Aluminum Sulfate

$Al_2(SO_4)_3$

(liquid or solid)

D Direct Use Chemical

Inputs to Manufacturing Process:
Aluminum Hydroxide
Sulfuric Acid

% of Total Domestic Consumption Attributed to Water Sector:
Approximately 45%

Product Family:
Aluminum

CAS No.:
10043-01-3

Derivative Water Treatment Chemicals:
None

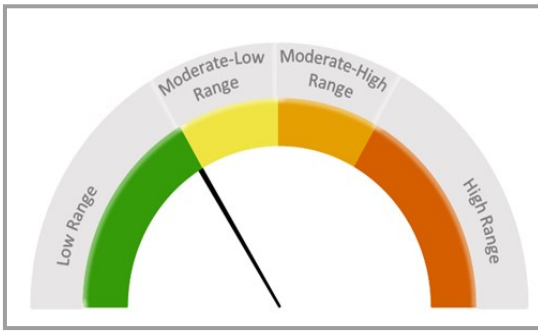
Understanding Chemical Supply Chains

Map of Suppliers & Manufacturers

Shelf Life:
36 Months

RISK OF SUPPLY DISRUPTION (Assessed in 2022)

RISK RATING: Low



RISK DRIVERS

Production of aluminum sulfate depends on supply of aluminum hydroxide and bauxite. The U.S. is entirely dependent on import of bauxite to produce aluminum hydroxide, which has experienced historic price volatility.

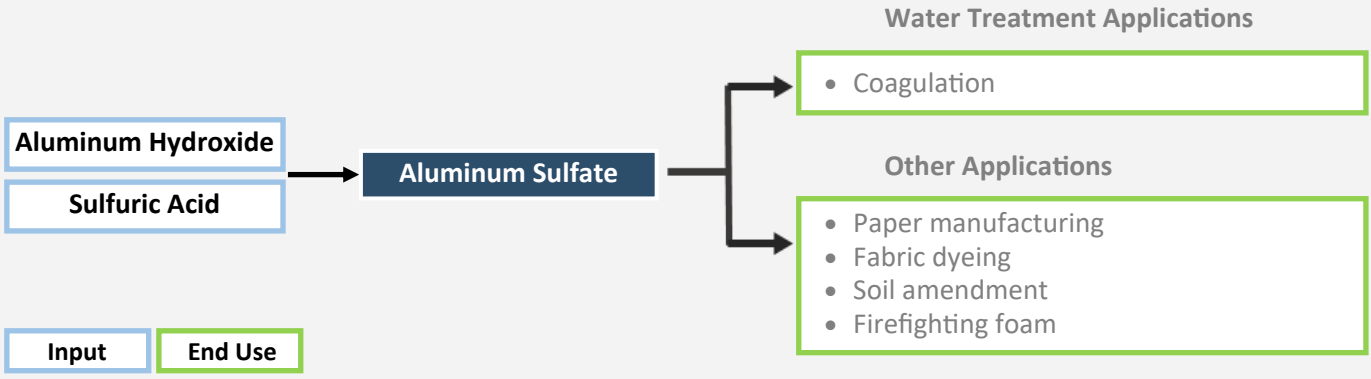
RISK PARAMETERS

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.

MANUFACTURING PROCESS



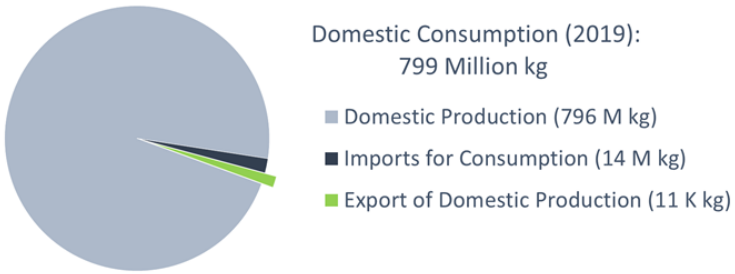
DOMESTIC PRODUCTION AND CONSUMPTION, AND INTERNATIONAL TRADE

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

International Trade (2019)

Primary Trading Partner (Imports): Canada

Primary Trading Partner (Exports): Canada



EPA

Product Description

Aluminum sulfate ($Al_2(SO_4)_3$), a water soluble aluminum salt, is one of the most widely used aluminum-based coagulants in water and wastewater treatment due to its low cost and widespread availability. Water treatment applications are the most common uses of aluminum sulfate in the U.S.

Use in Water Treatment

Aluminum sulfate (alum) is utilized directly as a liquid solution or solid in primary coagulation in drinking water treatment, municipal wastewater treatment, and industrial wastewater treatment. Aluminum sulfate is also used in source water clarification and nutrient removal (AWWA, 2016).

