Phosphoric Acid

H_3PO_4 (liquid)

D Direct Use Chemical P Precursor Chemical

Inputs to Manufacturing Process:
Phosphate Rock Sulfuric Acid

Derivative Water Treatment Chemicals:
Orthophosphates
Polyphosphates

% of Total Domestic Consumption Attributed to Water Sector:
Less than 1%

Understanding Chemical Supply Chains

Map of Suppliers & Manufacturers

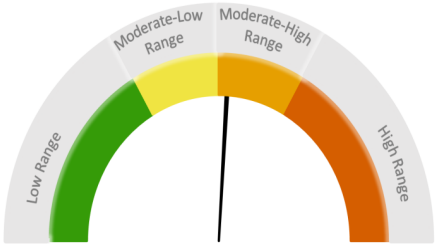
Product Family:
Phosphate

CAS No.:
7664-38-2

Shelf Life:
60 Months

RISK OF SUPPLY DISRUPTION (Assessed in 2022)

RISK RATING: Moderate-High



RISK DRIVERS

Competing use in fertilizers accounts for the majority of con-sumption of domestic production. Other uses of phosphoric acid may rely on import. Access to a key input (phosphate rock) on the inter-national market may be challenging.

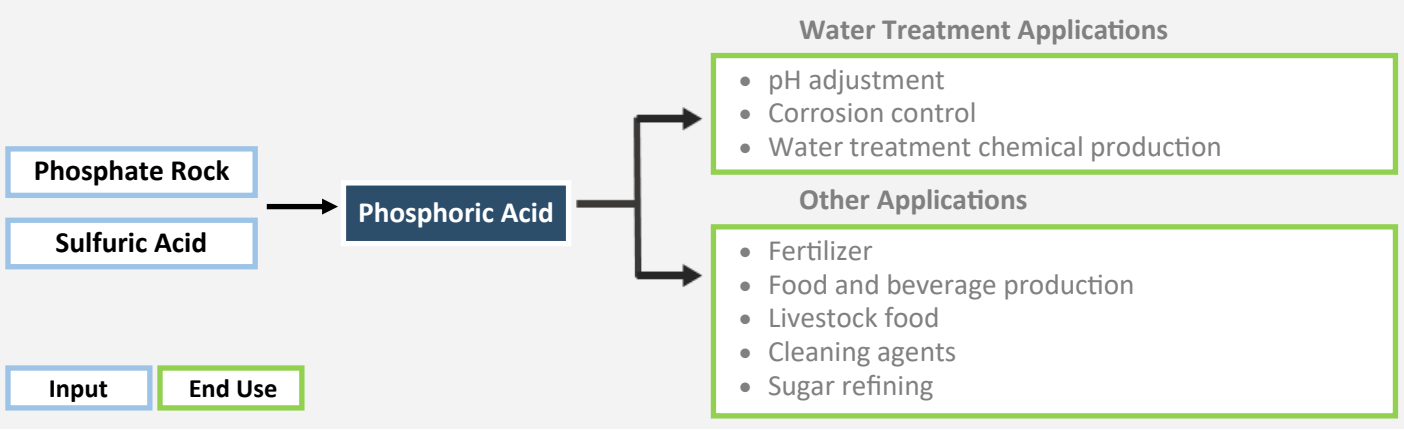
RISK SCORE PARAMETERS

Criticality: High. Essential for pH ad-justment, corrosion control, and production of water treatment chemicals.

Likelihood: High. Previous disruptions in supply that impacted the water sector. Concerns over access to manufac-turing inputs.

Vulnerability: Low. Distributed domestic manufacturing and supply. Consumption of domestic production dominated by use in fertilizer.

MANUFACTURING PROCESS



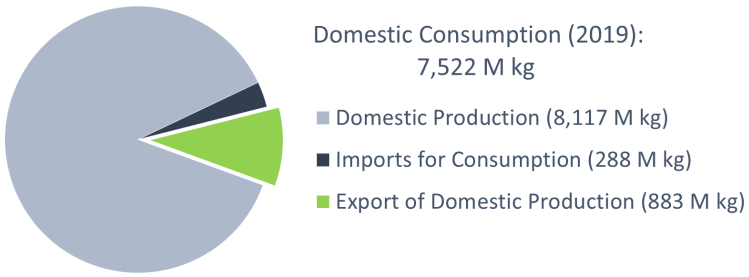
DOMESTIC PRODUCTION AND CONSUMPTION, AND INTERNATIONAL TRADE

Domestic Manufacturing Locations (2019):
19, distributed throughout the U.S.

