Sodium Salts of Polyphosphates

Sodium Hexametaphosphate: $Na_6(PO_3)_6$
Sodium Tripolyphosphate: $Na_5P_3O_{10}$

Direct Use Chemical

(solid or liquid)

Inputs to Manufacturing Process:
Monosodium Phosphate
Disodium Phosphate

% of Total Domestic Consumption Attributed to Water Sector:
Approximately 40%

Product Family:
Phosphate

CAS No.: 68915-31-1
7758-29-4

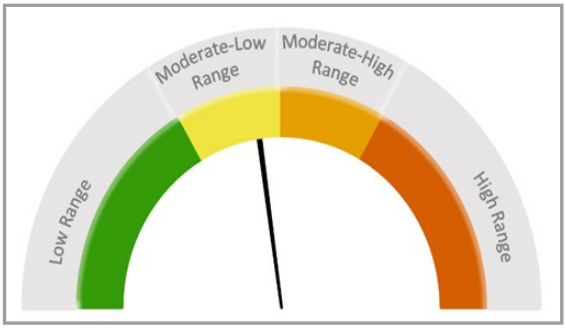
Derivative Water Treatment Chemicals:
None

Understanding Chemical Supply Chains
Map of Suppliers & Manufacturers

Shelf Life:
12-18 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 supply disruptions have occurred between 2000 and 2022.

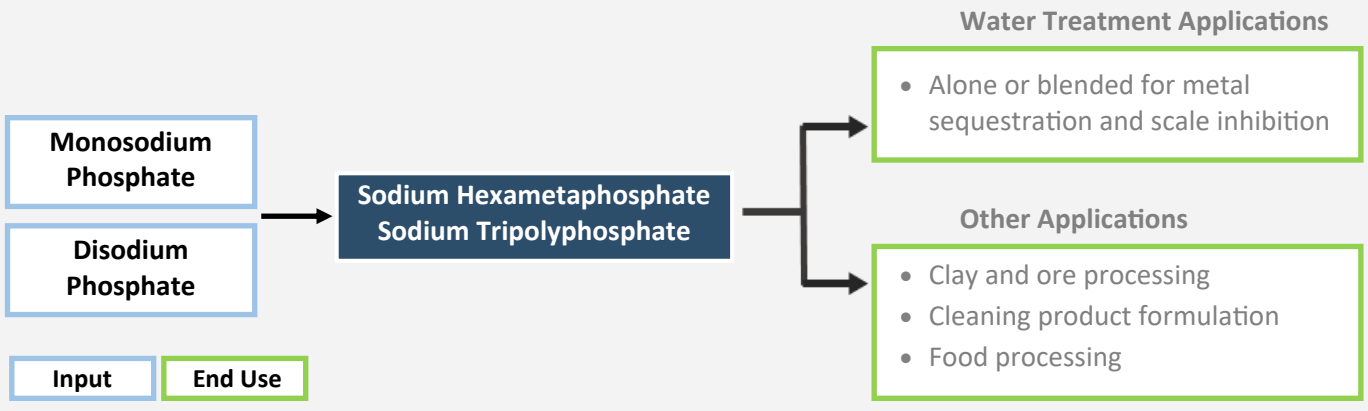
RISK PARAMETERS

Criticality: High. Essential for corrosion control.

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

Vulnerability: Moderate-High. Limited domestic manufacturing and reliance on international market for inputs and finished product.

MANUFACTURING PROCESS



DOMESTIC PRODUCTION AND CONSUMPTION, AND INTERNATIONAL TRADE

Domestic Manufacturing Locations (2015):
Sodium Hexametaphosphate: 2 locations
Sodium Tripolyphosphate: 3 locations

International Trade (2019)
Primary Trading Partner (Imports): Canada
Primary Trading Partner (Exports): Canada

Domestic Production and Consumption

Total domestic manufacturing of sodium tripolyphosphate reported under the TSCA CDR was approximately 0.014 M kg in 2019. Significantly, most domestic manufacturers of sodium tripolyphosphate and sodium hexametaphosphate did not report production. Due to this data gap and differences in reporting between production and trade data for sodium hexametaphosphate, U.S. consumption could not be estimated.