Use as a Precursor to Other Water Treatment Chemicals

Aluminum sulfate is not used to manufacture other water treatment chemicals.

Other Applications

Aluminum sulfate has a wide range of applications. The predominant use is in water treatment including drinking water, wastewater, and water resource management. Other uses include production of paper, textiles, soil amendment, firefighting foam, food, cosmetics, dyes, leather, and as a vaccine adjuvant (ATSDR, 2008; NCBI, 2021).

Primary Industrial Consumers

The primary use of aluminum sulfate is water and wastewater treatment. Past estimates have approximated the consumption of aluminum sulfate for water and wastewater treatment at 45% of total domestic consumption. Other common uses are paper manufacturing, and fabric dyeing. Additional uses include soil amendment, firefighting foam, vaccine adjuvant, chemical catalyst production (EPA, 2020; NCBI, 2021).

Manufacturing, Transport, & Storage

Manufacturing Process

Aluminum sulfate is primarily produced through a reaction of aluminum hydroxide and sulfuric acid. The process may begin with ground bauxite in place of aluminum hydroxide. The overall equation for the most common aluminum sulfate manufacturing process is outlined in Figure 1. In this process, aluminum hydroxide is mixed with sulfuric acid at a controlled temperature and pressure to yield aluminum sulfate. Liquid aluminum sulfate, the more commonly sold form, is prepared by diluting the prepared solution. The aluminum sulfate solution can be evaporated and allowed to crystallize to produce a dry powder.

Sulfuric Acid	+	Aluminum Hydroxide	→	Aluminum Sulfate	+	Water
$3H_2SO_4$	+	$2Al(OH)_3$	→	$Al_2(SO_4)_3$	+	$6H_2O$

Figure 1. Chemical Equation for the Reaction to Manufacture Aluminum Sulfate

Product Transport

Aluminum sulfate, primarily supplied as a solution but also available as a solid or powder, is widely transported in container and bulk by truck, rail, barge, and ship (USALCO, 2019).

Storage and Shelf Life

Aluminum sulfate, commonly sold as a solution, should be stored in a tightly closed container and kept indoors

or in a heated area. When stored properly, aluminum sulfate can have a shelf life of approximately 36 months, depending on storage conditions (USALCO, 2019).

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. Both production and trade data are specific to aluminum sulfate.

Table 1. Aluminum Sulfate Production and Trade Data Sources

Production and Trade Data			
Category	**Data Source**	**Identifier**	**Description**
Domestic Production	2020 TSCA Chemical Data Reporting	CAS No.: 10043-01-3	Aluminum Sulfate
Imports and Exports	U.S. International Trade Commission	HS Code: 2833.22	Aluminum Sulfate

Total U.S. domestic manufacturing of aluminum sulfate was approximately 796 million kilograms (M kg) in 2019 (EPA, 2020). The majority of reported domestic commercial manufacture of aluminum sulfate takes place at facilities located throughout the contiguous U.S. owned by a relatively small number of companies including *Chemtrade*, *GEO Specialty Chemicals*, *Southern Ionics*, *PQ Corporation*, *Thatcher Chemical Company*, and *USALCO* (EPA, 2020). The number of domestic manufacturing locations shown in Figure 2 represents operating facilities as of 2015. Supply of NSF/ANSI Standard 60 certified aluminum sulfate for use in drinking water treatment is also 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).

