Zinc Orthophosphate

$Zn_3(PO_4)_2$

(liquid)

D Direct Use Chemical

Inputs to Manufacturing Process:
Zinc
Phosphoric Acid

% of Total Domestic Consumption Attributed to Water Sector:
Less than 10%

Product Family:
Zinc, Phosphate

CAS No.:
7779-90-0

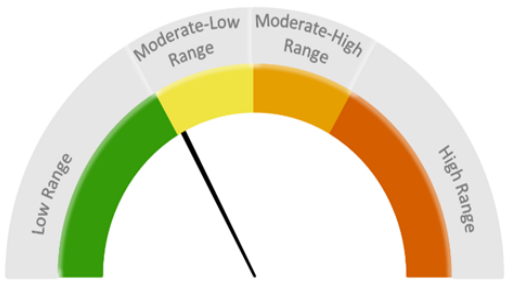
Derivative Water Treatment Chemicals:
None

Understanding Chemical Supply Chains
Map of Suppliers & Manufacturers

Shelf Life:
24 Months

RISK OF SUPPLY DISRUPTION (Assessed in 2022)

RISK RATING: Moderate-Low



RISK DRIVERS

Strong reliance on international market for manufacturing inputs, primarily phosphoric acid. Increased competition and reliance on imports have challenged phosphate manufacturers. Regional phosphoric acid supply disruptions have occurred between 2000 and 2022.

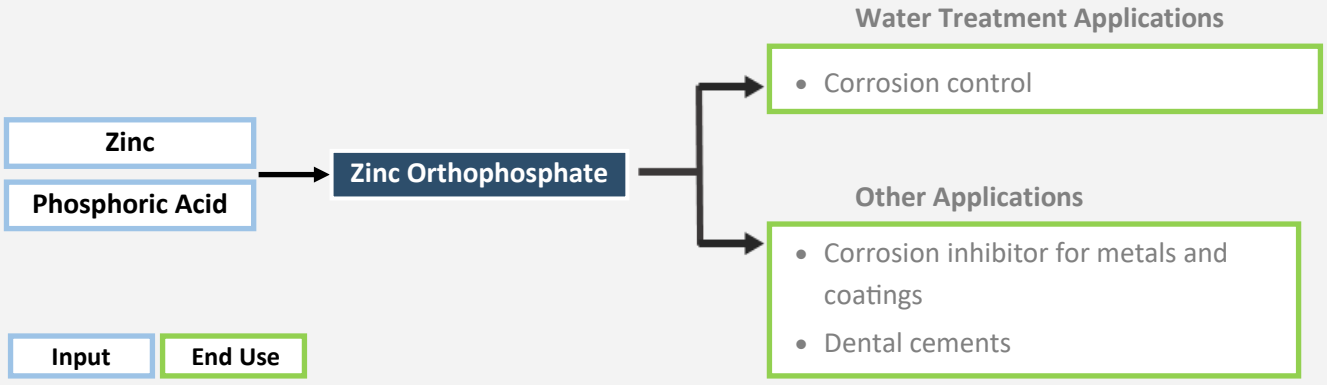
RISK PARAMETERS

Criticality: Moderate-High. Essential for corrosion control.

Likelihood: Moderate-High. Previous disruptions in supply that impacted manufacturing inputs.

Vulnerability: Low. Distributed domestic manufacturing and supply, however reliance on international market for inputs.

MANUFACTURING PROCESS



DOMESTIC PRODUCTION AND CONSUMPTION, AND INTERNATIONAL TRADE

Domestic Manufacturing Locations (2015):
8, distributed throughout the U.S.

International Trade (2019)

Primary Trading Partner (Imports): Germany

Primary Trading Partner (Exports): Canada

Domestic Production and Consumption

Total domestic manufacturing of zinc orthophosphate reported under the TSCA CDR was approximately 0.66 M kg in 2019. Significantly, several domestic manufacturers of zinc orthophosphate did not report production. Due to this data gap and differences in reporting between production and trade data, U.S. consumption of zinc orthophosphate could not be estimated.