Product Description

Sodium salts of polyphosphates are a class of phosphate salts with varying chemical formulas, all derived from phosphoric acid. Sodium polyphosphates are commonly used alkali metal polyphosphates in water treatment as blended phosphates for scale inhibition and metal sequestration. Two commonly used polyphosphates; sodium tripolyphosphate (STPP) and sodium hexametaphosphate (SHMP) are featured in this profile.

Use in Water Treatment

Polyphosphates are used alone or blended with orthophosphates for scale inhibition and sequestration of metals to reduce metals release in distribution systems. When sold as a commercial chemical product for water treatment, polyphosphates are sold in specific form, such as sodium tripolyphosphate and sodium hexametaphosphate or, more commonly, as a trademarked blend of orthophosphates and polyphosphates.

Use as a Precursor to Other Water Treatment Chemicals

Sodium salts of polyphosphates are not used to manufacture other water treatment chemicals.

Other Applications

Sodium tripolyphosphate and sodium hexametaphosphate have a range of applications. STPP is widely used in water treatment, dishwater detergents, and food processing (USITC, 2009). SHMP is used in water treatment, clay processing, cleaning products, and food processing (USITC, 2018).

Primary Industrial Consumers

Historically, water treatment has been the primary use for SHMP (40.7%), followed by clay processing, copper ore processing, drilling muds, and paper production (22.5%); industrial and institutional cleaners (16.8%); meat, seafood, and poultry processing (15.3%); bath salts (3.5%); and toothpastes (1.2%) (USITC, 2018). Water treatment, detergent formulation, and food processing are primary uses of STPP (USITC, 2009).

Manufacturing, Transport, & Storage

Manufacturing Process

This profile focuses on two sodium polyphosphates widely used alone or in blended solutions for water treatment: SHMP and STPP. Production of these polyphosphates starts with monosodium phosphate or a combination of monosodium and disodium phosphate and proceeds with heating and polymerization. The overall equations for the most common manufacturing processes for SHMP and STPP are outlined in Figure 1 and Figure 2, respectively.

Sodium hexametaphosphate is produced from a solution of monosodium phosphate. Monosodium phosphate is heated to form disodium pyrophosphate. This is in turn heated to form molten sodium hexametaphosphate, which solidifies into a glassy sheet as it cools. The sheet is milled to produce a granular or powdered product (AWWA, 2006; USITC, 2018).

Sodium tripolyphosphate is produced from a mixture of mono- and disodium phosphates. The mixed phosphates are calcined, which forces the mono- and disodium phosphate molecules to react and condense, forming polymers in a specific size range. The cooled, dried product is milled into a granular or powdered product (AWWA 2017; USITC, 2009).

Step 1

Monosodium Phosphate + Heat → Disodium Pyrophosphate + Water

$2NaH_2PO_4$ + Heat → $Na_2H_2P_2O_7$ + H_2O

Step 2

Disodium Pyrophosphate + Heat → Sodium Hexametaphosphate + Water

$3Na_2H_2P_2O_7$ + Heat → $Na_6(PO_3)_6$ + $3H_2O$

Figure 1. Chemical Equation for the Reaction to Manufacture Sodium Hexametaphosphate

Monosodium Phosphate + Disodium Phosphate → Sodium Tripolyphosphate + Water

$2NaH_2PO_4$ + Na_2HPO_4 → $Na_5P_3O_{10}$ + H_2O

Figure 2. Chemical Equation for the Reaction to Manufacture Sodium Tripolyphosphate

Product Transport

STPP and SHMP, primarily supplied in solution but also available as a solid or powder, are widely transported in container and bulk by truck, rail, barge, and ship.

Storage and Shelf Life

Sodium hexametaphosphate and sodium tripolyphosphate are stable and generally non-reactive. When stored properly, they can have a shelf life from 12 to 18 months (Carus, 2013; Carus, 2017; ICL, 2015; Innophos, 2019).

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 USITC Dataweb, as shown in Table 1. Production data are specific to SHMP and STPP. Trade data is available for STPP, however SHMP may be imported under several harmonized tariff schedule (HTS) codes. The SHMP HTS codes are not specific to SHMP and also include other phosphates and blends (USTIC, 2018). One of these codes has been referenced in Table 1.

