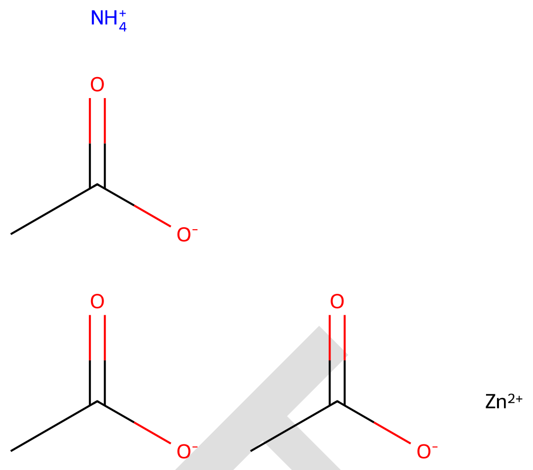

**Structural formula:**

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## Relevant physical and chemical properties

All chemicals in this group are described as solids under ambient conditions, except for zinc ammonium acetate, for which there is limited information.

In water, chemicals in this group will form zinc(2+) ions and associated counter ions. The water solubility values are presented in the table below:

| Chemical name | CAS RN | Water solubility (mg/L) |
|---|---|---|
| Zinc acetate | 557-34-6 | 400,000 at 25°C |
| Zinc acetate dihydrate | 5970-45-6 | 400,000 at 25°C |
| Zinc propionate | 557-28-8 | 320,000 at 15°C |

Quantitative water solubility values were identified for zinc acetate, zinc acetate dihydrate, and zinc propionate (Goodwin 2017; NCBI n.d.-a; n.d.-b). Zinc ammonium acetate is generated by dissolution of zinc acetate in aqueous ammonia solution (Ott n.d.) and sold in products as a solution (Loveland Agri Products n.d.). Therefore, the chemical is expected to have high water solubility.

No quantitative values for basic zinc propionate were identified. However, the water solubility of the other zinc salts of acetic and propanoic acid indicate that this chemical can also be considered readily soluble in water.

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# Introduction and use

## Australia

No specific information is available on the introduction use and end-use of these chemicals in Australia.

## International

Internationally, zinc acetate is the most widely used chemical in this group, with reported use volumes of 45.4 to 227 tonnes/year in the USA and 100 to 1000 tonnes/year in the EU (REACH n.d.-a; US EPA 2020). Zinc acetate dihydrate has a reported use volume of 6.7 tonnes/year for 2021 in the Nordic countries (Nordic Council of Ministers n.d.).

Zinc acetate and zinc acetate dihydrate are often mentioned interchangeably. These chemicals have several reported industrial uses. The most reported uses are as catalysts and/or cross-linking agents in plastic and rubber manufacture (including tyres) and starting materials in the manufacture of other chemicals. They also have reported uses in the textile industry as mordants, waterproofing agents and catalysts in the production of synthetic fibres. Additional uses are as antimicrobial/antiseptic agents in washing, cleaning, cosmetic and personal care products and in fertilisers (Goodwin 2017; Gubbels et al. 2018; NCBI n.d.-b; REACH n.d.-a; US EPA 2020). A frequency of use in 4 personal care products was reported for zinc acetate (which covers both the anhydrous and hydrate form) in the USA (Personal Care Products Council n.d.).

Zinc propionate has reported volumes of 10 to 100 tonnes/year in the EU and 1.8 tonnes/year in the USA (REACH n.d.-b; US EPA 2020). Zinc propionate is used as an additive in plastic and rubber manufacturing (including tyres) (REACH n.d.-b; US EPA 2020). No volumes or uses were identified for basic zinc propionate but it is often mentioned interchangeably with zinc propionate.

Zinc ammonium acetate has a reported use volume of up to 454 tonnes/year in fertiliser manufacture in the USA (US EPA 2020).

# Existing Australian regulatory status

## Environment

Contaminant guidelines for zinc in Australia are discussed in the AICIS evaluation of environmental fate and effects of zinc ions (AICIS 2024). In summary, there are default guideline values for zinc in freshwater, marine water, and sediments (ANZG 2021). The default guideline value for protection of 95% of species in both fresh and marine water is 8 µg Zn/L. In sediment, the recommended default guideline value is 200 mg/kg dry weight.

For soils in urban residential areas and public open space, the added contaminant limit ranges are 25–500 mg added Zn/kg and 70–1300 mg added Zn/kg for freshly contaminated (< 2 years) and aged (> 2 years) soils, respectively. The contaminant limit for a specific site will depend on soil pH and cation exchange capacity (NEPC 2013).

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For irrigated soil, the cumulative contaminant loading limit guideline value is 300 kg Zn/ha (ANZECC & ARMCANZ 2000). For biosolids, national limits of 200–250 mg Zn/kg are recommended if state or territory guidelines are unavailable (NRMMC 2004).

# International regulatory status

## European Union

Water-soluble zinc salts (unless listed elsewhere) are restricted to a maximum concentration of 1% zinc in cosmetic products under Annex III of EC No 1223/2009 (EU 2009).