Product Description

Zinc orthophosphate ($Zn_3(PO_4)_2$), also known as zinc phosphate, is widely used in corrosion control coatings on metal surfaces. It is primarily manufactured through the reaction of zinc and phosphoric acid. The majority of zinc orthophosphate manufactured in the U.S. is used in metal coating applications.

Use in Water Treatment

Zinc orthophosphate is used for corrosion control in distribution system piping. Zinc orthophosphate may be sold alone as a commercial chemical product for water treatment, or, more commonly, as a component of a trademarked blend of zinc phosphates along with other orthophosphates and polyphosphates (AWWA, 2006).

Use as a Precursor to Other Water Treatment Chemicals

Zinc orthophosphate is not used as a precursor in the commercial manufacture of other water treatment chemicals.

Other Applications

Zinc orthophosphate is widely used in many industries and a variety of settings as a corrosion inhibitor for metals and coatings. It is also used in cement applications, primarily dental cements (ATSDR, 2005; NCBI, 2021).

Primary Industrial Consumers

Zinc orthophosphate is primarily used for preparing metal coatings and in dental cements. While the percentage of consumption accounted for by water treatment is unknown, it is believed to be less than 10% based on estimates of other uses.

Manufacturing, Transport, & Storage

Manufacturing Process

Phosphoric acid and a source of zinc are the raw materials commonly used to produce zinc orthophosphate. There are numerous methods to produce zinc orthophosphate on a commercial scale, most commonly by mixing zinc oxide and phosphoric acid or a zinc salt (e.g., zinc chloride) and sodium orthophosphate or phosphoric acid, in various zinc to phosphate ratios. Zinc salts are formed by reacting zinc oxide, obtained from zinc-bearing ores which have undergone beneficiation steps and removal of impurities, with hydrochloric acid or sulfuric acid. Zinc salts are subsequently mixed with phosphoric acid, filtered, and provided as a liquid or subsequently dried to provide a solid product. The general equations for these reactions are shown in Figure 1.

Method 1

Zinc Chloride + Phosphoric Acid → Zinc Phosphate + Hydrochloric Acid

$3ZnCl_2 + 2H_3PO_4 \rightarrow Zn_3(PO_4)_2 + 6HCl$

Method 2

Zinc Sulfate + Phosphoric Acid → Zinc Phosphate + Sulfuric Acid

$3ZnSO_4 + 2H_3PO_4 \rightarrow Zn_3(PO_4)_2 + 3H_2SO_4$

Method 3

Zinc Oxide + Phosphoric Acid → Zinc Phosphate + Water

$3ZnO + 2H_3PO_4 \rightarrow Zn_3(PO_4)_2 + 3H_2O$

Figure 1. Chemical Equations for the Reactions to Manufacture Zinc Orthophosphate

Product Transport

Zinc orthophosphate, primarily supplied as a solution, is transported in container and bulk by truck, rail, barge, and ship.

Storage and Shelf Life

Zinc orthophosphate solutions are often produced as propriety mixtures. When stored properly, zinc orthophosphate solutions, though varied in composition, may have a shelf life up to approximately 24 month (Carus, 2001; Carus, n.d.).

Domestic Production & Consumption

Domestic Production

Production data was collected from the 2020 Toxic Substances Control Act (TSCA) Chemical Data Reporting (CDR) for the year 2019, while trade data was collected from the U.S. International Trade Commission (USITC) Dataweb, as shown in Table 1. While production data is specific to zinc orthophosphate, trade data includes zinc orthophosphate as part of a class of phosphates other than aluminum, calcium, potassium, sodium, triammonium, and trisodium phosphates.