Table 1. Sodium Hexametaphosphate and Sodium Tripolyphosphate Production and Trade Data Sources

Production and Trade Data			
Category	**Data Source**	**Identifier**	**Description**
Domestic Production	2020 EPA Chemical Data Reporting	CAS No.: 68915-31-1 CAS No.: 7758-29-4	Sodium Hexametaphosphate Sodium Tripolyphosphate
Imports and Exports	U.S. International Trade Commission	HTS Code: 2835.39.50 HS Code: 2835.31	Polyphosphates (other than sodium (or sodium tripolyphosphate) of potassium) (including sodium hexametaphosphate) Sodium Tripolyphosphate

Of the 27 facilities reporting as part of CDR in 2019, only three locations indicated domestic production of STPP, and of those only one reported a production quantity. Total reported U.S. domestic production of STPP for commercial sale was approximately 0.014 million kg (M kg) in 2019 (EPA, 2020). Of the 11 facilities reporting SHMP production or import as part of CDR in 2019, only three locations indicated domestic production of SHMP,

and of those only one reported a production quantity. This facility indicated that production of SHMP was primarily used at the manufacturing site. The company identifying SHMP production quantity, *Nalco*, manufactures SHMP for captive consumption and is not known to sell any product commercially (USITC, 2018). The primary domestic manufacturer for both STPP and SHMP is *ICL Specialty Products*. The number of domestic manufacturing locations shown in Figure 3 represents operating facilities as of 2015 (EPA, 2016). Supply of NSF/ANSI Standard 60 certified STPP and SHMP for use in drinking water treatment is 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).

