Polyaluminum Chloride

(multiple polymeric compounds)

Direct Use Chemical

(liquid or solid)

Inputs to Manufacturing Process:
Aluminum Hydroxide
Hydrochloric Acid

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

Product Family:
Aluminum Chlor-alkali

CAS No.: 1327-41-9

Derivative Water Treatment Chemicals:
None

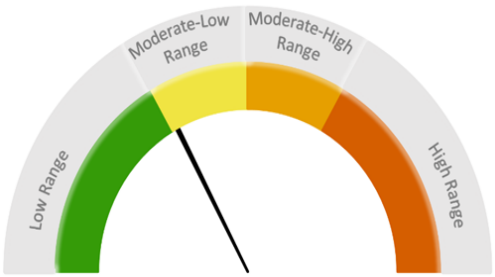
Understanding Chemical Supply Chains

Map of Suppliers & Manufacturers

Shelf Life:
12 Months

RISK OF SUPPLY DISRUPTION (Assessed in 2022)

RISK RATING: Moderate-Low



RISK DRIVERS

Production of polyaluminum chloride depends on supply of hydrochloric acid, aluminum hydroxide and bauxite. The U.S. is entirely dependent on import of bauxite to produce aluminum hydroxide, which has experienced historic price volatility. Supply of hydrochloric acid is dependent on availability of chlorine.

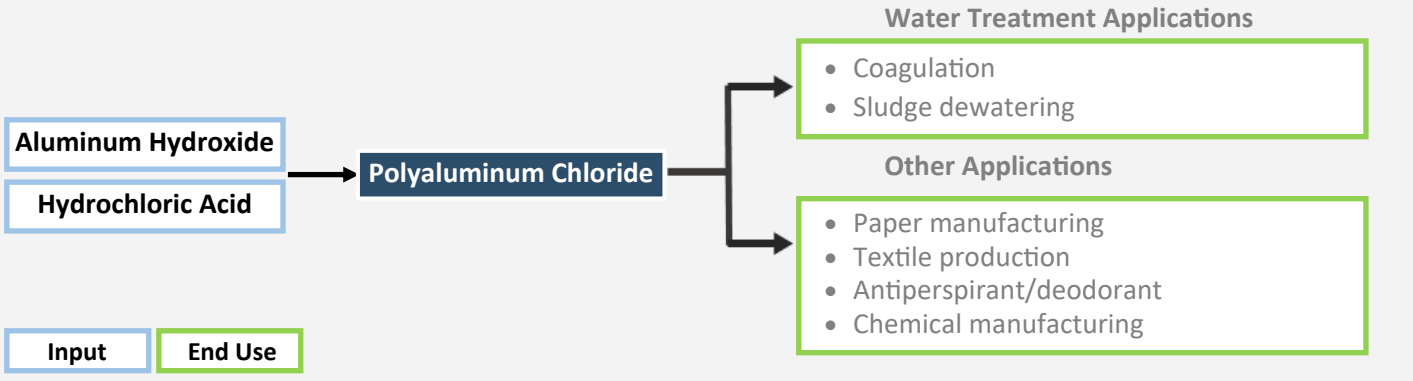
RISK PARAMETERS

Criticality: High. Essential and widely used for coagulation.

Likelihood: Low. No history of supply disruptions between 2000 and 2022.

Vulnerability: Moderate-High. Strong domestic manufacturing provides some resilience; however, the U.S. is dependent on imports of bauxite for production of aluminum hydroxide, and dependent on chlorine production for supply of hydrochloric acid.

MANUFACTURING PROCESS



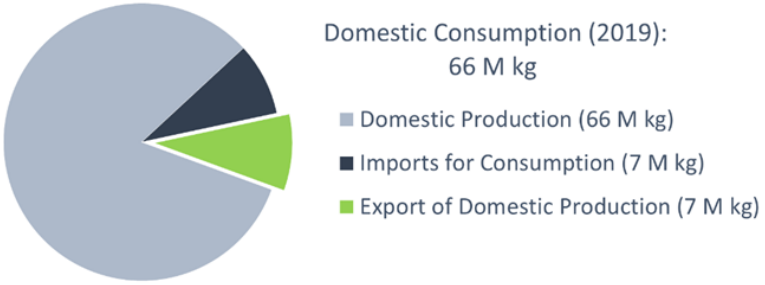
DOMESTIC PRODUCTION AND CONSUMPTION, AND INTERNATIONAL TRADE

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

International Trade (2019)

Primary Trading Partner (Imports): India

Primary Trading Partner (Exports): Canada



Product Description

Polyaluminum chlorides are a class of aluminum-based, inorganic polymeric chemicals containing aluminum, chloride, and hydroxide with a range of aluminum to chloride ratios. Polyaluminum chlorides are primarily used for coagulation in water and wastewater treatment and may be custom formulated as part of a trademarked blend of mixed aluminum polymers for this purpose. Water treatment applications are among the most common uses of polyaluminum chlorides in the U.S.

