Ammonium Hydroxide

NH_4OH

(liquid)

D Direct Use Chemical

Inputs to Manufacturing Process:
Anhydrous Ammonia
Water

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

Product Family:
Fossil Fuels

CAS No.: 1336-21-6

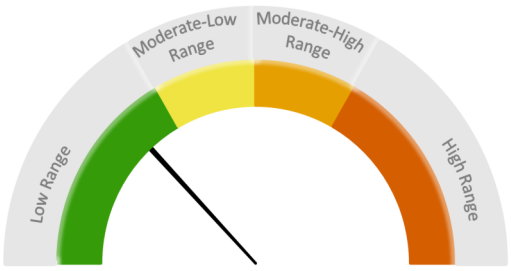
Derivative Water Treatment Chemicals:
None

Understanding Chemical Supply Chains
Map of Suppliers & Manufacturers

Shelf Life:
24 Months

RISK OF SUPPLY DISRUPTION (Assessed in 2022)

RISK RATING: Low



RISK DRIVERS

Ammonium hydroxide is a principal source of nitrogen in liquid fertilizer and a primary source of nitrogen in household cleaners. Though it is widely manufactured, use in liquid fertilizer and household cleaners are prominent demands, which may leave tight supply availability for other uses.

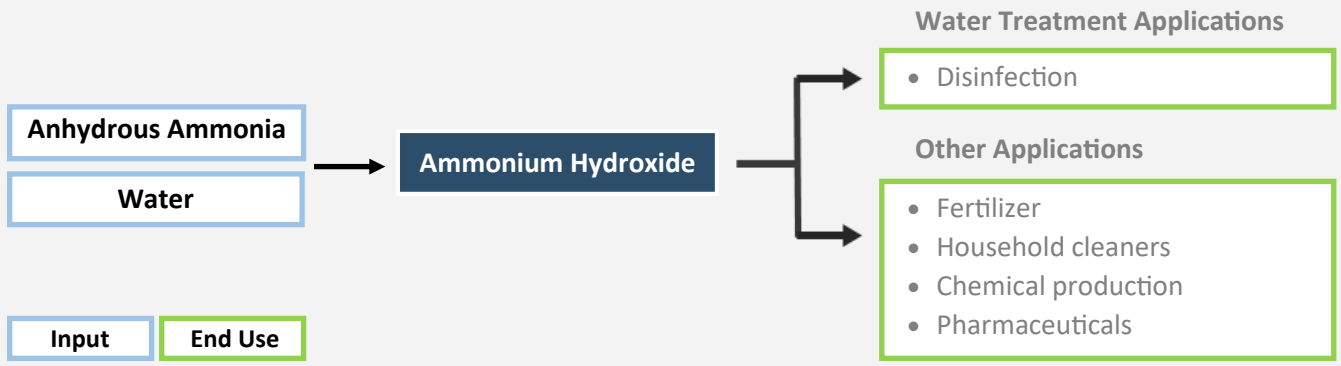
RISK PARAMETERS

Criticality: High. Essential for disinfection.

Likelihood: Low. The water sector has not experienced an ammonium hydroxide supply disruption between 2000 and 2022.

Vulnerability: Low. Widely distributed domestic manufacturing and supply.

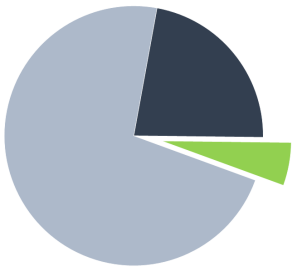
MANUFACTURING PROCESS



DOMESTIC PRODUCTION AND CONSUMPTION, AND INTERNATIONAL TRADE

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

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



Domestic Consumption (2019): 206 M kg

- Domestic Production (167 M kg)
- Imports for Consumption (51 M kg)
- Export of Domestic Production (12 M kg)

Product Description

Ammonium hydroxide (NH_4OH), an inorganic chemical and corrosive liquid, is widely used in conjunction with chlorine for secondary disinfection. It is a primary source of nitrogen in liquid fertilizer, commercially produced by adding water to anhydrous ammonia. The majority of ammonium hydroxide manufactured in the U.S. is used in liquid fertilizer production.

Use in Water Treatment

Ammonium hydroxide is directly used in conjunction with chlorine to produce chloramines for secondary disinfection (AWWA, 2015).

Use as a Precursor to Other Water Treatment Chemicals

Ammonium hydroxide is not used to manufacture other water treatment chemicals.