## New Zealand

Water-soluble zinc salts are restricted to a maximum concentration of 1% zinc in cosmetic products under Schedule 5 of the Cosmetic Products Group Standard 2006 (NZ EPA 2019).

## Asia

Water-soluble zinc salts are restricted to a maximum concentration of 1% zinc in cosmetic products under Annex III of the ASEAN Cosmetic Directive (ASEAN 2019).

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# Environmental exposure

Based on international data, the water-soluble zinc(2+) salts in this group are expected to be found in a wide range of products. These include plastic and rubber products (including tyres), dishwashing and cleaning products, personal care products, textiles, and fertilisers. According to data reported to the National Pollutant Inventory (NPI), 1100 tonnes of zinc and zinc compounds were emitted to the Australian environment from reportable sources in 2021–22 (NPI n.d.).

In plastic manufacture, zinc chemicals are used as catalysts and crosslinking agents (Goodwin 2017). A heterogenous zinc acetate catalyst is commonly used in the gas phase acetylene-based production of vinyl acetate, a process that produces approximately one third of global vinyl acetate (Bienewald et al. 2024). No inclusion of the zinc catalyst into the final product is expected as it is immobilised on a solid substrate during reaction. When used as a crosslinking agent, such as in crosslinking adhesives, the zinc chemicals are incorporated into the product (Czech 2003). Reported zinc emissions from polymer product manufacturing in 2021/22 represent < 0.02% (~140 kg) of total emissions reported to the NPI (NPI n.d.). Most zinc-containing waste from these facilities is reportedly transferred to off-site landfill and recycling facilities. Zinc incorporated into products may be released to wastewater through washing of items and surfaces. Zinc may be released in abraded plastic particles from wear and tear of the product during use, which can be directly released to the environment or mobilised into the environment through stormwater runoff. However, studies in Europe suggest that the major zinc sources in urban runoff are likely to be from building and roofing materials (ICON 2001). The majority of incorporated zinc is expected to remain within the plastic product for its lifetime, and either be recycled or disposed to landfill at end of life.

Zinc compounds are used as vulcanisation activators in rubber manufacture, with high volume use in tyres. Tyre tread rubber contains approximately 1% by weight zinc (Councell et al. 2004). Zinc propionate has reported use in rubber manufacture (US EPA 2020). However, the main zinc compound expected to be used in rubber manufacture by volume is zinc oxide (Councell et al. 2004; Goodwin 2017). According to data reported to the National

Pollutant Inventory, tyre manufacture is a minor source of zinc emissions to the Australian environment, representing < 0.0001% (0.25 kg) of total reported emissions in 2021–22 (NPI n.d.). All reported emissions from tyre manufacture were to air. Zinc release from tyres via abrasion and/or leaching has been identified as a significant source of zinc in the environment. In 1999 in the USA, an estimated 10,000 tonnes of zinc per year was released via tyre wear, based on average driving conditions (Councell et al. 2004). Zinc from tyre wear is released to air but quickly deposits to water and soil and eventually reaches the sediment compartment. While chemicals in this evaluation may contribute to zinc emissions from tyre wear, the main zinc source in tyres is likely to be zinc oxide (ZnO) as it is the main zinc compound used in tyre manufacture (Councell et al. 2004).

Uses in dishwashing, cleaning, and personal care products will result in release to wastewater. An Australian review of contaminants in domestic wastewater noted zinc concentrations in bathroom wastewater up to 6.3 mg/L (Tjandraatmadja and Diaper 2006). Approximately 70–75% of zinc entering STPs is expected to be removed from wastewater by adsorption to sewage sludge (European Commission 2010; ICON 2001; Tjadraatmadja and Diaper 2006), which may be applied to agricultural land in biosolids. The remaining 25–30% zinc in wastewater is expected to be released to surface waters in effluent. Around 73% of household zinc emissions to wastewater are reportedly from the bathroom and likely due to use in personal care products such as sunscreen, deodorant and shampoo (Gray and Becker 2002; Tjandraatmadja and Diaper 2006). However, zinc oxide is identified as the main zinc-based ingredient in personal care products in this analysis, suggesting the organic zinc salts in this evaluation do not contribute significantly to wastewater emissions. In addition, these chemicals have a low frequency of reported use in personal care products internationally.

Zinc ammonium acetate has identified use in fertiliser, which involves direct release to soil. Zinc chemicals are commonly used on agricultural crops to promote growth and increase the dietary zinc content of food (Das and Green 2016). The fertiliser is applied to crops either in solution as a foliar spray or in granulated form added to the soil. Release of zinc from fertiliser use is likely to be a significant source of zinc emissions to Australian soil and water (AICIS 2024). The main zinc compounds used in fertilisers are zinc sulfates, oxides or various chelates (Incitec Pivot Fertilisers 2022). The zinc chemicals in this group are not expected to significantly contribute to zinc content in fertilisers in Australia.

