Aluminum Hydroxide

$Al(OH)_3$

Precursor Chemical

(solid)

Inputs to Manufacturing Process:
Bauxite
Sodium Hydroxide

% of Total Domestic Consumption Attributed to Water Sector:
Approximately 1%

Product Family:
Aluminum

Derivative Water Treatment Chemicals:
Aluminum Sulfate
Polyaluminum Chloride

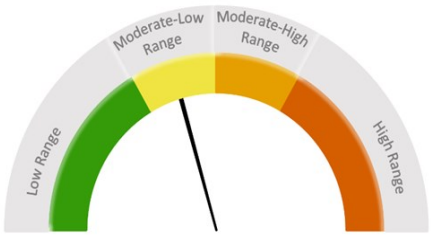
Understanding Chemical Supply Chains

CAS No.: 21645-51-2

Shelf Life:
60+ Months

RISK OF SUPPLY DISRUPTION (Assessed in 2022)

RISK RATING: Moderate-Low



RISK DRIVERS

Though production of aluminum hydroxide takes place at numerous domestic locations, the U.S. is completely reliant on import of a key raw material, bauxite.

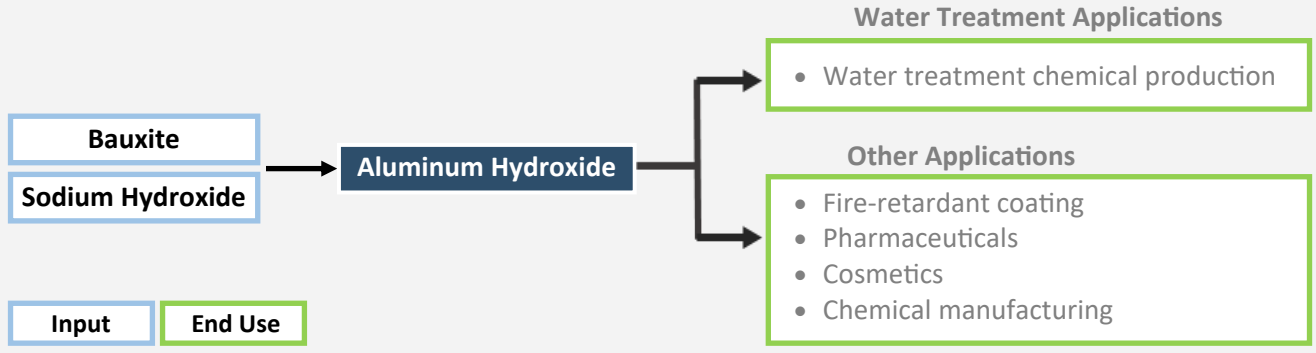
RISK PARAMETERS

Criticality: High. Essential precursor for aluminum-based coagulants.

Likelihood: Low. Historic price increases have impacted price of derivative water treatment chemicals, but there have been no supply disruptions between 2000 and 2022.

Vulnerability: Moderate-High. Distributed domestic manufacturing, but entirely reliant on imports for supply of key raw material, bauxite.

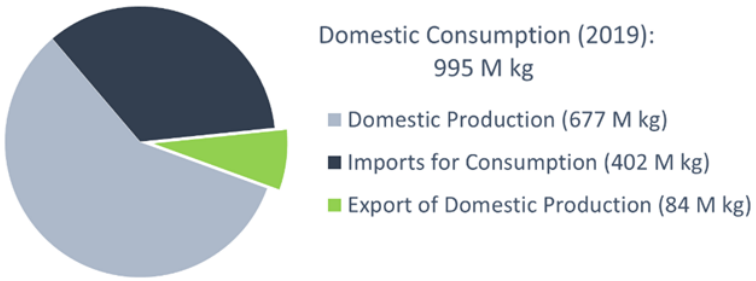
MANUFACTURING PROCESS



DOMESTIC PRODUCTION AND CONSUMPTION, AND INTERNATIONAL TRADE

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

International Trade (2019)
Primary Trading Partner (Imports): Brazil
Primary Trading Partner (Exports): Mexico



EPA

Product Description

Aluminum hydroxide ($Al(OH)_3$), an amphoteric substance, is the hydrated form of alumina. It is not used directly in water treatment but serves as a precursor chemical to manufacture aluminum-based coagulants. Aluminum hydroxide is widely used in fire-retardant coatings and pharmaceuticals including vaccines and antacids.