Other Applications

Similar to anhydrous ammonia, ammonium hydroxide is used widely and in large quantities for ammonium nitrate fertilizer production. However, ammonium hydroxide has a lower nitrogen content (approximately 20%) than anhydrous ammonia (above 80%), but has fewer safety considerations, allowing both to have wide use as fertilizer in various applications. Ammonium hydroxide is widely used in the production of household cleaners, and has use in manufacturing rayon, rubber, pharmaceuticals, wood staining, and ice rink surfacing (NCBI, 2020).

Primary Industrial Consumers

The predominant use of ammonium hydroxide is as a liquid nitrogen fertilizer. Production of household cleaners and organic chemicals are the other most common uses, while numerous other miscellaneous uses account for the remaining consumption (NCBI, 2020).

Manufacturing, Transport, & Storage

Manufacturing Process

Anhydrous ammonia and water are the starting materials used to produce ammonium hydroxide. As described in the manufacturing process for the anhydrous ammonia supply chain (EPA, 2022a), hydrogen gas generated from fossil fuel stock, most commonly methane, oil, or coal is combined with nitrogen gas over a catalyst at high temperature and pressure through the Haber-Bosch process, from which anhydrous ammonia is recovered as a steam. Ammonium hydroxide is formed by dissolving compressed liquid anhydrous ammonia in water, as presented in Figure 1.

Anhydrous Ammonia	+	Water	→	Ammonium Hydroxide
NH_3	+	H_2O	→	NH_4OH

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

Product Transport

Ammonium hydroxide with a concentration greater than 10% requires specialized transport as a corrosive substance. Ammonium hydroxide may be transported in bulk or repackaged into smaller containers and transported by tank or drum by rail, truck, and ship (Airgas, 2009).

Storage and Shelf Life

Ammonium hydroxide should be stored in a cool place away from direct sunlight. When stored properly,

ammonium hydroxide can have a shelf life of 24 months (CF, 2016).

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 ammonium hydroxide.

Table 1. Ammonium Hydroxide Production and Trade Data Sources

Production and Trade Data			
Category	**Data Source**	**Identifier**	**Description**
Domestic Production	2020 EPA Chemical Data Reporting	CAS No.: 1336-21-6	Ammonium Hydroxide
Imports and Exports	USITC	HS Code: 2814.20	Ammonia in Aqueous Solution

Total U.S. domestic production of ammonium hydroxide was approximately 167 million kilograms (M kg) in 2019 (EPA, 2020). Domestic commercial manufacture of ammonium hydroxide takes place in numerous states throughout the country. The number of domestic manufacturing locations shown in Figure 2 represents operating facilities as of 2015. Supply of NSF/ANSI Standard 60 certified ammonium hydroxide 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, 2022b).