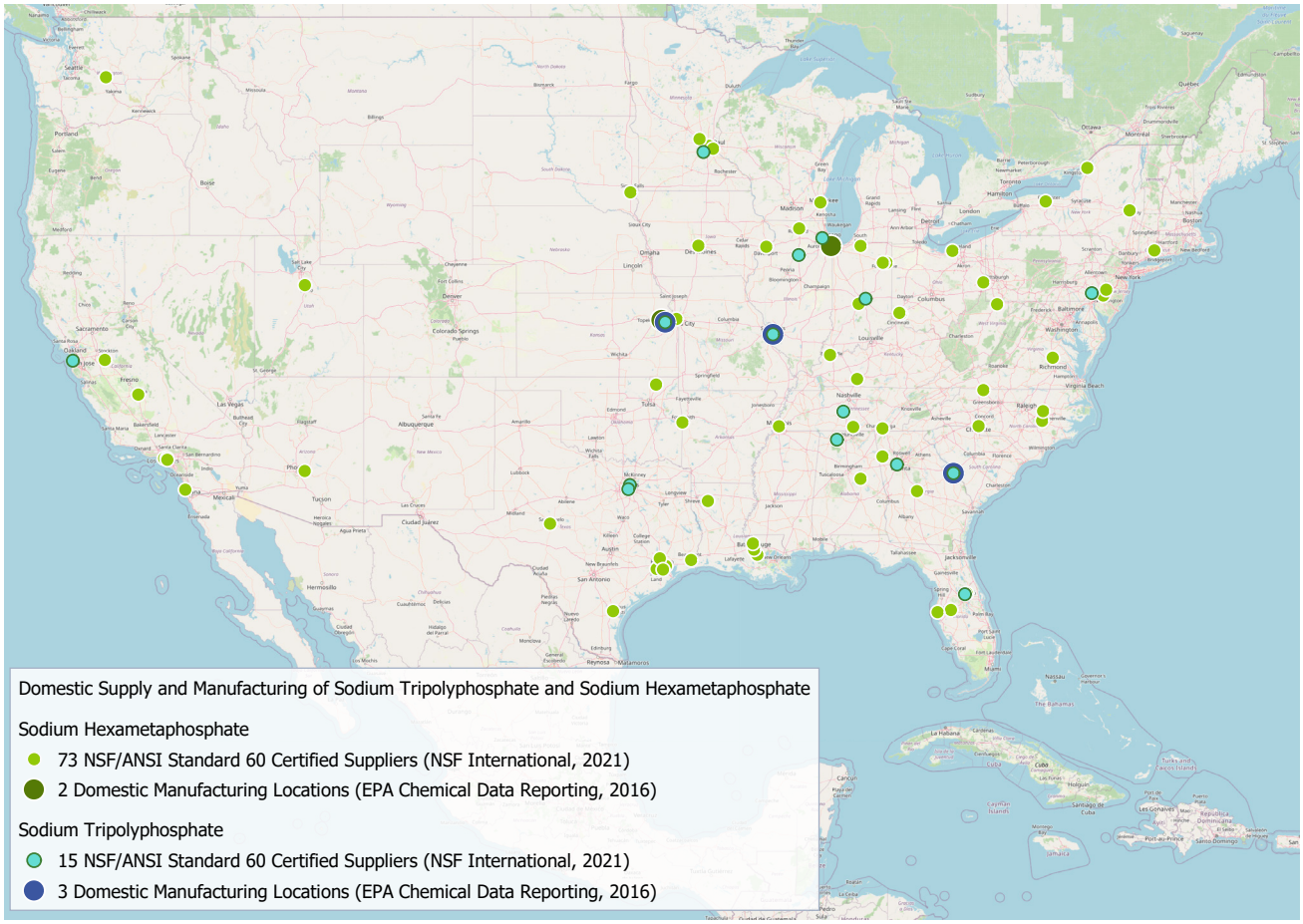


Figure 3. Domestic Supply and Manufacturing of Sodium Hexametaphosphate and Sodium Tripolyphosphate

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 CDR, U.S. consumption of SHMP could not be estimated. Consumption of STPP was not estimated due to the significant number of producers that did not report production.

Trade &Tariffs

Worldwide Trade

Worldwide import and export data for sodium tripolyphosphate are reported through the World Bank's World Integrated Trade Solutions (WITS) software, as a category specific to STPP. In 2021, the U.S. ranked tenth worldwide in total exports and first in total imports of STPP. In 2021, China ranked first worldwide in total

exports (WITS, 2022) as shown in Table 2. As previously noted, trade reporting for sodium hexametaphosphate may be covered by several trade categories, none of which are specific to sodium hexametaphosphate.

Table 2. WITS Worldwide Export and Import of Sodium Tripolyphosphate in 2021

2021 Worldwide Trade Sodium Tripolyphosphate (HS Code 2835.31)			
Top 5 Worldwide Exporters		Top 5 Worldwide Importers	
China	177 M kg	**United States**	**54 M kg**
Russian Federation	77 M kg	India	49 M kg
Belgium	64 M kg	Indonesia	29 M kg
Tunisia	43 M kg	Brazil	19 M kg
Canada	43 M kg	Peru	15 M kg

Domestic Imports and Exports

Domestic import and export data are reported by USITC in a category specific to STPP. Figure 4 summarizes imports for consumption[1] and domestic exports[2] of STPP between 2015 and 2020. During this period, the overall quantity of imports remained relatively steady, with imports consistently exceeding exports, while the quantity of exports varied, with a high in 2017. Over this five-year period, Canada was the primary recipient of domestic exports and the primary source of imports (USITC, 2022a).