Use in Water Treatment

Polyaluminum chlorides are utilized directly in primary coagulation in drinking water and municipal wastewater treatment. Polyaluminum chlorides are also used in sludge dewatering applications (AWWA, 2010).

Use as a Precursor to Other Water Treatment Chemicals

Polyaluminum chlorides are not used to manufacture other water treatment chemicals.

Other Applications

Polyaluminum chlorides have a wide range of applications, including production of paper and textiles, cleaning products, personal care products such as antiperspirants and deodorants, adhesives and binding agents, and as one of many chemicals in drilling fluid used for hydraulic fracturing (EPA, 2020; Gulbrandsen Technologies, n.d.; Kemira, n.d.).

Primary Industrial Consumers

The primary domestic uses of polyaluminum chlorides are water and wastewater treatment including industrial wastewater treatment, paper and textile production, antiperspirant and deodorant production, and chemical manufacturing (EPA, 2020; Gulbrandsen Technologies, n.d.; Kemira, n.d.).

Manufacturing, Transport, & Storage

Manufacturing Process

A variety of processes exist for producing polyaluminum chlorides. Manufacturing technique may depend on the basicity (i.e., the hydroxide to aluminum ratio) and strength (i.e., percent aluminum oxide) required in the final formulation. Inputs include a source of aluminum and hydrochloric acid. Generally, low basicity formulas are produced through a reaction of aluminum hydroxide with hydrochloric acid or aluminum chloride. For water treatment applications where a higher-basicity formula is desired, additional steps are required. Additional steps to produce high basicity polyaluminum chloride are characterized by use of one of two primary, conventional methods. The first method relies on the reaction of the low-basicity polyaluminum chloride or aluminum chloride with a base, such as sodium hydroxide. The second method utilizes the reaction of low-basicity polyaluminum chloride or aluminum chloride or hydrochloric acid with aluminum metal. Additional reactions between hydrochloric acid or aluminum chloride or low-basicity polyaluminum chloride with aluminum metal can produce an ultra-high-basicity polyaluminum chloride. The ultra-high basicity polyaluminum chloride is known as aluminum chlorohydrate (AWWA, 2010; Shen and Dempsey, 1998).

Product Transport

Polyaluminum chlorides, primarily supplied as a solution but also available as a solid or powder, are widely transported in container and bulk by truck, rail, barge, and ship (GEO Specialty Chemicals, 2015; Kemira, 2014).

Storage and Shelf Life

Polyaluminum chlorides should be stored in a tightly closed container and kept indoors or above freezing. When stored properly, polyaluminum chlorides can have a shelf life of approximately 12 months, depending on storage conditions and mixture components (GEO Specialty Chemicals, 2015; Kemira, 2014).

Domestic Production & Consumption

Domestic Production

Production data was collected from the EPA Toxic Substances Control Act (TSCA) Chemical Data Reporting (CDR) 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 polyaluminum chlorides, this class of chemicals may be identified by several Chemical Abstract Service (CAS) numbers. Similarly, import and export of polyaluminum chlorides may be classified by several trade categories, none of which are specific to polyaluminum chlorides. Two commonly used trade categories are shown in Table 1.

Table 1. Polyaluminum Chloride Production and Trade Data Sources

Production and Trade Data			
Category	**Data Source**	**Identifier**	**Description**
Domestic Production	2020 TSCA Chemical Data Reporting	CAS No.: 1327-41-9	Polyaluminum Chloride
Imports and Exports	U.S. International Trade Commission	HS Code: 2827.32 HS Code: 2827.49	Aluminum Chlorides Other Chloride, Oxides, and Hydroxides

Total U.S. domestic manufacturing of polyaluminum chloride as defined by the CAS number in Table 1, was approximately 66 million kilograms (M kg) in 2019 (EPA, 2020). The majority of reported domestic commercial manufacture of polyaluminum chloride takes place at facilities owned by a relatively small number of companies including *Chemtrade*, *GEO Specialty Chemicals*, *Kemira Water Solutions*, and *USALCO* (EPA, 2020). *GEO Specialty Chemicals* reported largest percentage of total domestic polyaluminum chloride production in 2019. The number of domestic manufacturing locations shown in Figure 1 represents operating facilities as of 2015. Supply of NSF/ANSI Standard 60 certified polyaluminum chloride 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).