Use in Water Treatment

Aluminum hydroxide is not used directly in water treatment.

Use as a Precursor to Other Water Treatment Chemicals

Aluminum hydroxide is used as a precursor in the commercial manufacture of aluminum-based water treatment chemicals such as aluminum sulfate and polyaluminum chloride.

Other Applications

Common application of aluminum hydroxide include fire-retardant coatings, as an adjuvant in vaccines and other pharmaceutical applications including antacids, food additive, cosmetics, and derivative chemical manufacturing (ATSDR, 2008; CIR, 2013; NCBI, 2022).

Primary Industrial Consumers

Aluminum hydroxide has a wide range of uses. Significant uses include use in fire-retardant coatings, pharmaceuticals (including vaccines and over-the-counter products), and cosmetics. Water treatment chemical production, including industrial water treatment, is estimated as a small percentage of overall aluminum hydroxide consumption (ATSDR, 2008; CIR, 2013; EPA, 2020).

Manufacturing, Transport, & Storage

Manufacturing Process

Aluminum hydroxide is primarily produced through the Bayer process from a reaction of bauxite with a solution of sodium hydroxide. The most common aluminum hydroxide manufacturing process proceeds in steps, the overall equations for this process are outlined in Figure 1. Crushed bauxite is dissolved in a sodium hydroxide solution with heat, yielding a solution of sodium aluminate. Aluminum hydroxide is then precipitated from the resultant sodium aluminate solution by cooling and seeding the solution with previously produced aluminum hydroxide. Aluminum hydroxide crystals are produced, which are removed after settling to the bottom of the tank (ATSDR, 2008; The Aluminum Association, n.d.). Alumina is produced by dehydrating aluminum hydroxide.

Step 1:

Bauxite + Sodium Hydroxide → Sodium Aluminate + Water

Al_2O_3 + 2NaOH → $2NaAlO_2$ + H_2O

Step2:

Sodium Aluminate + Water → Aluminum Hydroxide + Sodium Hydroxide

$NaAlO_2$ + $2H_2O$ → $Al(OH)_3$ + NaOH

↑

Seeding with Aluminum Hydroxide

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

Product Transport

Aluminum hydroxide, primarily supplied as a solid, is widely transported in container and bulk by truck, rail, barge, and tanker.

Storage and Shelf Life

When stored properly, aluminum hydroxide can have a shelf life in excess of 60 months, depending on storage conditions (Flinn Scientific, 2014).

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

Table 1. Aluminum Hydroxide Production and Trade Data Sources

Production and Trade Data			
Category	**Data Source and Date**	**Identifier**	**Description**
Domestic Production	2020 EPA Chemical Data Reporting	CAS No.: 21645-51-2	Aluminum Hydroxide
Imports and Exports	U.S. International Trade Commission	HS Code: 2818.30	Aluminum Hydroxide

Total U.S. domestic manufacturing of aluminum hydroxide reported under the CDR was approximately 677 million kilograms (M kg) in 2019 (EPA, 2020). Production at the Gramercy, Louisiana *Noranda Alumina* facility accounted for the majority of reported aluminum hydroxide production in 2019. *Chemtrade Solutions*, which manufactures derivative aluminum-based water treatment chemicals, accounted for approximately 1% of total reported domestic production, though a considerable number of manufacturers claimed confidential business information for production volumes, including known water treatment chemical manufacturers.

Domestic Consumption

U.S. consumption of aluminum hydroxide in 2019 is estimated at 995 M kg. This includes production of 677 M kg, import of 402 M kg, minus export of 84 M kg (EPA, 2020; USITC, 2021), as shown in Figure 2.