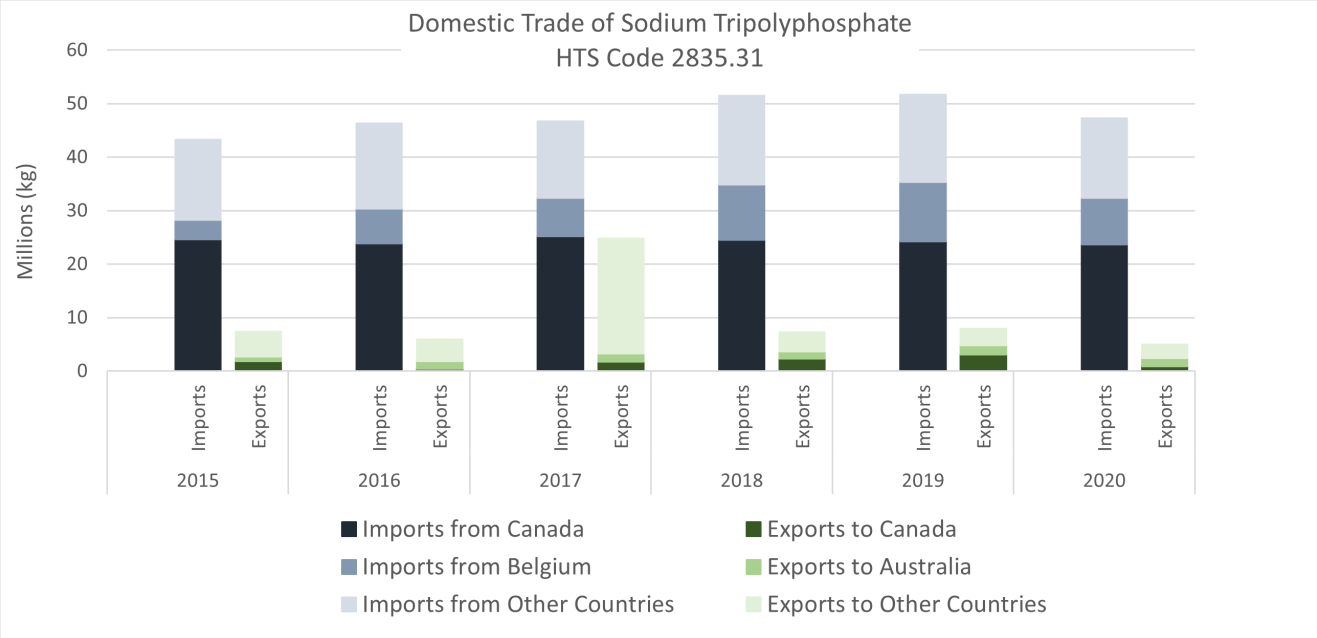


Figure 4. USITC Domestic Import and Export of Sodium Tripolyphosphate between 2015 and 2020

[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 1.4% general duty for import of STPP and an additional 25% duty on imports from China (USITC, 2022b), as summarized in Table 3.

Table 3. 2020 Domestic Tariff Schedule for Sodium Tripolyphosphate

HS Code	General Duty	Additional Duty – China (Section 301 Tariff List)	Special Duty
2835.31	1.4%	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 chain for phosphate rock can have a significant impact on availability of phosphoric acid and phosphates used in corrosion control applications. The increased demand for phosphoric acid and phosphates for use in fertilizers and animal feed 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. Imports of finished product (SHMP and STPP) are also important for meeting domestic demand. 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 and domestic suppliers.

Risk Evaluation

The complete risk assessment 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:

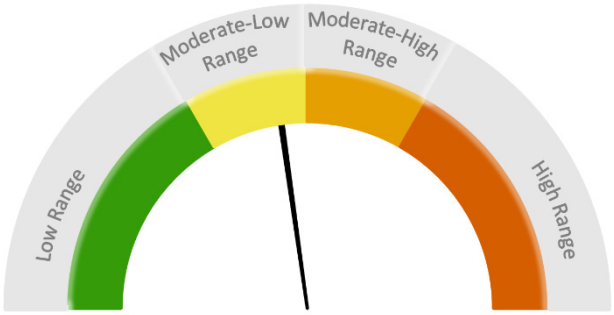
Risk = Criticality x Likelihood x Vulnerability	
Criticality	Measure of the importance of a chemical to the water sector
Likelihood	Measure of the probability that the chemical will experience a supply disruption in the future, which is estimated based on past occurrence of supply disruptions
Vulnerability	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 Sodium Salts of Polyphosphates

Risk Parameter Ratings and Drivers		
Criticality High	**Likelihood Moderate- Low**	**Vulnerability Moderate-High**
Sodium salts of polyphosphates are essential to the water sector and have widespread application for corrosion control.	The water sector has experienced regional supply disruptions in the past. Concerns are primarily due to increased competition and reliance on imports for inputs (phosphoric acid, and mono- and disodium phosphate).	Domestic manufacturing is limited; however supply is widespread. There is a significant reliance on imports for both inputs and finished product.
Risk Rating: Moderate-Low		



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