Table 1. Zinc Orthophosphate Production and Trade Data Sources

Production and Trade Data			
Category	**Data Source and Date**	**Identifier**	**Description**
Domestic Production	2020 TSCA Chemical Data Reporting	CAS No.: 7779-90-0	Zinc Phosphate
Imports and Exports	U.S. International Trade Commission	HS Code: 2835.29.51	Phosphates other than aluminum, calcium, potassium, sodium, triammonium, and trisodium

Total domestic manufacturing of zinc orthophosphate reported under the CDR was approximately 0.66 M kg in 2019 (EPA, 2020); however, several domestic manufacturers claimed confidential business information and did not report production volumes to EPA, including historic significant domestic manufacturers *ICL Specialty Products* and the *Thatcher Company*. Most zinc orthophosphate production facilities produce zinc orthophosphate blends for metal coating. *Carus Corporation* is the largest producer of zinc orthophosphate blends for water treatment reporting production in 2019. The number of domestic manufacturing locations shown in Figure 2 represents operating facilities as of 2015 (EPA, 2016). Supply of NSF/ANSI Standard 60 certified zinc orthophosphate for use in drinking water treatment is widely distributed throughout the U.S. (NSF International, 2021). For a more current listing of manufacturing locations and supplier locations, visit the U.S. Environmental Protection Agency's (EPA's) Chemical Locator Tool (EPA, 2022a).