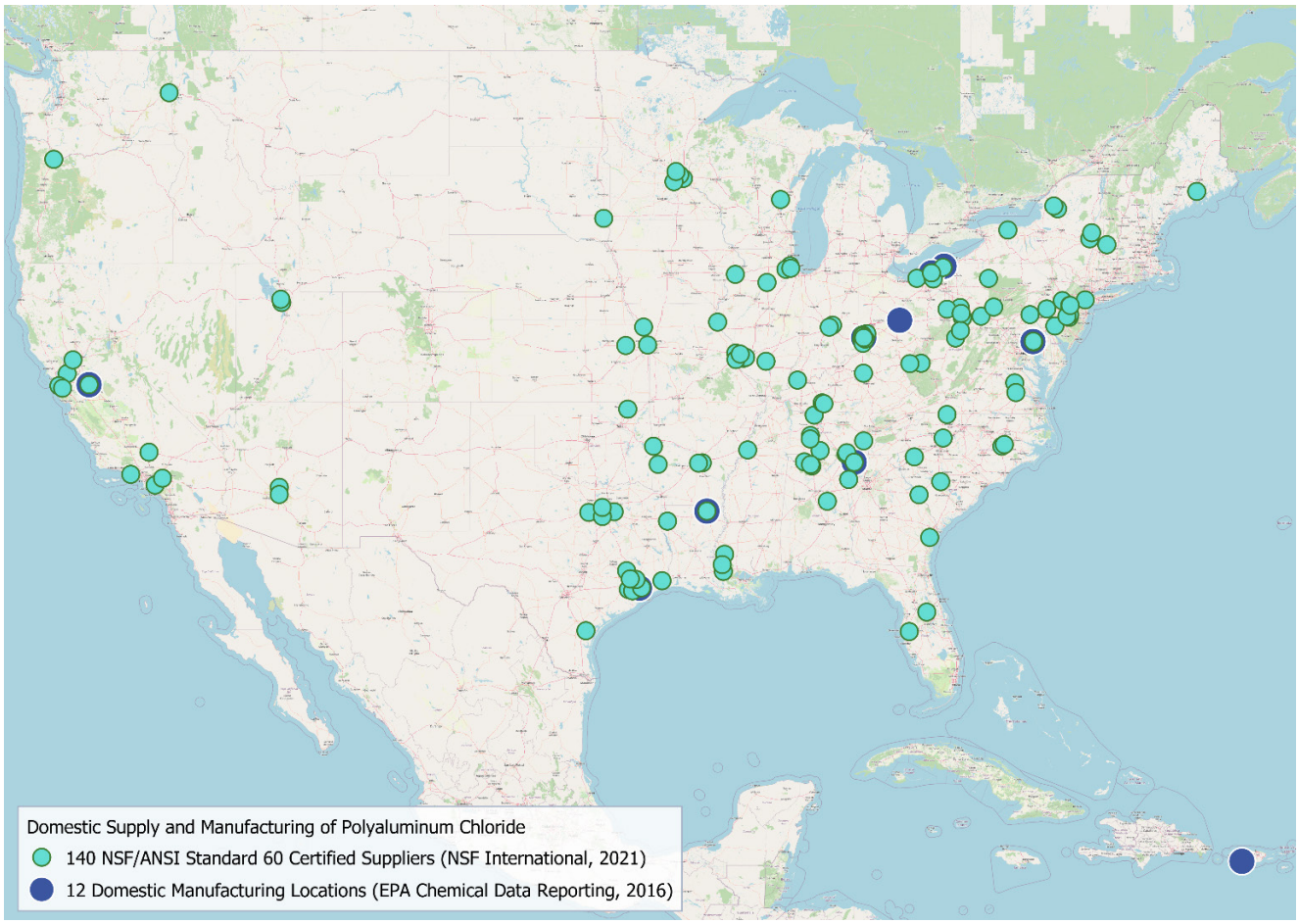


Figure 1. Domestic Supply and Manufacturing of Polyaluminum Chloride

Domestic Consumption

U.S. consumption of polyaluminum chloride in 2019 is estimated at 66 M kg. This estimate includes production of 66 M kg, import of 7 M kg, minus export of 7 M kg (EPA, 2020; USITC, 2021), as shown in Figure 2. Imports and exports represent trade of aluminum chlorides (HS Code 2827.32), while production data is specific to polyaluminum chloride.