International Trade (2019)

Primary Trading Partner (Imports): Canada

Primary Trading Partner (Exports): Mexico



ProductDescription

Phosphoric acid (H_3PO_4) is an inorganic, strong acid that is widely used for pH adjustment and is a key input in the production of all phosphate derivative chemicals. Phosphoric acid is domestically manufactured primarily through the wet acid process. The majority of phosphoric acid manufactured in the U.S. is used in fertilizer formulations.

UseinWaterTreatment

Phosphoric acid is used in water treatment for pH adjustment and corrosion control (AWWA, 2016).

UseasaPrecursortoOtherWaterTreatmentChemicals

Phosphoric acid is used to manufacture phosphate-derived products including all orthophosphates and polyphosphates.

OtherApplications

Phosphoric acid has a wide range of applications, but is predominantly used in fertilizer formulations. Other uses include pH adjustment for food and beverage processing, livestock food, cleaning agent formulation, sugar refining, and synthetic phosphate manufacturing (NCBI, 2021; Shriver and Atkins, 2010; USDA, 2021).

PrimaryIndustrialConsumers

The use of phosphoric acid for fertilizer manufacturing accounts for consumption of approximately 85% of the phosphoric acid produced (Shriver and Atkins, 2010). Other significant uses are in food and beverage processing, sugar refining, and as a source of phosphate detergent in cleaning applications (USDA, 2021). Direct use in water treatment and use as a starting material in producing phosphate derivative products for water treatment are a small percent (< 1%) of the domestic market.

Manufacturing,Transport,&Storage

ManufacturingProcess

Phosphoric acid can be produced from minerals (such as fluorapatite) through the wet acid process, or from elemental phosphorous using the thermal process. Historically, the wet method was only used to manufacture phosphoric acid for fertilizer production and other non-technical applications. Applications requiring a higher purity phosphoric acid, including food- and technical-grade phosphoric acid, require additional purification steps or a different production method. In recent years, further development of the wet acid method, including a solvent-based extraction, have allowed this method to become the dominant North American technology to manufacture purified phosphoric acid, however the electric furnace (thermal) method may also be used to produce food- or technical-grade phosphoric acid (Innophos, 2011; Mosaic, 2021; Potash, 2015). Using the wet acid method, phosphoric acid is produced by reacting sulfuric acid with finely ground phosphate rock. Gypsum formed in this reaction is filtered out of the solution and the hydrogen fluoride vapors may be recovered. The chemical reaction of the wet acid method is shown in Figure 1. The production of phosphoric acid via the wet acid method relies heavily on significant quantities of sulfuric acid. Commercially, it is economical to produce sulfuric acid on-site from sulfur. Many phosphoric acid producers therefore also produce sulfuric acid. The wet process produces a dilute phosphoric acid which is subsequently concentrated and sold as an industrial grade product typically used in fertilizer or further concentrated and processed to produce a high purity product. This process may limit the quantity of high purity product that can be produced.

Phosphate Rock	+	Sulfuric Acid	→	Phosphoric Acid	+	Gypsum	+	Hydrogen Fluoride
$Ca_5(PO_4)_3F$	+	$5H_2SO_4$	→	$3H_3PO_4$	+	$5CaSO_4$	+	HF

Figure 1. Chemical Equation for the Reaction to Manufacture Phosphoric Acid

Product Transport

Phosphoric acid is typically sold as a liquid in a range of concentrations, and primarily delivered by specialized rail cars to suppliers who repackage and sell the product directly to customers. Transport of phosphoric acid must adhere to the appropriate methods and regulations related to its status as a highly corrosive substance (AWWA, 2016; CORECHEM, 2017).

Storage and Shelf Life

Phosphoric acid should be stored in corrosion-resistant vessels in a cool place away from direct sunlight. When stored properly, phosphoric acid can have a shelf life of 60 months, depending on concentration and size of storage container (CORECHEM, 2017).

Domestic Production & Consumption

Domestic Production

Production data was collected from the EPA 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 characterized in Table 1. While production data is specific to phosphoric acid, trade data includes phosphoric acid and polyphosphoric acid, a polymerized form of phosphoric acid more common in solution at very high concentrations (USDA, 2021).