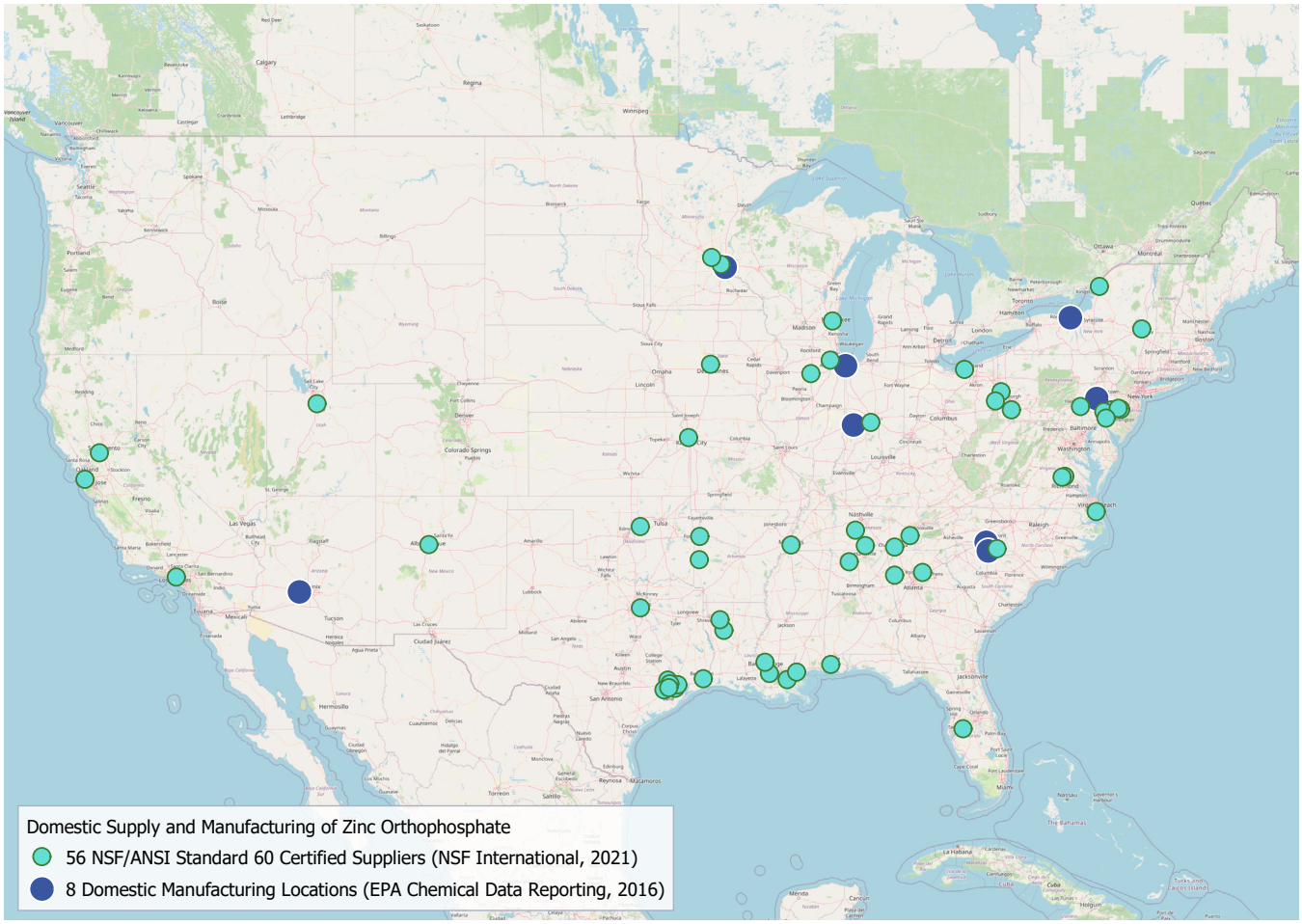


Figure 2. Domestic Supply and Manufacturing of Zinc Orthophosphate

Domestic Consumption

Due to differences in reporting for production and trade data, as well as the significant number of producers that did not report production data under the 2020 CDR, U.S. consumption of zinc orthophosphate could not be estimated. Domestic production of zinc orthophosphate represents a small quantity when compared to the import and export volume for the category of phosphates including zinc orthophosphate.

Trade &Tariffs

Worldwide Trade

Worldwide import and export data for zinc orthophosphate are reported through the World Bank's World Integrated Trade Solutions (WITS), as a category representing a class of compounds including phosphates other than sodium, potassium, and calcium phosphates. In 2021, the U.S. ranked third worldwide in total exports and fifth in total imports of phosphates other than sodium, potassium, and calcium phosphates. In 2021, China ranked first worldwide in total exports (WITS, 2022), as shown in Table 2. Import and export data specific to zinc orthophosphate are unavailable from the referenced sources.

Table 2. WITS Worldwide Export and Import of Phosphates Other than Sodium, Potassium, and Calcium, in 2021

2021 Worldwide Trade Phosphates Other than Sodium, Potassium, and Calcium (HS Code 2835.29)			
Top 5 Worldwide Exporters		Top 5 Worldwide Importers	
Germany	30 M kg	Malaysia	42 M kg
Malaysia	9 M kg	Belgium	13 M kg
United States	**6 M kg**	United Kingdom	10 M kg
Sweden	5 M kg	Germany	9 M kg
Netherlands	5 M kg	**United States**	**8 M kg**

Domestic Imports and Exports

Domestic imports and export data are reported by USITC in a category including phosphates other than aluminum, calcium, potassium, sodium, triammonium, and trisodium. Figure 3 summarizes imports for consumption[1] and domestic exports[2] of phosphates other than aluminum, calcium, potassium, sodium, triammonium, and trisodium between 2015 and 2020. During this period, the overall quantity of exports and imports remained relatively steady, with domestic exports exceeding imports for consumption. Over this five-year period, Canada was the primary recipient of domestic exports while Germany was the primary source of imports (USITC, 2022a).

