ETHYLENE DIAMINETETRAACETIC ACID TETRASODIUM SALT [NA_4EDTA]

This dossier on ethylene diaminetetraacetic acid tetrasodium salt (Na_4EDTA) presents the most critical studies pertinent to the risk assessment of Na_4EDTA in its use in water treatment systems. It does not represent an exhaustive or critical review of all available data. The information presented in this dossier was obtained primarily from the EU Risk Assessment Report on Na_4EDTA, 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 – Na_4EDTA is classified as a **tier 1** chemical and requires a hazard assessment only.

1 BACKGROUND

Na_4EDTA is not readily biodegradable, but it can under certain conditions (*i.e.*, alkaline pH), which is realistic under environmental surface water conditions, be degraded. Therefore, it can be concluded that EDTA is ultimately biodegradable under such environmental conditions. It is not expected to adsorb to soil or sediment. Na_4EDTA has a low potential for bioaccumulation. If nutrient metal concentrations are increased, then Na_4EDTA has a low toxicity concern for algae; this is the more likely scenario in the environment.

2 CHEMICAL NAME AND IDENTIFICATION

Chemical Name (IUPAC): Tetrasodium{[2-bis-carboxymethyl-amino)-ethyl]-carboxymethyl-amino}-acetate

CAS RN: 64-02-8

Molecular formula: $C_{10}H_{12}N_2O_8Na_4$

Molecular weight: 380.2 g/mol

Synonyms: Tetrasodium ethylenediaminetetraacetate; ethylenediaminetetraacetic acid tetrasodium salt; ethylene dinitrilotetraacetic tetrasodium salt; Edetic acid tetrasodium salt; Na_4EDTA or Na_4EDTA tetrasodium; Edetate sodium or Sodium ededate; N,N’-1,2-Ethanediylbis[N-(carboxymethyl)glycine]tetrasodium salt; tetrasodium 2,2’,2’’,2’’’-(ethane-1,2-diyldinitrilo)tetraacetate

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 Na_4EDTA

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	White powder	2	ECHA
Melting Point	>150°C; >300°C; decomposition may occur at >150°C (pressure not provided)	2	ECHA
Boiling Point	-	-	-
Density	1670 kg/m^3 @ 20°C	2	ECHA
Vapour Pressure	-	-	-
Partition Coefficient (log K_{ow})	-	-	-
Water Solubility	500 g/L @ 20°C	2	ECHA

The most important property of Na_4EDTA is that it forms complexes (usually 1:1-complexes) with multivalent metal ions (EU, 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 Na_4EDTA.

Based on an assessment of environmental hazards, NICNAS identified Na_4EDTA as a chemical of low concern to the environment (NICNAS, 2017). Chemicals of low concern are unlikely to have adverse environmental effects if they are released to the environment from coal seam gas operations.

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

A. Summary

Na_4EDTA is not readily biodegradable, but it can under certain conditions (*i.e.*, alkaline pH), which is realistic under environmental surface water conditions, be degraded. Therefore, it can be concluded that EDTA is ultimately biodegradable under such environmental conditions (REACH). It is not expected to adsorb to soil or sediment. Na_4EDTA has a low potential for bioaccumulation.

B. Partitioning

Na_4EDTA is typically released to the environment in its complexed form (Nowack et al., 2001). The speciation of metal complexes is determined by the complex released, and metal exchange reactions mediated by its interactions with the chemistry of the receiving water compartment (Nowack, 2002; EU, 2004). However, complexes of Na_4EDTA with iron(III) are often detected in river water due to the ubiquity of iron(III) and the slow kinetics of relevant metal exchange reactions (half-life approximately 20 days) (Nowack, 2002).

Partitioning of complexed EDTA between water and sediment compartments is dependent on the metal ion complexed. For example, EDTA complexed with cobalt(III) and iron(III) partitions predominately to the water compartment, while lead(II) EDTA complexes adsorb strongly to sediment (Nowack, 2002).