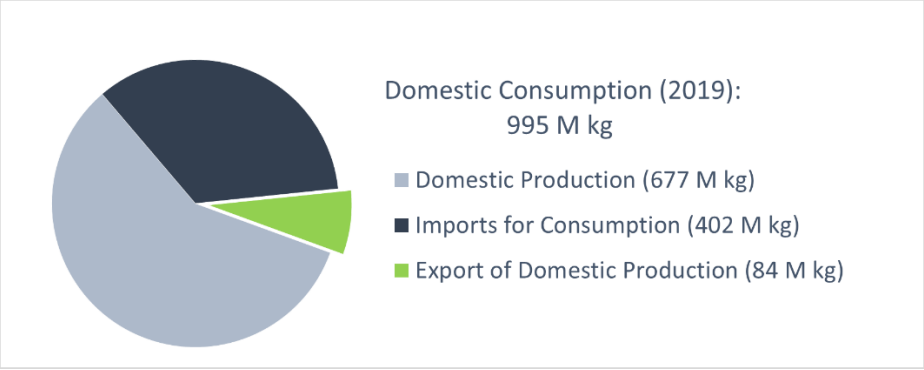


Figure 2. Domestic Production and Consumption of Aluminum Hydroxide in 2019

Trade &Tariffs

Worldwide Trade

Worldwide import and export data for aluminum hydroxide are reported through the World Bank's World

Integrated Trade Solutions (WITS), as a category specific to aluminum hydroxide. In 2021, the U.S. ranked tenth worldwide in total exports and third in total imports of aluminum hydroxide. In 2021, Brazil ranked first worldwide in total exports and Japan ranked first in total imports (WITS, 2022), as shown in Table 2.

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

2021 Worldwide Trade Aluminum Hydroxides (HS Code 2818.30)			
Top 5 Worldwide Exporters		Top 5 Worldwide Importers	
Brazil	718 M kg	Japan	678 M kg
Australia	507 M kg	South Korea	375 M kg
Germany	458 M kg	**United States**	**298 M kg**
Spain	412 M kg	Netherlands	205 M kg
Greece	386 M kg	Germany	200 M kg

Domestic Imports and Exports

Domestic imports and export data are reported by USITC in a category specific to aluminum hydroxide. Figure 3 summarizes imports for consumption[1] and domestic exports[2] of aluminum hydroxide between 2015 and 2020. During this period, the overall quantity of exports remained relatively steady, while the quantity of imports varied, with the largest quantity imported in 2019. Over this five-year period, Mexico was the primary recipient of domestic exports while Brazil was the primary source of imports (USITC, 2021).

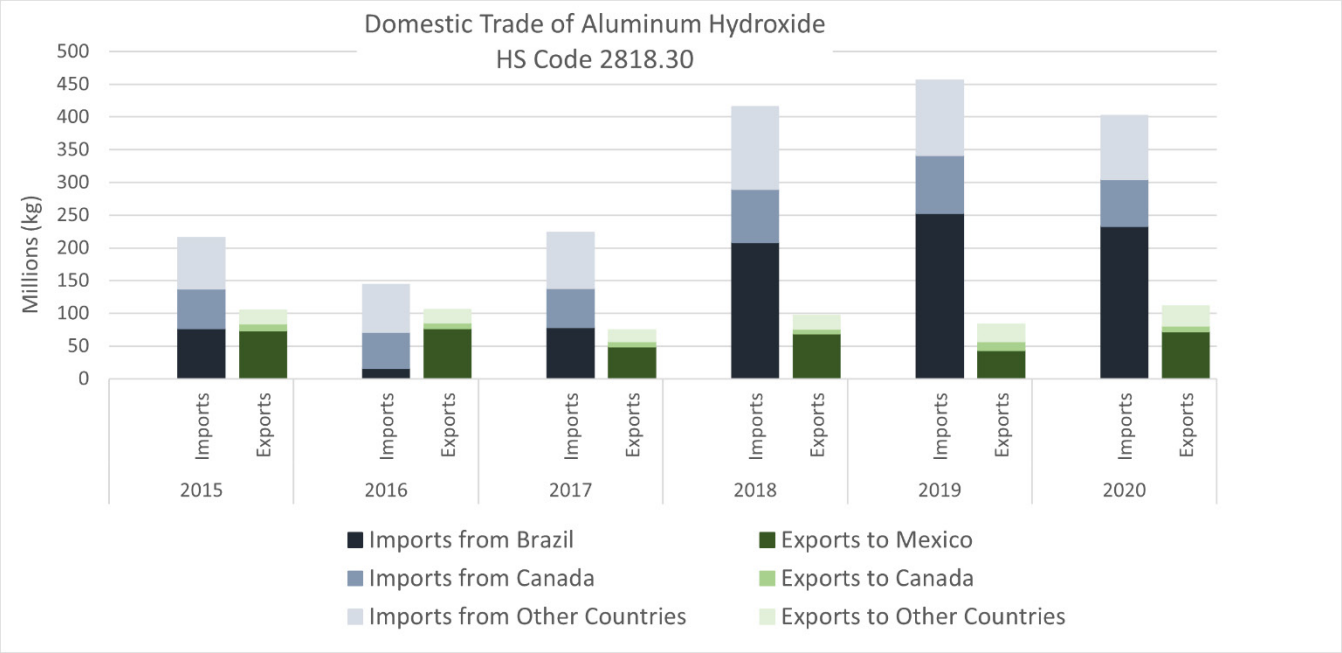


Figure 3. USITC Domestic Import and Export of Aluminum Hydroxide between 2015 and 2020