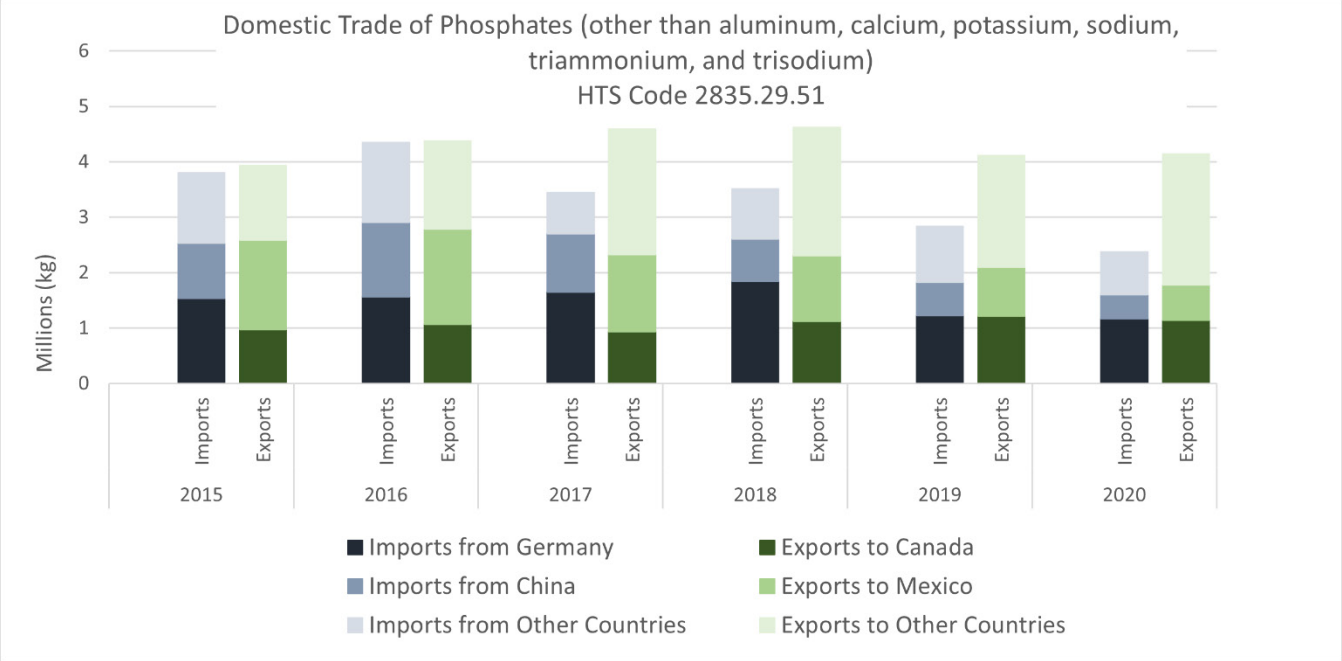


Figure 3. USITC Domestic Import and Export of Phosphates Other than Aluminum, Calcium, Potassium, Sodium, Triammonium, and Trisodium between 2015 and 2020

[1] Imports for consumption are a subset of general imports, representing the total amount cleared through customs and entering consumption channels, not anticipated to be reshipped to foreign points, but may include some reexports.

[2] Domestic exports are a subset of total exports, representing export of domestic merchandise which are produced or manufactured in the U.S. and commodities of foreign origin which have been changed in the U.S.

Tariffs

There is a 4.1% general duty for import of the category of phosphates including zinc orthophosphate and an 25% additional duty on imports from China (USITC, 2022), as summarized in Table 3.

Table 3. 2021 Domestic Tariff Schedule for Phosphates Other than Aluminum, Calcium, Potassium, Sodium, Triammonium, and Trisodium

HS Code	General Duty	Additional Duty - China (Section 301 Tariff List)	Special Duty
2835.29.51	4.1%	25%	Free (A, AU, BH, CL, CO, D, E, IL, JO, KR, MA, OM, P, PA, PE, S, SG)[3]

Market History & Risk Evaluation

History of Shortages

Disruptions to phosphoric acid production and the supply of phosphate rock can have a significant impact on availability of phosphates used in corrosion control applications. The increased demand for phosphoric acid for use in fertilizers has led to price increases and supply disruptions. Domestic manufacturers and suppliers of phosphate-based water treatment chemicals oftentimes rely on the international market for supply of phosphate rock and phosphoric acid and may encounter persistent challenges in obtaining these raw materials. This has led to repeated shortages of phosphate-based water treatment chemicals. In 2021, disruptions in international trade caused by the COVID-19 pandemic severely challenged these manufacturers.

Risk Evaluation

The complete risk evaluation methodology is described in *Understanding Water Treatment Chemical Supply Chains and the Risk of Disruptions* (EPA, 2022b). The risk rating is calculated as the product of the following three risk parameters:

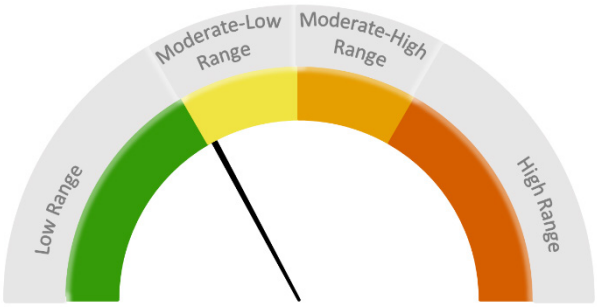
Risk = Criticality x Likelihood x Vulnerability	
Criticality	Measure of the importance of a chemical to the water sector
Likelihood	Measure of the probability that the chemical will experience a supply disruption in the future, which is estimated based on past occurrence of supply disruptions
Vulnerability	Measure of the market dynamics that make a chemical market more or less resilient to supply disruptions

The individual parameter rating is based on evaluation of one or more attributes of the chemical or its supply chain. The ratings and drivers for these three risk parameters are shown below in Table 4.