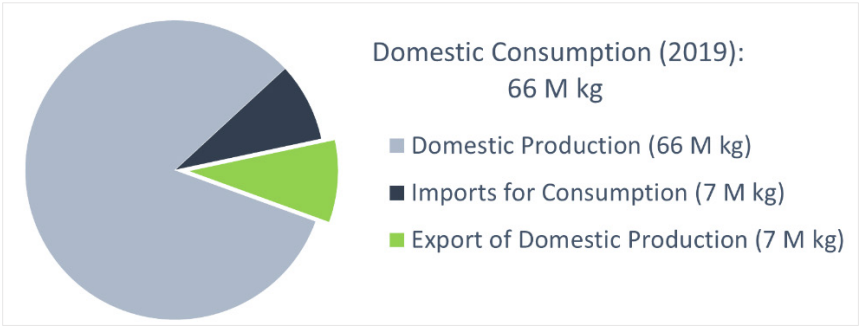


Figure 2. Domestic Production and Consumption of Polyaluminum Chloride in 2019

Trade & Tariffs

Worldwide Trade

Worldwide import and export data for polyaluminum chlorides are reported through the World Bank's World

Integrated Trade Solutions (WITS) software across multiple categories. Trade data reviewed in Table 2 represents trade data for the category of aluminum chlorides (HS Code 2827.32). In 2021, U.S. ranked 63rd worldwide in total exports and 12th in total imports of aluminum chlorides. In 2021, India ranked first worldwide in total exports while Indonesia ranked first in total imports (WITS, 2022), as shown in Table 2.

Table 2. WITS Worldwide Export and Import of Aluminum Chlorides, including Polyaluminum Chlorides in 2021

2021 Worldwide Trade Aluminum Chlorides (HS Code 2827.32)			
Top 5 Worldwide Exporters		Top 5 Worldwide Importers	
India	90 M kg	Indonesia	43 M kg
Netherlands	52 M kg	Malaysia	36 M kg
Germany	49 M kg	Italy	24 M kg
Austria	34 M kg	Germany	21 M kg
Spain	28 M kg	Norway	18 M kg

Domestic Imports and Exports

Domestic import and export data are reported by USITC in categories specific to aluminum chlorides. Figure 3 summarizes imports for consumption[1] and domestic exports[2] of aluminum chlorides (HS Code 2827.32) between 2015 and 2020. During this period, the overall quantities of exports and imports fluctuated, with domestic exports consistently exceeding imports for consumption. Over this five-year period, Canada was the primary recipient of domestic exports while India was the primary source of imports for consumption (USITC, 2021).