[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

Imports of aluminum hydroxides are primarily supplied from Brazil and Canada. There is no general duty for import of aluminum hydroxide, however there is an additional 25% duty on imports from China (USITC, 2022), as summarized in Table 3.

Table 3. 2022 Domestic Tariff Schedule for Aluminum Hydroxide

HS Code	General Duty	Additional Duty - China (Section 301 Tariff List)	Special Duty
2818.30	None	25%	None

Market History & Risk Evaluation

History of Shortages

While there are no notable shortages of aluminum hydroxide between 2000 and 2022, there have been several instances of price increases for aluminum hydroxide. This led some manufacturers of derivative products such as aluminum sulfate (alum), including domestic manufacturers and suppliers of alum, to raise alum prices as well. The demand for aluminum hydroxide in other uses, primarily fire-retardant coatings, is expected to continue to increase (USGS, 2022).

Risk Evaluation

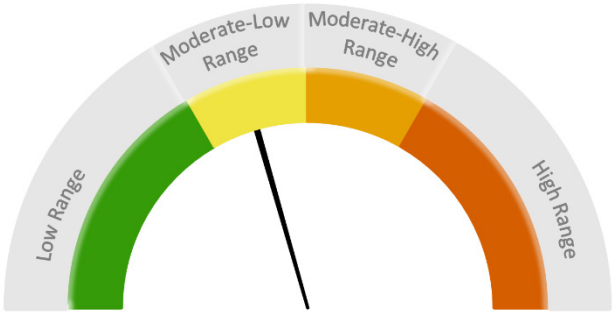
The complete risk evaluation methodology is described in *Understanding Water Treatment Chemical Supply Chains and the Risk of Disruptions* (EPA, 2022). The risk rating is calculated as the product of the following three risk parameters:

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 Hydroxide

Risk Parameter Ratings and Drivers		
Criticality: High	**Likelihood: Low**	**Vulnerability: Moderate-High**
Aluminum hydroxide is essential to the water sector for production of aluminum-based coagulants.	The water sector has not experienced aluminum hydroxide supply disruptions between 2000 and 2022, but there have been notable price increases during this period.	Strong domestic manufacturing capabilities and a distributed manufacturing base provide some resilience to supply disruptions. However, a key raw material, bauxite, must be imported.
Risk Rating: Moderate-Low		



References

Agency for Toxic Substances and Disease Registry (ATSDR), 2008. *Toxicological profile for Aluminum*, retrieved from https://www.atsdr.cdc.gov/toxprofiles/tp22.pdf

Cosmetic Ingredient Review (CIR), 2013. *Safety Assessment of Alumina and Aluminum Hydroxide as Used in Cosmetics*, Cosmetic Ingredient Review, Washington, D.C., retrieved from https://www.cir-safety.org/sites/default/files/Alumin_062013.pdf

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

EPA, 2022. *Understanding Water Treatment Chemical Supply Chains and the Risk of Disruptions*, retrieved from https://www.epa.gov/waterutilityresponse/risk-disruptions-supply-water-treatment-chemicals

Flinn Scientific, 2014. Safety Data Sheet for Aluminum Hydroxide, retrieved from https://www.flinnsci.com/sds_39-aluminum-hydroxide/sds_39/

National Center for Biotechnology Information (NCBI), 2022. PubChem Compound Summary for CID 10176082, Aluminum hydroxide, retrieved from https://pubchem.ncbi.nlm.nih.gov/compound/Aluminum-hydroxide

The Aluminum Association, n.d. Alumina Refining 101, retrieved from https://www.aluminum.org/alumina-refining-101

U.S. Geological Survey (USGS), 2022. *2018 Minerals Yearbook: Bauxite*, retrieved from https://pubs.usgs.gov/myb/vol1/2018/myb1-2018-bauxi.pdf

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