.	Overall PBT Assessment [1]	Chemical Databases of Concern Assessment Step		Persistence Assessment Step		Bioaccumulative Assessment Step	Toxicity Assessment Step			Risk Assessment Actions Required[3]
			Listed as a COC on relevant databases?	Identified as Polymer of Low Concern	P criteria fulfilled?	Other P Concerns	B criteria fulfilled?	T criteria fulfilled?	Acute Toxicity [2]	Chronic Toxicity[2]	
Disodium metasilicate	6834-92-0	Not a PBT	No	No	NA	No	No	No	1	1	1

Footnotes:

1 - PBT Assessment based on PBT Framework.

2 - Acute and chronic aquatic toxicity evaluated consistent with assessment criteria (see Framework).

3 – Tier 1 – Hazard Assessment only.

Notes:

NA = not applicable

PBT = Persistent, Bioaccumulative and Toxic

B = bioaccumulative

P = persistent

T = toxic

9 REFERENCES, ABBREVIATIONS AND ACRONYMS

A. References

Davis, S.N. (1964). Silica in streams and ground water. Am. J. Sci. 262: 870-891.

Department of the Environment, Water, Heritage and the Arts (DEWHA). (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia.

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USEPA. (2012). Ecological Effects Test Guidelines. OCSPP 850.3020: Honey Bee Acute Contact Toxicity Test. January.

B. Abbreviations and Acronyms

^{o}C	degrees Celsius
AICS	Australian Inventory of Chemical Substances
COC	constituent of concern
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
g/L	grams per litre
hPa	hectopascal
IUPAC	International Union of Pure and Applied Chemistry
kg	kilogram
kg/m^3	kilograms per cubic metre

kPa	kilopascal
L	litre
LC	lethal concentration
LD	lethal dose
m	metre
mg/L	milligrams per litre
MR	molar ratio
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SGG	Synthetic Greenhouse Gases
SIDS	Screening Information Data Set
USEPA	United States Environmental Protection Agency
µg	micrograms