SILICIC ACID, POTASSIUM SALT

This dossier on silicic acid, potassium salt (potassium silicate) presents the most critical studies pertinent to the risk assessment of potassium silicate in its use in drilling muds. 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 potassium silicate (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 – Silicic acid, potassium salt is classified as a **tier 1** chemical and requires a hazard assessment only.

1 BACKGROUND

Silicic acid, potassium salt or potassium silicate is an amorphous glass, and it is solidified as a glass from the melt (solid or lump glasses). It is essentially anhydrous and differs from ordinary glasses in that it is soluble in water at elevated temperature and pressure leading to silicate solutions (liquid glasses). Both solid and liquid glasses are often referred to as waterglass. Silicate solutions are defined by their density and viscosity, which together with the MR defines a unique composition for the silicate solution. By evaporation of silicate solutions, fine powders or granules are obtained that have a residual water content of approximately 20%. Unlike ground lump glass, these materials dissolve readily in water to give silicate solutions (OECD, 2004).

Upon dissolution in water, potassium silicate forms potassium ions (K+) 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).

Silicic acid, potassium salt or potassium silicate is an amorphous glass in the form of fine powders or granules. As an inorganic substance, it is not amenable to biodegradation; it is not expected to bioaccumulate. Potassium silicate is of low toxicity concern to aquatic organisms.

2 CHEMICAL NAME AND IDENTIFICATION

Chemical Name (IUPAC): Potassium hydroxyl(oxo)silanolate

CAS RN: 1312-76-1

Molecular formula: K2O · nO2Si

Molecular weight: 248.44 g/mol (tetrapotassium orthosilicate); soluble silicates are not generally stoichiometric chemical substances (with a specific chemical formula and molecular weight), but rather glasses or aqueous solutions of glasses.

Synonyms: Potassium silicate; potassium waterglass; potassium polysilicate; silicic acid, potassium salt; soluble potash glass

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 Potassium Silicate

Property	Value	Klimisch score	Reference
Physical state	Amorphous glass melt; aqueous solution of spray-dried powder with ~20% residual water	-	OECD, 2004
Flow Point	905°C	2	ECHA
Density	1260 – 1600 kg/m^3 (solution) @ 20°C; 750 kg/m^3 spray-dried powder	2	ECHA
Vapour Pressure	Negligible at ambient temperature	-	OECD, 2004
Partition Coefficient (log K_{ow})	Not relevant	-	OECD, 2004
Water Solubility	Solution: infinitely miscible; spray-dried solution: readily dissolvable	-	OECD, 2004

*Due to their glass nature, solid amorphous silicates do not have discrete melting points but rather flow points.

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 silicic acid, potassium salt.

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

Potassium silicate readily dissolves in water to potassium ions (K^+) 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; they are present in inorganic matter (i.e., minerals and soils) and in organic matter.

Silica is found in all natural waters and the median values in the United States 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).

Potassium silicate is an inorganic substance and therefore not amenable to biodegradation. It is not expected to bioaccumulate.

6 ENVIRONMENTAL EFFECTS SUMMARY

A. Summary

Potassium silicate is of low toxicity concern to aquatic organisms. All of the available aquatic ecotoxicity tests with potassium silicate and with sodium silicate (used as read-across for algae) show toxicity at concentrations well above 100 mg/L.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on potassium silicate.

Table 3 Acute Aquatic Toxicity Studies on Potassium Silicate

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Leuciscus idus	48-hour LC_{50}	>146	2	OECD, 2004; ECHA
Daphnia magna	24-hour EC_{50}	>146	2	OECD, 2004; ECHA
Scenedesmus subspicatus	72-hour EC_{50}	207* (biomass)	2	OECD, 2004; ECHA

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

Chronic Studies

No chronic studies are available.

C. Terrestrial Toxicity

A honey bee acute contact toxicity study performed per (USEPA OCSPP 850.3020) was conducted on AgSil™ 25 potassium silicate solution (29.1% potassium silicate in water). The 48-hour LD_0 was 25 µg/animal and the 48-hour 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).

Potassium silicate is an inorganic compound that dissociates completely to potassium and silicate ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions; both potassium 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.

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

No chronic toxicity data exist on potassium silicate; however, the acute EC_{50} values are >1 mg/L in fish, invertebrates and algae. Therefore, potassium silicate does not meet the screening criteria for toxicity.

The overall conclusion is that potassium silicate is not a PBT substance.

B. Other Characteristics of Concern

No other characteristics of concern were identified for potassium silicate.

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]	
Silicic Acid, Potassium Salt	1312-76-1	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

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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
IUPAC	International Union of Pure and Applied Chemistry
kg/m^3	kilograms per cubic metre
LC	lethal concentration

LD	lethal dose
mg	milligram
OCSPP	Office of Chemical Safety and Pollution Prevention
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	microgram