MAGNESIUM OXIDE

This dossier on magnesium oxide presents the most critical studies pertinent to the risk assessment of magnesium oxide in its use in drilling muds. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from 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 – Magnesium oxide is classified as a **tier 1** chemical and requires a hazard assessment only.

1 BACKGROUND

MgO is one of the components in Portland cement in dry process plants. Additionally, magnesium, an essential element to most biological systems, is provided to soil and groundwater microbial populations during MgO-assisted metals remediation. Magnesium oxide is of low toxicological concern and is used for relief of heartburn and dyspepsia, as an antacid, magnesium supplement and as a short-term laxative. It is also used to improve symptoms of indigestion.

Magnesium oxide is of low toxicity concern to environmental receptors, In fact, magnesium oxide is used extensively in the soil and groundwater remediation, wastewater treatment, drinking water treatment, air emissions treatment and waste treatment industries for its acid buffering capacity and related effectiveness in stabilizing dissolved heavy metal species.

2 CHEMICAL NAME AND IDENTIFICATION

Chemical Name (IUPAC): Oxomagnesium

CAS RN: 1309-48-4

Molecular formula: MgO

Molecular weight: 40.305 g/mol

Synonyms: Magnesia, oxomagnesium, Periclase, Seawater magnesia, Magnesium oxide, Causmag, Granmag, Maglite

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 Magnesium Oxide

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Solid, hygroscopic fine white powder.	-	Pubchem

Property	Value	Klimisch score	Reference
Melting Point	2,800 °C[1]	-	Pubchem
Boiling Point	3,600 °C[1]	-	Pubchem
Density	3600 kg/m^3	-	Pubchem
Vapour Pressure	0 Pa @ 25°C	-	Pubchem
Partition Coefficient (log K_{ow})	not applicable	-	-
Water Solubility	Poorly soluble (i.e., 0.009% @ 86°F)	-	Pubchem
Viscosity	Not applicable	-	-

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 magnesium oxide.

NICNAS has assessed magnesium oxide in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to human health or the environment[2]. It was identified as an inorganic substance with low toxicity and/or low bioavailability. Low concern to the environment.

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] No information on atmospheric pressure provided.
[2] https://www.industrialchemicals.gov.au/chemical-information/search-assessments?assessmentcasnumber=1309-48-4

5 ENVIRONMENTAL FATE SUMMARY

A. Summary

Magnesium oxide is an inorganic substance that is not subject to biodegradation, is not expected to bioaccumulate, and has a low potential to adsorb to soil.

B. Biodegradation

Magnesium oxide is an inorganic substance. According to Annex VII of the REACH regulations (ECHA), biodegradation testing for inorganic chemicals is not required.

C. Environmental Distribution

As an inorganic substance, magnesium oxide is expected to disassociate in the environment to its respective cation and anion as limited by its aqueous solubility and pH.

In soil, as well as in sediment-water systems, magnesium oxide will react and release magnesium ions and hydroxyl ions. Therefore, relevant information on adsorption/desorption of magnesium oxide can be broadened to data on adsorption/desorption of magnesium. The behaviour of hydroxyl ions depends on the pH buffer capacity of the tested medium. The pH buffer capacity is controlled by a whole range of processes (mineral dissolution/precipitation, protonation/deprotonation of pH dependent charge sites, reaction with CO_2, biological processes, etc.) and as such, partition coefficients are not relevant for the fate and behaviour of OH- in soils or sediment.

D. Bioaccumulation

There are no bioaccumulation studies on magnesium oxide. Magnesium is an essential element in biological systems. Magnesium occurs typically as the Mg2+ ion. It is an essential mineral nutrient and is present in every cell type in every organism. For example, ATP (adenosine triphosphate), the main source of energy in cells, must bind to a magnesium ion in order to be biologically active. As such, magnesium plays a role in the stability of all polyphosphate compounds in the cells, including those associated with the synthesis of DNA and RNA.

Over 300 enzymes require the presence of magnesium ions for their catalytic action, including all enzymes utilising or synthesising ATP, or those that use other nucleotides to synthesise DNA and RNA.

6 ENVIRONMENTAL EFFECTS SUMMARY

A. Summary

Magnesium oxide is of low acute toxicity concern to aquatic organisms, in part because of the effect of pH changes from the dissociated hydrogen ion.

B. Aquatic Toxicity

Acute Studies

No studies were available on magnesium oxide. Thus, **Table 3** presents the results of acute aquatic toxicity studies on the hydrated magnesium hydroxide.

Table 3 Acute Aquatic Toxicity Studies on Magnesium Hydroxide

Test Substance	Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Magnesium hydroxide	*Pimephales promelas*	96-hour LC_{50}	306.79	2	ECHA
Magnesium hydroxide	*Daphnia magna*	96-hour EC_{50}	170.6	2	ECHA
Magnesium hydroxide	*Chlorella vulgaris*	72-hour EC_{50}	>100	2	ECHA

Acute aquatic toxicity studies on soluble magnesium salts also indicates low toxicity. Toxicity endpoints identified generally exceeded 100 mg/L (ECHA).

Chronic Studies

No studies are available. Long-term toxicity of fish and invertebrates is unlikely to occur based on the physico-chemical properties of magnesium hydroxide, the breakdown pathway of the substance and the fact that magnesium ions are ubiquitous in the natural environment.

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).

Magnesium oxide is an inorganic mineral. Thus, biodegradation is not applicable to this substance. For the purposes of this PBT assessment, the persistent criteria are not considered applicable to magnesium oxide.

Magnesium oxide is a naturally inorganic substance, while magnesium is naturally found in eukaryotic and prokaryotic cells involved in multiple biochemical pathways. Thus, magnesium oxide does not meet the screening criteria for bioaccumulation.

The NOECs from the acute aquatic toxicity studies on magnesium hydroxide (a magnesium oxide surrogate) are greater than 100 mg/L. Thus magnesium oxide, does not meet the criteria for toxicity.

Thus, magnesium oxide is not a PBT substance.

B. Other Characteristics of Concern

No other characteristics of concern were identified for magnesium oxide.

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]	
Magnesium oxide	1309-48-4	Not a PBT	No	No	No	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: http://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.

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

Pubchem. Open chemistry database at the National Institutes of Health (NIH). https://pubchem.ncbi.nlm.nih.gov/

B. Abbreviations and Acronyms

^{o}C	degrees Celsius
°F	degrees Fahrenheit
AICS	Australian Inventory of Chemical Substances
ATP	adenosine triphoshphate
COC	constituent of concern
DEWHA	Department of the Environment, Water, Heritage and the Arts
DNA	deoxyribonucleic acid
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/m^3	kilograms per cubic metre
Kl	Klimisch scoring system
kPa	kilopascal

LC	lethal concentration
mg/L	milligrams per litre
NOEC	no observed effect concentration
PBT	Persistent, Bioaccumulative and Toxic
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RNA	ribonucleic acid
SGG	Synthetic Greenhouse Gases