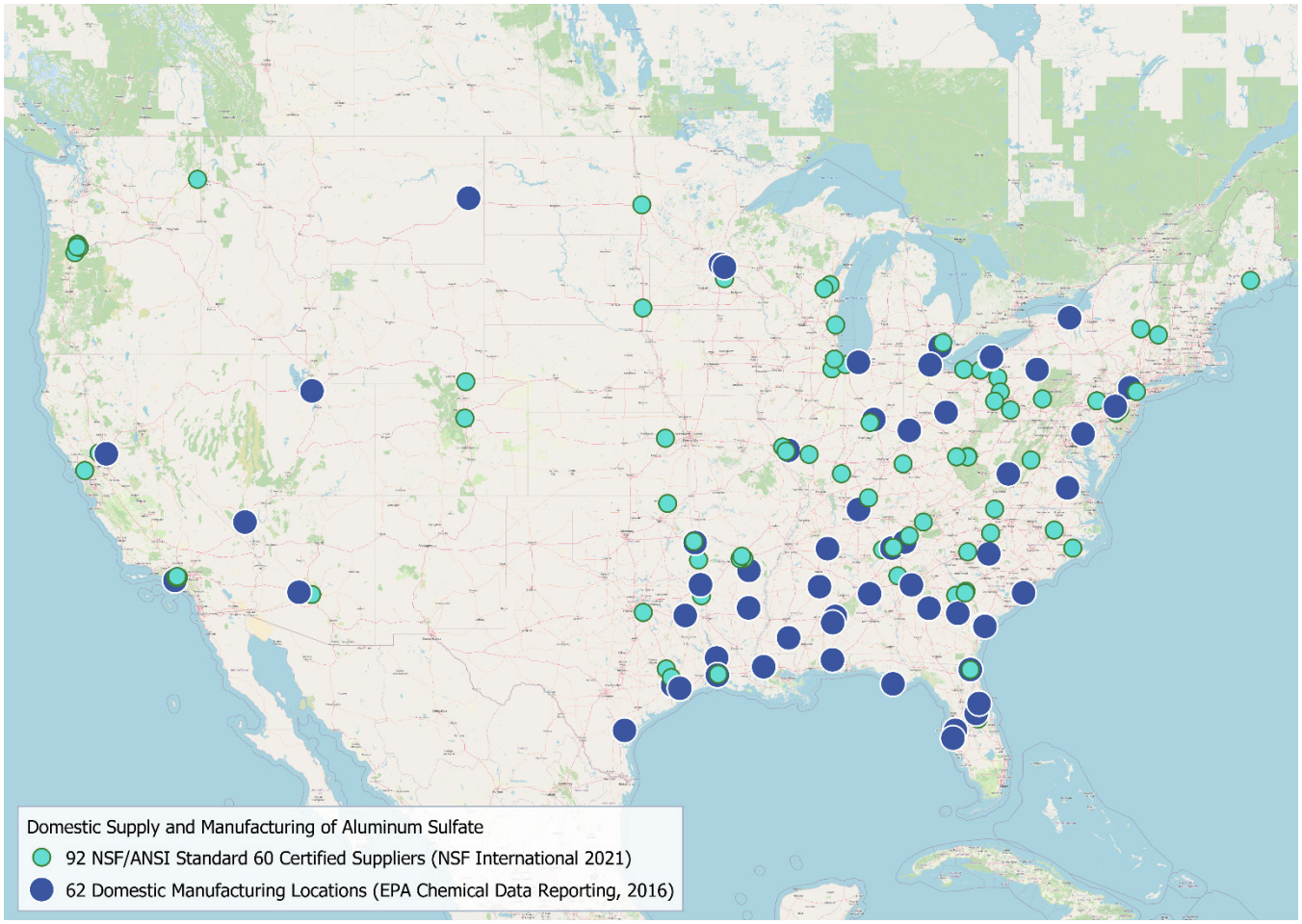


Figure 2. Domestic Supply and Manufacturing of Aluminum Sulfate

Domestic Consumption

U.S. consumption of aluminum sulfate in 2019 is estimated at 799 M kg. This includes production of 796 M kg, import of 14 M kg, minus export of 11 M kg (EPA, 2020; USITC, 2021), as shown in Figure 3.

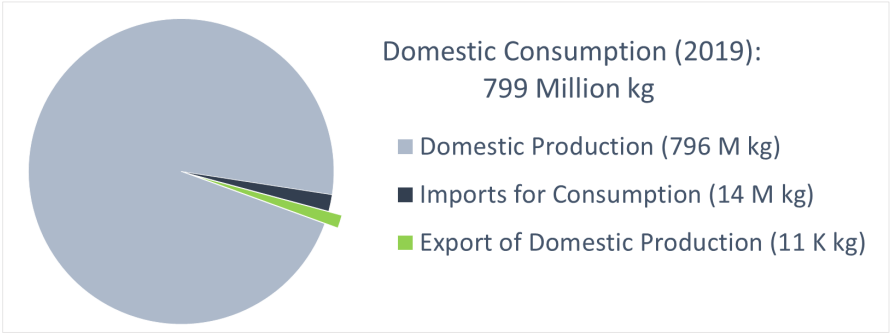


Figure 3. Domestic Production and Consumption of Aluminum Sulfate in 2019

Trade & Tariffs

Worldwide Trade

Worldwide import and export data for aluminum sulfate are reported through the World Bank's World Integrated Trade Solutions (WITS) software, as a category specific to aluminum sulfate. In 2021, U.S. ranked 16th

worldwide in total exports and fourth in total imports of aluminum sulfate. In 2021, China ranked first worldwide in total exports while Austria ranked first in total imports (WITS, 2022), as shown in Table 2.