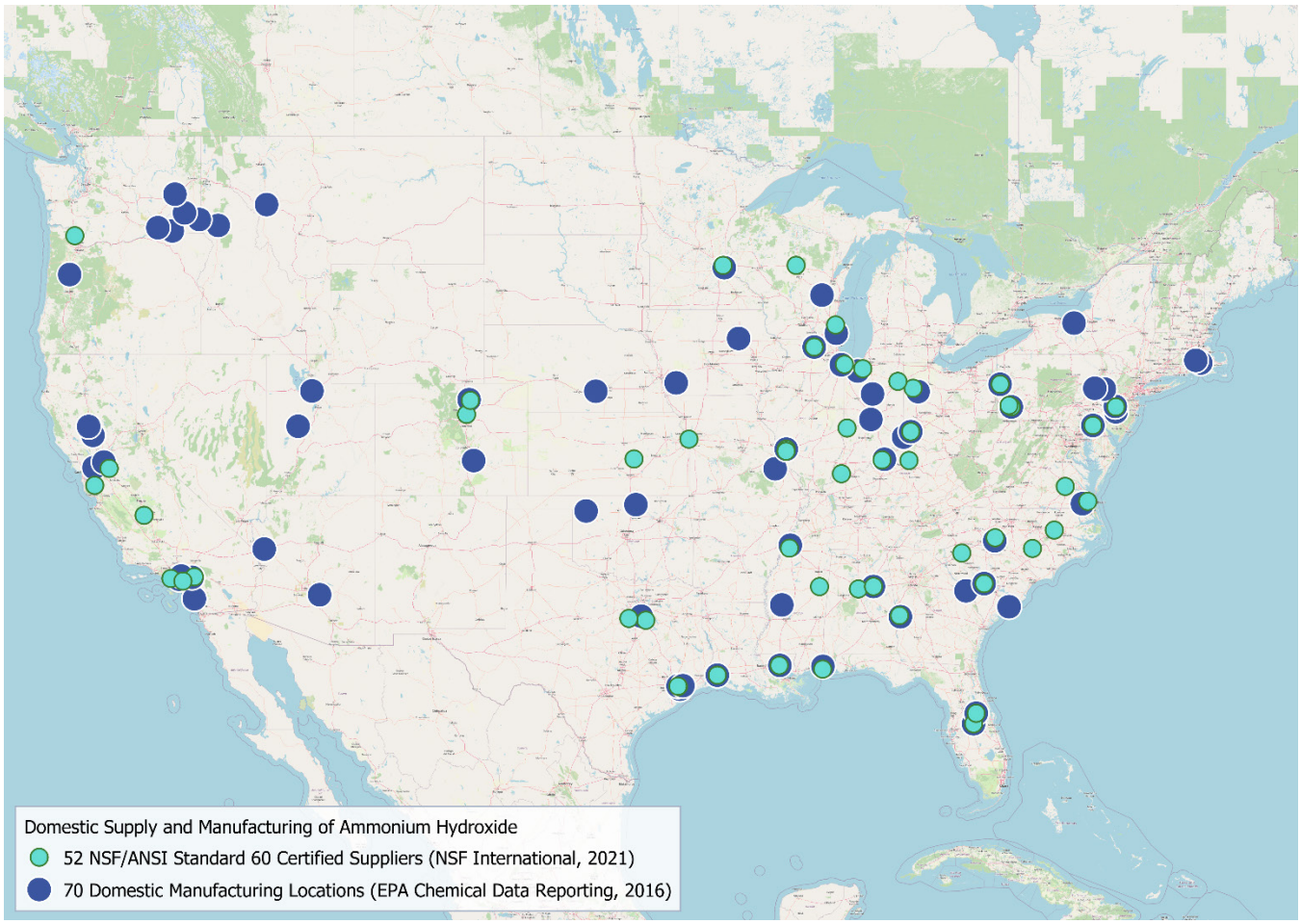


Figure 2. Domestic Supply and Manufacturing of Ammonium Hydroxide

Domestic Consumption

U.S. consumption of ammonium hydroxide in 2019 is estimated at 206 M kg. This estimate includes production of 167 M kg, import of 51 M kg, minus export of 12 M kg (EPA, 2020, USITC, 2021), as shown in Figure 3.

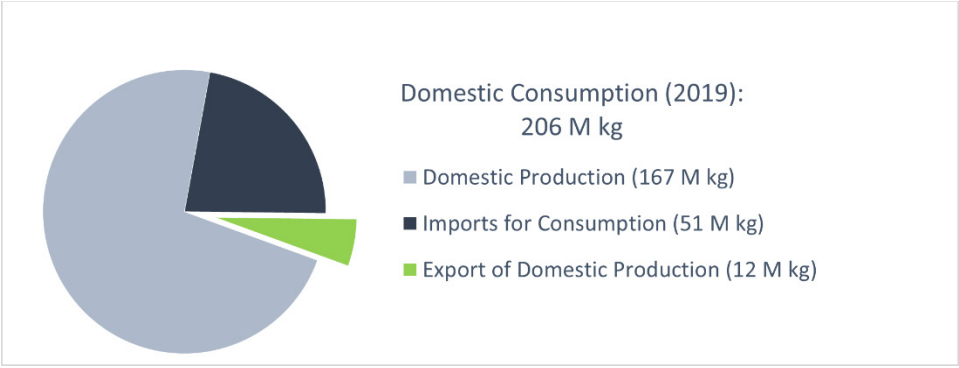


Figure 3. Domestic Production and Consumption of Ammonium Hydroxide in 2019

Trade &Tariffs

Worldwide Trade

Worldwide import and export data for ammonium hydroxide is reported through the World Bank's World

Integrated Trade Solutions (WITS) software as a category specific to ammonium hydroxide, referred to as ammonia in aqueous solution. In 2021, the U.S. ranked first worldwide in total imports of ammonium hydroxide. In 2021, Saudi Arabia ranked first worldwide in total exports (WITS, 2022), while the U.S. ranked fifth as shown in Table 2.

Table 2. WITS Worldwide Export and Import of Ammonium Hydroxide in 2021

2021 Worldwide Trade Ammonia in Aqueous Solution (HS Code 2814.20)			
Top 5 Worldwide Exporters		Top 5 Worldwide Importers	
Saudi Arabia	350 M kg	**United States**	**108 M kg**
Egypt	79 M kg	France	107 M k g
Netherlands	79 M kg	Germany	55 M kg
Canada	35 M kg	Belgium	32 M kg
United States	**30 M kg**	Sweden	22 M kg

Domestic Imports and Exports

Domestic imports and export data are reported by USITC in categories specific to ammonium hydroxide (ammonia in aqueous solution). Figure 4 summarizes imports for consumption[1] and domestic exports[2] of ammonium hydroxide between 2015 and 2020. During this period, the overall quantity of exports and imports remained relatively steady, with imports for consumption exceeding domestic exports. Over this five-year period, Ireland and Japan were the primary recipient of domestic exports while Canada was the primary source of imports (USITC, 2021).