Table 1. Phosphoric Acid Production and Trade Data Sources

Production and Trade Data			
Category	**Data Source**	**Identifier**	**Description**
Domestic Production	2020 TSCA Chemical Data Reporting	CAS No.: 7664-38-2	Phosphoric Acid
Imports and Exports	U.S. International Trade Commission	HS Code: 2809.20	Phosphoric Acid and Polyphosphoric Acid

otal U.S. domestic manufacturing of phosphoric acid was approximately 8,117 million kilograms (M kg) in 2019 (EPA, 2020a). The majority of domestic commercial manufacture of phosphoric acid takes place at phosphate rock processing facilities located throughout the contiguous U.S. Many of these facilities are owned by a relatively small number of companies including the *Mosaic Company* (*Mosaic*), *PCS Phosphate*, and *J.R. Simplot* (EPA, 2020a). *Mosaic* reported production of approximately 3,900 M kg of phosphoric acid in 2019, with a capacity of 4,500 M kg, which they estimate as approximately 58% of North American annual capacity. *Mosaic* ships phosphate rock concentrate from Peru to their Louisiana processing facility for production of phosphoric acid and fertilizers (Mosaic, 2021). The number of domestic manufacturing locations shown in Figure 2 represents operating facilities as of 2015. Supply of NSF/ANSI Standard 60 certified phosphoric acid 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).

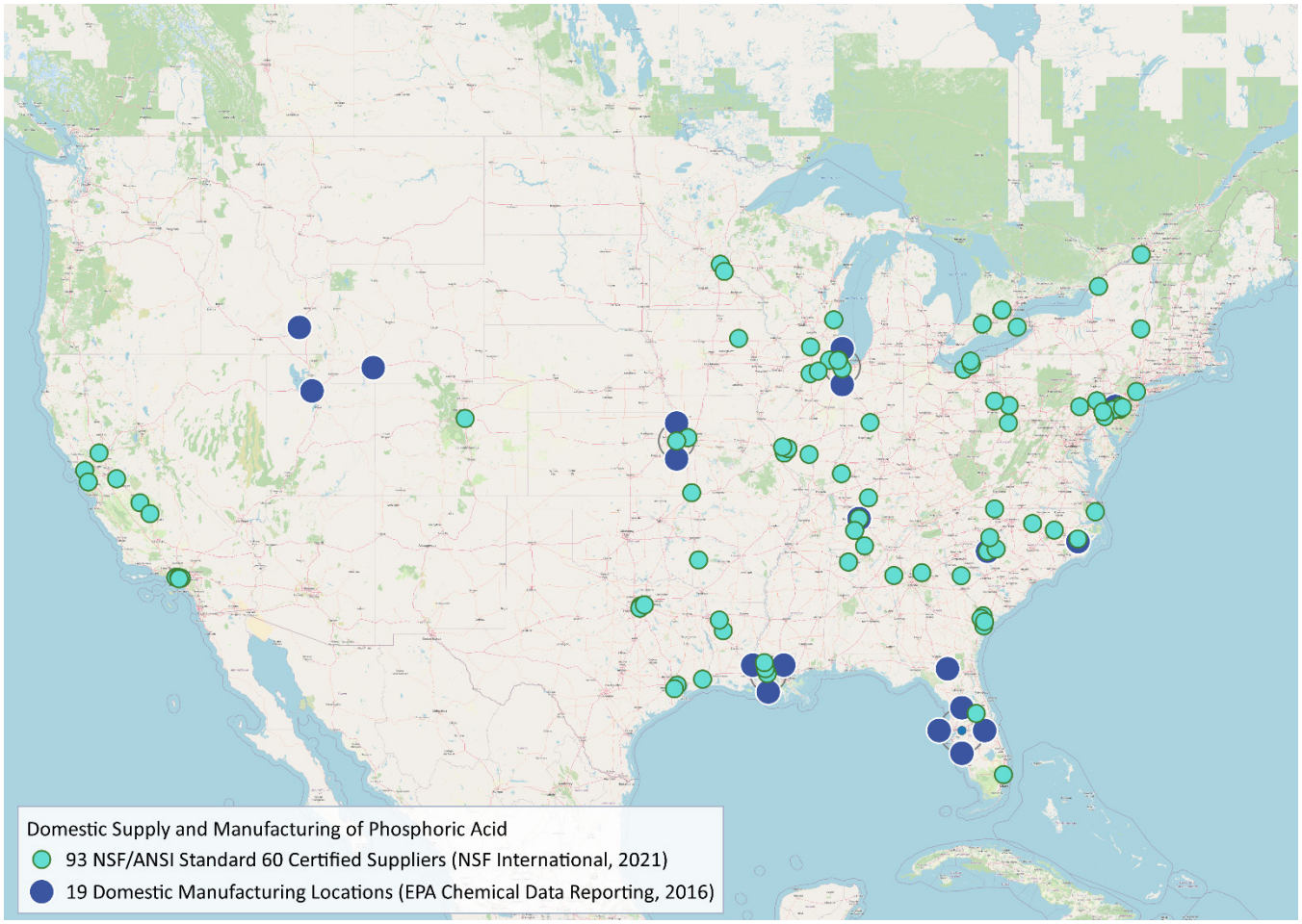


Figure 2. Domestic Supply and Manufacturing of Phosphoric Acid

Domestic Consumption

U.S. consumption of phosphoric acid in 2019 is estimated at 7,522 M kg. This includes production of 8,117 M kg, import of 288 M kg, minus export of 883 M kg (EPA, 2020a; USITC, 2021), as shown in Figure 3.