Na_4EDTA is resistant to hydrolysis. However, EDTA is photolytically unstable when complexed with iron(III) ions. The complex is reported to have a half-life of 5 hours in central Europe in summer, with a worst-case half-life of 20 days (EU, 2004).

C. Biodegradation

There have been many degradation tests conducted on Na_4EDTA; in most cases, the acid or the sodium salt was tested, but not Na_4EDTA in its complexed form. Na_4EDTA is not readily biodegradable (EU, 2004). In a 28-day Sturm test, there was only 10% degradation (measured as CO2) after 28 days (EU, 2004). In a Closed Bottle test, degradation was 3% and 0% of TOD after 28 days in two separate tests (EU, 2004). Inherent biodegradability tests have shown variable results, ranging from 0 to 37% biodegradation rates (EU, 2004). If a chemical is found to be not readily or inherently biodegradable, it is categorised as Persistent since its half-life is greater than 60 days (DoEE, 2017).

Na_4EDTA can be degraded under alkaline conditions. A Closed Bottle test was conducted to investigate the potential of samples from a river, a ditch and a lake to degrade $CaNa_2EDTA$ (8 mg/L) at pH values 6.5 – 8.0. There was little to no biodegradation (2-12%) at pH 6.5 within the first 28 days and 60-83% after 49 days. At pH 8, rates of 53, 62 and 72% were seen after 28 days and 75-89% after 35 days (van Ginkel, 1999). The pH values of lakes and river water range from 7.7 to 8.5; however, Na_4EDTA is preferably complexed with heavy metal ions (EU, 2004).

Na_4EDTA can be biodegraded in soil under aerobic conditions. After four weeks, biodegradation of Na_4EDTA was between 4.8 and 7.9% at 30°C was determined in agriculture soil of mid-Michigan (EU, 2004). Another study showed primary degradation of 53 to 60% after 173 days at 22°C. Additional 39% of the substance was assumed to be eliminated by sorption and abiotic degradation (EU, 2004).

D. Environmental Distribution

Environmental transport of Na_4EDTA will be determined by the metal ions it is complexed with. Most studies investigating the transport of Na_4EDTA complexes compare this to transport of the uncomplexed metal. Generally, Na_4EDTA is found to decrease adsorption of metals and therefore increase its potential for transport in the environment. For instance, the mobility of Na_4EDTA in soil was investigated by eluting solutions of H_4EDTA and ZnEDTA through cores of two various surface soils. H_4EDTA was slightly adsorbed and moved quite readily through both soils. The Na_4EDTA from ZnEDTA also moved readily through the soils (EU, 2004).Therefore, due to the ionic structure of Na_4EDTA, no adsorption to the organic fraction of soils is expected under environmental relevant pH conditions and the substance is expected to be mobile..

E. If released to water, Na_4EDTA will not evaporate from the water surface into the atmosphere and, based on its high water solubility value and ionic structure noted above, is likely to remain in water and not adsorb to sediment. Bioaccumulation

BCF values of 1.8 (0.08 mg/L Na_4EDTA) and 1.1 (0.76 mg/L Na_4EDTA) were determined in a 28-day bioaccumulation test on *Lepomis macrochirus* (EU, 2004). These measured values indicate a low potential for bioaccumulation.

6 ENVIRONMENTAL EFFECTS SUMMARY

A. Summary

Details on the aquatic toxicity studies on Na_4EDTA and its sodium salts can be found in the EU Risk Assessment Report (RAR) on Na_4EDTA (EU, 2004). The mode-of-action of Na_4EDTA in aquatic systems involves disturbances of metal metabolism; hence the complex formation properties of Na_4EDTA need to be taken into account.

B. Aquatic Toxicity

Uncomplexed Na_4EDTA will only be present in the test media of aquatic toxicity studies when present in an excess amount relative to the calcium and magnesium ions, as well as some level of heavy metal ions, which are present mainly as trace nutrients. Complexes with the heavy metals predominant because the formation constants are several orders of magnitude higher than those of the calcium and magnesium ions. After addition of Na_4EDTA (as an acid or sodium salt), the concentration of uncomplexed trace metals will decrease considerably, and if there is a surplus of Na_4EDTA, there will also be complexing with the calcium and magnesium ions.