International data suggests that the zinc chemicals in this group are not commonly used as mordants in textiles, and zinc content in textiles is primarily from zinc oxide, which is incorporated for multiple reasons, including its antimicrobial and UV protection properties (Verbič et al. 2019).

## Environmental fate

Chemicals in this group are expected to be released into the atmosphere, surface waters, and soils where they will dissociate into the corresponding acids, ammonium ions, and ionic zinc.

A detailed account of the environmental fate and effects of ionic zinc is available in the AICIS evaluation of environmental fate and effects of zinc ions (AICIS 2024). A short summary is presented below.

The behaviour of the zinc(2+) ion depends on the chemistry of the environmental compartment into which it is released. Dissolved zinc will exist in natural waters as the free (hydrated) zinc(2+) ion, inorganic compounds and complexes, and complexes with dissolved organic matter (DOM), depending on the pH, water hardness, salinity and presence of DOM.

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Most of this zinc will partition to sediments via adsorption and precipitation but may be dissolved or desorbed due to decreasing pH, increasing salinity or oxidising conditions. Zinc in soils is expected to be strongly sorbed to particulates, and therefore have low mobility, but may be released due to decreasing pH or oxygen concentrations. Atmospheric zinc is primarily bound to aerosols, which then partitions to soil and water via wet and dry deposition.

### Predicted environmental concentration (PEC)

A PEC for the water-soluble zinc(2+) salts in this evaluation was not calculated. These chemicals will form zinc(2+) ions that are indistinguishable from environmental zinc(2+) ions arising from other natural and anthropogenic sources.

Detailed information on zinc concentrations in the environment is reported in the AICIS evaluation Environmental fate and effects of zinc ions (AICIS 2024). Zinc is naturally present in the environment at varying background levels, but concentrations were elevated above national guideline values in surface waters and sediments in several areas around Australia. High zinc concentrations were also found in roadside soils. Uses of industrial zinc-containing chemicals in personal care products, fertilisers and tyre rubber may contribute to these zinc concentrations (AICIS 2024).

## Environmental effects

All living organisms require a minimum level of zinc for essential functions. However, excessive environmental zinc concentrations can overwhelm homeostasis and result in adverse effects on aquatic and terrestrial life. While sensitivity of aquatic organisms varies between taxa, zinc toxicity is predominantly caused by free zinc(2+) ions. Therefore, zinc toxicity will be highest when environmental conditions favour free zinc(2+) ion speciation. The most important toxicity modifying factors for zinc in aquatic environments are water hardness, pH and dissolved organic carbon. Maximum zinc toxicity in freshwater is expected in waters with low hardness, circumneutral pH, and low dissolved organic carbon concentrations.

Acute and chronic ecotoxicity data for fish and invertebrates are described in the AICIS evaluation, Environmental fate and effects of zinc ions (AICIS 2024).

## Categorisation of environmental hazard

### Persistence, bioaccumulation and toxicity (PBT)

It is not currently possible to categorise the environmental hazards of metals and other inorganic chemicals according to standard persistence, bioaccumulation, and toxicity (PBT) hazard criteria. These criteria were developed for organic chemicals and do not take into consideration the unique properties of inorganic substances and their behaviour in the environment (UNECE 2017).

A PBT hazard characterisation was not performed for the organic acid components of these chemicals, as they were previously assessed under the Inventory Multi-tiered Assessment and Prioritisation (IMAP) framework established by the former National Industrial Chemicals Notification and Assessment Scheme (NICNAS). Acetic acid (CAS RN 64-19-7) and propionic acid (CAS RN 79-09-4) were determined to be not PBT.

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## GHS classification of environmental hazard

Chemicals reported in this evaluation satisfy the criteria for classification according to the GHS for environmental hazards. The aquatic hazards of these chemicals are based on the identified ecotoxicity values for zinc(2+) as identified in the AICIS evaluation Environmental fate and effects of zinc ions (AICIS 2024), in accordance with the classification procedure for metals and metal compounds under the GHS (UNECE 2017). The classifications for chemical in this evaluation were made after correcting for the molecular weight of the respective zinc salts. The lowest median effective concentration (EC50) of the dissolved zinc(2+) ion is 1.8 µg/L (AICIS 2024). All the weight corrected EC50 values for each chemical in this group were substantially lower than their measured or estimated solubilities. Therefore, all chemicals in this evaluation are classified as Acute Aquatic Category 1 and Chronic Aquatic Category 1.

### Uncertainty

This evaluation was conducted based on a set of information that may be incomplete or limited in scope. Some relatively common data limitations can be addressed through use of conservative assumptions (OECD 2019) or quantitative adjustments such as assessment factors (OECD 1995). Others must be addressed qualitatively, or on a case-by-case basis (OECD 2019).

The most consequential areas of uncertainty for this evaluation are:

- No Australian volume or use data are available for chemicals in this group. Should information become available to indicate that chemicals in this group are used in high volumes, the outcome of this evaluation may change.

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