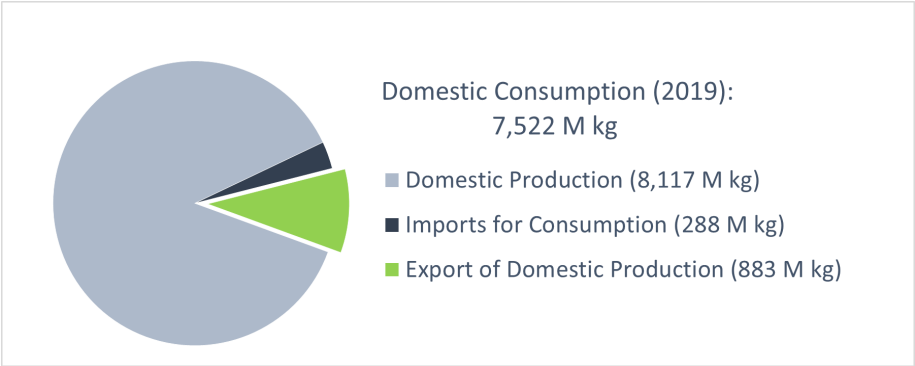


Figure 3. Domestic Production and Consumption of Phosphoric Acid in 2019

Trade & Tariffs

Worldwide Trade

Worldwide import and export data for phosphoric acid are reported through the World Bank's World Integrated

Trade Solutions (WITS) software, as a category specific to phosphoric acid and polyphosphoric acid. In 2021, U.S. ranked first worldwide in total exports and seventh in total imports of phosphoric acid. In 2021, India ranked first worldwide in total imports (WITS, 2022), as shown in Table 2.

Table 2. WITS Worldwide Export and Import of Phosphoric Acid in 2021

2021 Worldwide Trade Phosphoric Acid and Polyphosphoric Acid (HS Code 2809.20)			
Top 5 Worldwide Exporters		Top 5 Worldwide Importers	
United States	**500 M kg**	India	6,592 M kg
Senegal	478 M kg	Pakistan	711 M kg
Belgium	302 M kg	Turkey	476 M kg
Netherlands	210 M kg	Belgium	376 M kg
European Union	182 M kg	Spain	336 M kg

Domestic Imports and Exports

Domestic import and export data are reported by USITC in categories specific to phosphoric acid and polyphosphoric acid. Figure 4 summarizes imports for consumption[1] and domestic exports[2] of phosphoric acid and polyphosphoric acid between 2015 and 2020. During this period, the volume of exports and imports fluctuated, with domestic exports consistently exceeding imports for consumption. Over this five-year period, Mexico and Canada were the primary recipients of domestic exports while Canada was the primary source of imports (USITC, 2021).