[3] Symbols used to designate the various preference programs and trade agreements. A full list of special trade agreements and associated acronyms can be found at https://help.cbp.gov/s/article/Article-310?language=en_US and the General Notes Section of the Harmonized Tariff Schedule https://hts.usitc.gov/current

Table 4. Supply Chain Risk Evaluation for Zinc Orthophosphate

Risk Parameter Ratings and Drivers		
Criticality: Moderate-High	**Likelihood: Moderate-High**	**Vulnerability: Low**
Zinc orthophosphate is broadly used in corrosion control. It is not used to manufacture other water treatment chemicals.	Phosphoric acid is a critical input in zinc orthophosphate manufacturing. The water sector has experienced regional phosphoric acid supply disruptions in the past. Concerns are primarily due to increased competition and reliance on imports of phosphate rock and phosphoric acid.	Strong domestic manufacturing capabilities and a distributed manufacturing base provide some resilience to supply disruptions. However, the need to obtain manufacturing inputs on the international market could increase vulnerability.
Risk Rating: Moderate-Low		



References

Agency for Toxic Substances & Disease Registry (ATSDR), 2005. *Toxicological Profile for Zinc*, retrieved from https://www.atsdr.cdc.gov/toxprofiles/tp60.pdf

American Water Works Association (AWWA), 2006. *B506, Zinc Orthophosphate*. Denver, CO: American Water Works Association.

Carus Corporation (Carus), 2001. *Fact Sheet for Virchem 511, Zinc Orthophosphate*, retrieved from https://www.waterwiseenterprises.com/Carus/Virchem%20511%20Fact%20Sheet.pdf

Carus Corporation (Carus), (n.d.). *Carus Proprietary Zinc Phosphate Water Treatment Chemicals Product Safety Summary*, retrieved from https://www.carusllc.com/wp-content/uploads/CarusZincAndOrthoPhosphate_ProductSafetySummarycp.pdf

EPA, 2016. 2016 TSCA Chemical Data Reporting, retrieved from https://www.epa.gov/chemical-data-reporting/access-cdr-data#2016

EPA, 2020. 2020 TSCA Chemical Data Reporting, retrieved from https://www.epa.gov/chemical-data-reporting/access-cdr-data#2020

EPA, 2022a. Chemical Suppliers and Manufacturers Locator Tool, retrieved from https://www.epa.gov/waterutilityresponse/chemical-suppliers-and-manufacturers-locator-tool

EPA, 2022b. *Understanding Water Treatment Chemical Supply Chains and the Risk of Disruptions*, retrieved from https://www.epa.gov/waterutilityresponse/water-sector-supply-chain-resilience

National Center for Biotechnology Information (NCBI), 2022. PubChem Compound Summary for CID 24519, Zinc Phosphate, retrieved from https://pubchem.ncbi.nlm.nih.gov/compound/Zinc-Phosphate

NSF International (NSF), 2021. Search for NSF Certified Drinking Water Treatment Chemicals, retrieved from https://info.nsf.org/Certified/PwsChemicals/

U.S. International Trade Commission (USITC), 2022a. USITC DataWeb, retrieved from https://dataweb.usitc.gov/

U.S. International Trade Commission (USITC), 2022b. Harmonized Tariff Schedule (HTS) Search, retrieved from https://hts.usitc.gov/current

World Integrated Trade Solutions (WITS), 2022. Trade Statistics by Product (HS 6-digit), retrieved from https://wits.worldbank.org/trade/country-byhs6product.aspx?lang=en#void