

SODIUM PERSULFATE

This dossier on sodium persulfate presents the most critical studies pertinent to the risk assessment of sodium persulfate in its use in hydraulic fracturing fluids. This dossier does not represent an exhaustive or critical review of all available data. Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch *et al.*, 1997).

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

1 BACKGROUND

Sodium persulfate dissociates in aqueous media to the sodium cation (Na⁺) and persulfate anion (S₂O₈²⁻). The persulfate anion will readily hydrolyse (decompose) into sulfate ions. Biodegradation is not applicable to inorganic compounds. Sodium persulfate is not expected to bioaccumulate; it will dissociate (and decompose) to ions that are ubiquitous in the environment. Sodium persulfate is not expected to adsorb to soil or sediment because of its dissociation properties, instability (hydrolysis) and high water solubility. Sodium persulfate exhibits moderate acute toxicity by the oral route and low acute toxicity by the inhalation and dermal routes. In humans, sodium persulfate has the potential for skin irritation; it is also a skin sensitiser to guinea pigs and humans. Human exposure to persulfates (including sodium persulfate) have been linked to a variety of skin and respiratory complaints indicative of sensitisation. The complaints consist of immediate and delayed contact hypersensitivity, contact urticarial, rhinitis, bronchitis and asthma. Repeated oral exposure to sodium persulfate resulted in irritation to the gastrointestinal tract; and respiratory irritation was seen in rats repeatedly exposed by inhalation to ammonium persulfate. Sodium persulfate is not genotoxic. A dermal carcinogenicity study showed no carcinogenic effects in mice. In a screening study, there was no reproductive or developmental toxicity in rats given oral gavage doses of ammonium persulfate. Sodium persulfate has a low toxicity concern to aquatic organisms.

2 CHEMICAL NAME AND IDENTIFICATION

Chemical Name (IUPAC): Disodium [(sulfonatoperoxy)sulfonyl]oxidanide

CAS RN: 7775-27-1

Molecular formula: O₈S₂.2Na

Molecular weight: 238.1 g/mol

Synonyms: Sodium persulfate; disodium persulfate; sodium peroxodisulfate; disodium [(sulfonatoperoxy)sulfonyl]oxidanide

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 Sodium Persulfate

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	White, crystalline, odorless solid	1	ECHA
Melting point	Decomposes at 180°C @ 101.1 kPa before melting point is reached.	1	ECHA
Boiling point	No value determined	-	ECHA
Density	1680 kg/m ³ @ 20 °C	1	ECHA
Vapour pressure	Negligible	2	ECHA
Partition coefficient (log K _{ow})	Not applicable	-	-
Water solubility	730 g/L @ 25 °C (Very soluble)	2	ECHA
Dissociation constant (pKa)	Not applicable	-	ECHA

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 sodium persulfate.

NICNAS has assessed sodium persulfate in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment¹.

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

¹ <https://www.industrialchemicals.gov.au/chemical-information/search-assessments?assessmentcasnumber=7775-27-1%2C+>

5 ENVIRONMENTAL FATE SUMMARY

Sodium persulfate dissociates in aqueous media to the sodium cation (Na^+) and persulfate anion ($\text{S}_2\text{O}_8^{2-}$) (OECD 2005; ECHA). The persulfate anion will readily hydrolyse (decompose) into sulfate ions.

The rates of hydrolysis are expected to be similar for sodium persulfate, potassium persulfate, and ammonium persulfate. The rates of decomposition (hydrolysis) were measured at 50°C at various pHs. The half-lives increased from 20 hours at pH 1 to 210 hours at pH 10 (Koltoff and Miller, 1951).

Biodegradation is not applicable to inorganic compounds. Sodium persulfate is not expected to bioaccumulate; it will dissociate (and decompose) to ions that are ubiquitous in the environment. Sodium persulfate is not expected to adsorb to soil or sediment because of its dissociation properties, instability (hydrolysis), and high water solubility.

6 ENVIRONMENTAL EFFECTS SUMMARY

A. Summary

Sodium persulfate has a low toxicity concern to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies on sodium persulfate.

Table 3 Acute Aquatic Toxicity Studies on Sodium Persulfate

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
<i>Oncorhynchus mykiss</i>	96-hour LC_{50}	163	1	ECHA
<i>Daphnia magna</i>	48-hour EC_{50}	133	1	ECHA
<i>Selenastrum capricornutum</i>	72-hour EC_{50}	116	1	ECHA

Chronic Studies

No data are available for sodium persulfate. A 21-day EC_{10} value in *Daphnia magna* was 25.9 mg/L was reported for diammonium peroxodisulphate (APS) (read-across) (ECHA) [Kl. Score = 1].

C. Terrestrial Toxicity

No data are available.

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).

Sodium persulfate is an inorganic compound that dissociates completely to sodium and persulfate ions in aqueous solutions. Persulfate ions are further hydrolysed to sulphate ions. Biodegradation is not applicable to these compounds. For the purposes of this PBT assessment, the persistent criteria are not considered applicable to sodium persulfate or its dissociated compounds.

Sodium persulfate is an inorganic compound that dissociates completely in water to ionic compounds that are ubiquitous in the environment. Thus, sodium persulfate is not expected to bioaccumulate and does not meet the screening criteria for bioaccumulation.

There are no chronic aquatic toxicity data on sodium persulfate. Chronic EC₁₀ values for invertebrates from a read-across substance (APS) was >0.1 mg/L. The acute EC₅₀ values for fish, invertebrates, and algae are >1 mg/L. Thus, sodium persulfate does not meet the screening criteria for toxicity.

Therefore, sodium persulfate is not a PBT substance.

B. Other Characteristics of Concern

No other characteristics of concern were identified for sodium persulfate.

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	
Sodium Persulfate	7775-27-1	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

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.

ECHA. ECHA REACH database: <https://echa.europa.eu/information-on-chemicals/registered-substances>

European Chemicals Agency [ECHA]. (2008). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland.

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Koltoff, I., and Miller, I.K. (1951). The chemistry of persulfate. I. The kinetics and mechanism of the decomposition of the persulfate ion in aqueous medium. J. Am. Chem. Soc. 73: 3055-3059.

OECD. (2005). IUCLID Data Set for Ammonium persulfate (CAS No. 7727-54-0); Potassium persulfate (CAS No. 7727-27-1); Sodium persulfate (CAS No. 7775-27-1), UNEP Publications. Available at: https://hpvchemicals.oecd.org/UI/SIDS_Details.aspx?id=5D4B16BE-8BA8-4BE4-8787-469DE31A76E9

B. Abbreviations and Acronyms

°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
IUPAC	International Union of Pure and Applied Chemistry
kg/m ³	kilograms per cubic metre
kPa	kilopascal
LC	lethal concentration
mg/L	milligrams per litre

PBT	Persistent, Bioaccumulative and Toxic
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SGG	Synthetic Greenhouse Gases