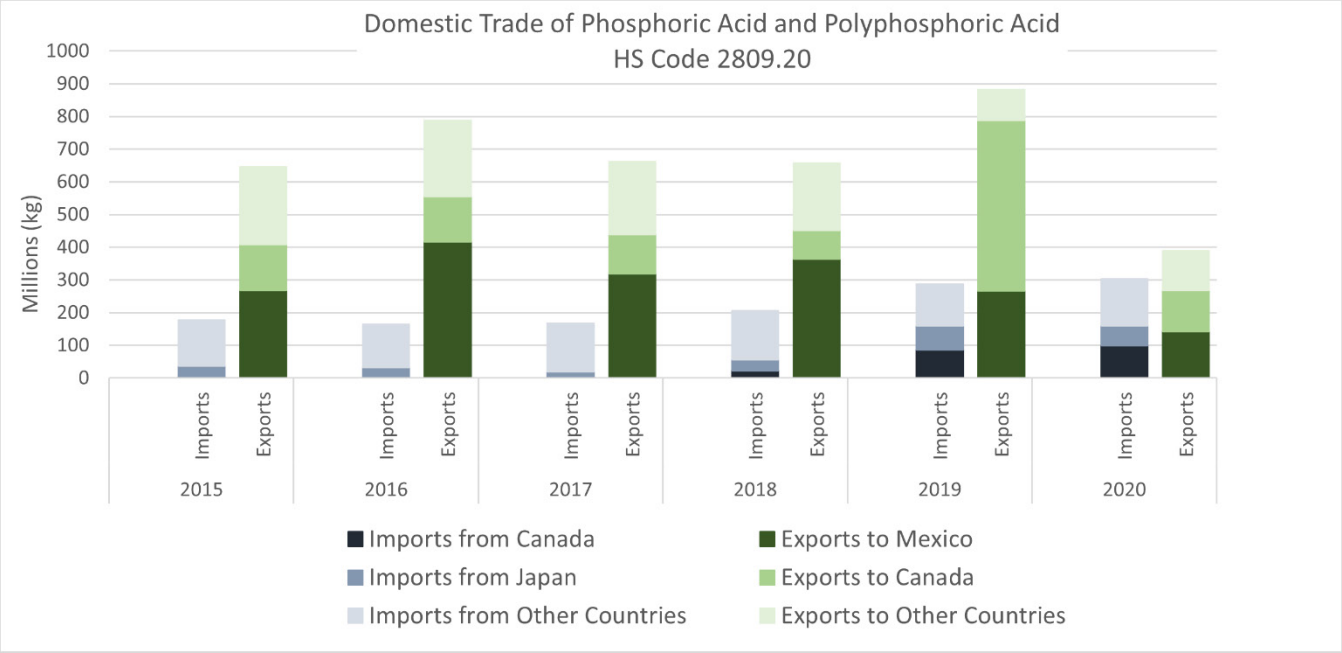


Figure 4. USITC Domestic Import and Export of Phosphoric Acid and Polyphosphoric Acid between 2015 and 2020

[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 no general duty for import of phosphoric acid, however there is an additional 25% duty on imports from China (USITC, 2022), as summarized in Table 3.

Table 3. Domestic Tariff Schedule for Phosphoric Acid in 2020

HS Code	General Duty	Additional Duty – China (Section 301 Tariff List)	Special Duty
2809.20	None	25%	None

Market History & Risk Evaluation

History of Shortages

The majority (approximately 85%) of domestically produced phosphoric acid is used to produce fertilizers. This may lead domestic suppliers of phosphoric acid and domestic manufacturers of phosphate-based chemicals other than fertilizer to rely on import of phosphoric acid from other countries which produce high purity phosphoric acid required for their formulations. High purity phosphoric acid produced from phosphate rock found in Morocco, Saudi Arabia, Peru, and other locations, is thought to be domestically competitive with domestically produced phosphoric acid (EPA, 2020b). Phosphoric acid suppliers and manufacturers, and suppliers of phosphoric acid derivative chemicals such as orthophosphates and polyphosphates may encounter persistent challenges in acquiring phosphoric acid on the international market, which may be impacted by trade barriers, international events, and natural disasters. Between 2020 and 2022, the disruptions in international trade caused by the COVID-19 pandemic severely challenged domestic phosphoric acid supply.

Risk Evaluation

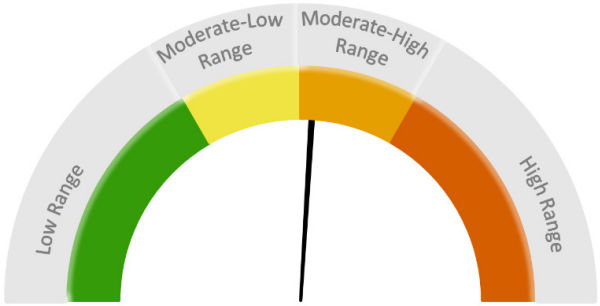
The complete risk assessment methodology is described in *Understanding Water Treatment Chemical Supply Chains and the Risk of Disruptions* (EPA, 2022b). The risk rating is calculated as the product of the following three risk parameters:

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.

Table 4. Supply Chain Risk Evaluation for Phosphoric Acid

Risk Parameter Ratings and Drivers		
Criticality: High	**Likelihood: High**	**Vulnerability: Low**
Phosphoric acid is essential to the water sector for pH adjustment and corrosion control. It is a precursor in the production of numerous critical water treatment chemicals.	The water sector has experienced regional phosphoric acid supply disruptions in the past. Concerns are primarily due to increased competition and reliance on imports for raw material (phosphate rock).	Strong domestic manufacturing provides some resilience to supply disruptions. However, the majority of domestic manufacturing is intended for fertilizer. Phosphoric acid for other uses may rely on imports.
Risk Rating: Moderate-High		



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