Table 2. WITS Worldwide Export and Import of Aluminum Sulfate in 2021

2021 Worldwide Trade Aluminum Sulfate (HS Code 2833.22)			
Top 5 Worldwide Exporters		Top 5 Worldwide Importers	
China	97 M kg	Austria	32 M kg
Turkey	74 M kg	Netherlands	22 M kg
Sweden	50 M kg	Hong Kong	19 M kg
Indonesia	29 M kg	**United States**	**17 M kg**
Netherlands	29 M kg	Sweden	17 M kg

Domestic Imports and Exports

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

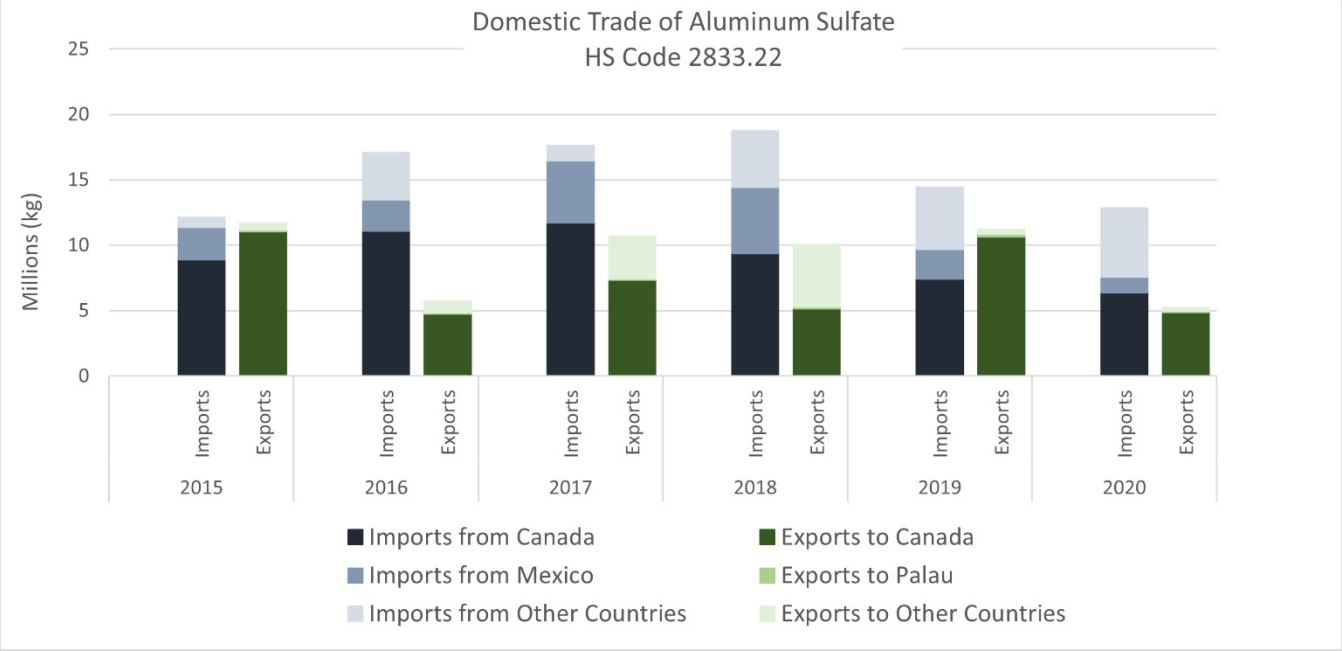


Figure 4. USITC Domestic Import and Export of Aluminum Sulfate between 2015 and 2020

Tariffs

There is no general duty for import of aluminum sulfate (USITC, 2022), however there is a 25% additional duty on imports from China, as summarized in Table 3.

[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.

Table 3. Domestic Tariff Schedule for Aluminum Sulfate in 2022

HS Code	General Duty	Additional Duty – China (Section 301 Tariff List)	Special Duty
2833.22	None	25%	None

Market History & Risk Evaluation

History of Shortages

There were no identified aluminum sulfate supply chain disruptions impacting the water sector between 2000 and 2022.

Risk Evaluation

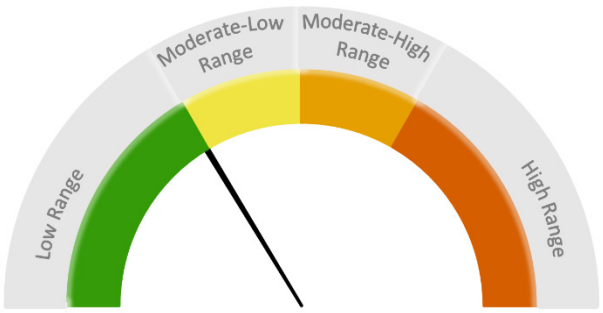
The complete risk assessment methodology is described in *Understanding Water Treatment Chemical Supply Chains and the Risk of Disruptions* (EPA, 2022b). The risk rating is calculated as the product of the following three risk parameters:

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 Aluminum Sulfate

Risk Parameter Ratings and Drivers		
Criticality: High	**Likelihood: Low**	**Vulnerability: Moderate-High**
Aluminum sulfate is essential to the water sector and has widespread application as a coagulant in drinking water and wastewater.	The water sector did not experience aluminum sulfate 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).
Risk Rating: Low		



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