Na_4EDTA and its sodium salts appear to be more toxic in an uncomplexed form in the acute toxicity studies. Most of the acute fish studies have LC_{50} values that are much greater than 100 mg/L, with the exception of two studies tested with H_4EDTA in soft and very soft water: the LC_{50} values were 41 and 59.8 mg/L, respectively. It is thought that there was an excess of uncomplexed Na_4EDTA in the test media of these two studies due to the low levels of magnesium and calcium ions in soft water; this, however, is an unlikely scenario in the environment.

The EU RAR (EU, 2004) considered the most relevant chronic fish toxicity study to be an early-life stage test on zebrafish; the NOEC was >26.8 mg/L H_4EDTA ($CaNa_2EDTA$ was the test substance) (EU, 2004).

The acute toxicity tests on *Daphna magna* reported 24-hour EC_{50} values of 480 to 790 mg/L (EU, 2004). The 21-day NOEC from a *Daphnia* reproduction test was 22 mg/L (EU, 2004).

Essential trace metal bioavailability seems to be the critical factor in algal toxicity from Na_4EDTA exposure. The ratio of the Na_4EDTA concentration to the metal cations is a critical element to algal growth and not the absolute Na_4EDTA concentration. H_4EDTA concentrations up to 310 mg/L will not cause any effect on algal growth if there is sufficient trace metals present. Since there is a considerable amount of metal ions present in the environment, Na_4EDTA is not expected to have an intrinsic toxic effect on plants. In a study with *Scenedesmus subspicatus*, an EC_{10} value of 0.37 mg/L was obtained (EU, 2004). The EU RAR considered that the effect was probably due to nutrient deficiency because essential metals (Cu, Zn, Co) are largely complexed to the Na_4EDTA, resulting in considerably reduced concentrations. In another study with *Pseudokirchnerella subcapitata* conducted according to OECD TG 201, the ECb_{50} and ECr_{50} of Fe(III)EDTA were >100 mg/L; the NOEC values were 79.4 and 48.4 mg/L, respectively, when based on mean measured concentrations.

C. Terrestrial Toxicity

No relevant studies are available. The only test results that are available are those that have investigated the decrease of heavy metal toxicity caused by Na_4EDTA.

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).

Na_4EDTA is not readily biodegradable; thus, it meets the screening criteria for persistence.

The experimental BCF of Na_4EDTA in fish is 1.1 – 1.8. Thus, Na_4EDTA does not meet the criteria for bioaccumulation.

The lowest NOEC from chronic aquatic toxicity studies is >0.1 mg/L. Na_4EDTA and its sodium salts appear to be more toxic in an uncomplexed form in the acute toxicity studies. Acute EC_{50} values in fish, invertebrates, and algae are >1 mg/L. Thus, Na_4EDTA does not meet the screening criteria for toxicity.

The overall conclusion is that Na_4EDTA is not a PBT substance.

B. Other Characteristics of Concern

No other characteristics of concern were identified for Na_4EDTA .

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]	
Na_4EDTA	64-02-8	Not a PBT	No	No	Yes	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

°C	degrees Celsius
AICS	Australian Inventory of Chemical Substances
BCF	bioconcentration factor
COC	constituent of concern
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECb	effective concentration (biomass)
ECHA	European Chemicals Agency
ECr	effective concentration (growth rate)
EU	European Union
g/L	grams per litre
hPa	hectopascal
IUPAC	International Union of Pure and Applied Chemistry
kg/m^3	kilogram per cubic metre
kPa	kilopascal
LC	lethal concentration
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
Pa	Pascal
PBT	Persistent, Bioaccumulative and Toxic
RAR	Risk Assessment Report
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SGG	Synthetic Greenhouse Gases
TG	test guideline
TOD	Total oxygen demand