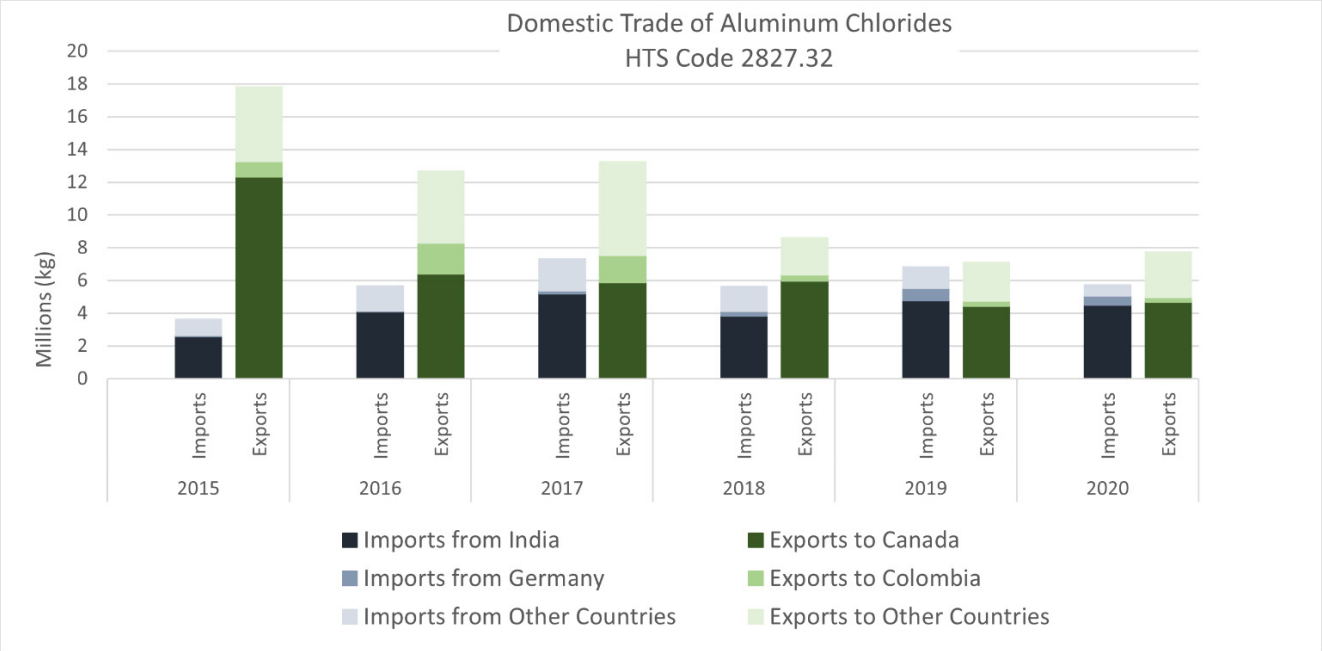


Figure 3. USITC Domestic Import and Export of Aluminum Chlorides, including Polyaluminum Chlorides between 2015 and 2020

[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 polyaluminum chlorides as imported under HS code 2827.32 (aluminum chlorides). There is a 5.5% general duty for import of polyaluminum chlorides as categorized under HS code 2827.49 (other chloride oxides and hydroxides) (USITC, 2022), and an additional 25% duty on imports from China under both trade categories, as summarized in Table 3.

Table 3. Domestic Tariff Schedule for Aluminum Chlorides, including Polyaluminum Chlorides, in 2022

HS Code	General Duty	Additional Duty – China (Section 301 Tariff List)	Special Duty
2827.32	None	25%	None
2827.49	5.5%	25%	None

Market History & Risk Evaluation

History of Shortages

There were no identified polyaluminum chloride domestic supply chain disruptions that impacted the water sector between 2000 and 2022.

Risk Evaluation

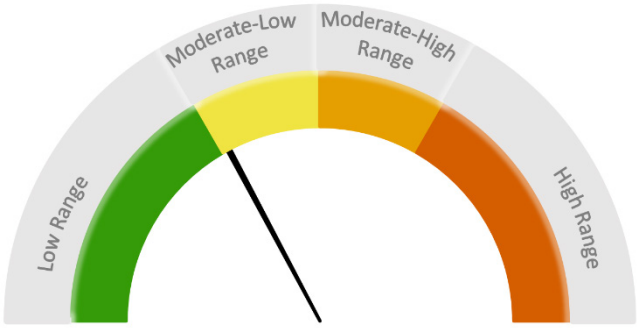
The complete risk assessment methodology is described in *Understanding Water Treatment Chemical Supply Chains and the Risk of Disruptions* (EPA, 2022b). The risk rating is calculated as the product of the following three risk parameters:

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 Polyaluminum Chloride

Risk Parameter Ratings and Drivers		
Criticality: High	**Likelihood: Low**	**Vulnerability: Moderate-High**
Polyaluminum chlorides are essential to the water sector and have widespread application as coagulants in drinking water and wastewater.	The water sector has not experienced polyaluminum chloride supply chain disruptions between 2000 and 2022.	Strong domestic manufacturing provides some resilience to supply disruptions. However, production of a key input, aluminum hydroxide, relies on import of raw material (bauxite). Production of another key input, hydrochloric acid, is dependent on the chlor-alkali industry.
Risk Rating: Moderate-Low		



References

American Water Works Association (AWWA), 2010. *B408 Liquid Polyaluminum Chloride.* Denver, CO: American Water Works Association.

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/risk-disruptions-supply-water-treatment-chemicals

GEO Specialty Chemicals, 2015. Safety Data Sheet for Polyaluminum chloride solution, retrieved from https://www.geosc.com/Assets/Files/MSDS-Files/Polyaluminum-chloride-solution-(1)/SDS-3204J-Polyaluminum-chloride-solution-AGHS-EN.pdf

Gulbrandsen Technologies, n.d. Our Products, retrieved from https://gulbrandsentechnologies.com/what-we-do/water-treatment/#our-products

Kemira Water Solutions (Kemira), 2014. Safety Data Sheet for Kemira PAX -18, retrieved from https://www.hillbrothers.com/pdf/downloads/msds/sds/n/pax-18.pdf

Kemira Water Solutions (Kemira), n.d. Products, retrieved from https://www.kemira.com/products/

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

Shen, Y.H. and Dempsey, B.A., 1998. Synthesis and speciation of polyaluminum chloride for water

treatment. *Environment International*, 24(8), pp.899-910.

U.S. International Trade Commission (USITC), 2021. Harmonized Tariff Schedule (HTS) Search, retrieved from https://hts.usitc.gov/

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

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