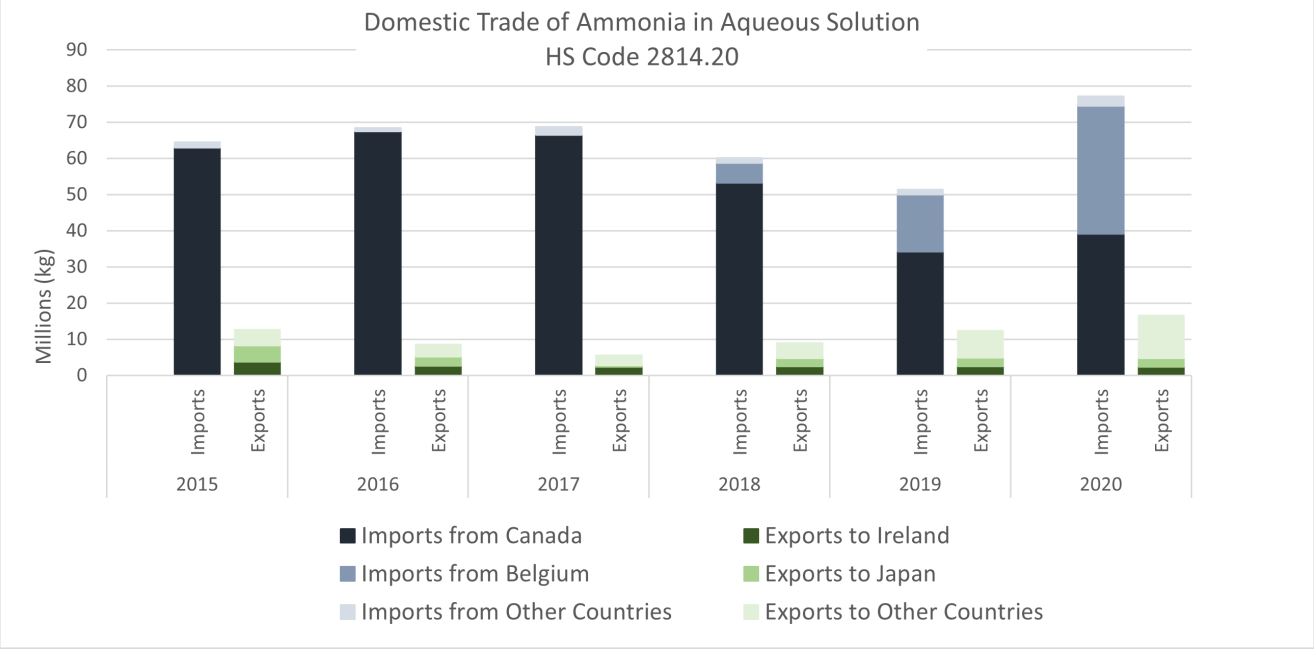


Figure 4. USITC Domestic Import and Export of Ammonium Hydroxide between 2015 and 2020

[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

There is no general duty for import of ammonium 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 Ammonium Hydroxide

HS Code	General Duty	Additional Duty - China (Section 301 Tariff List)	Special Duty
2814.20	None	25%	None

Market History & Risk Evaluation

History of Shortages

Ammonium hydroxide is widely used as a source of nitrogen in liquid fertilizer, and use in fertilizer dominates domestic consumption. There were no identified ammonium hydroxide supply chain disruptions between 2000 and 2022.

Risk Evaluation

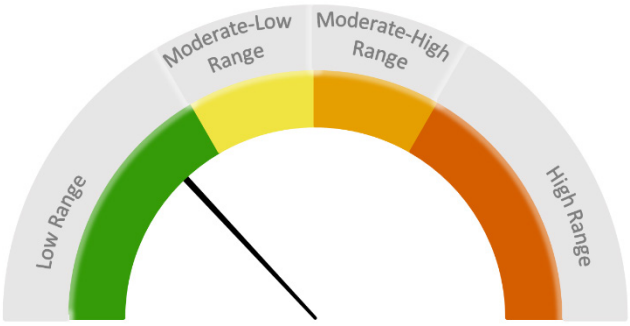
The complete risk evaluation methodology is described in *Understanding Water Treatment Chemical Supply Chains and the Risk of Disruptions* (EPA, 2022c). The risk rating is calculated as the product of the following three risk parameters:

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 Ammonium Hydroxide

Risk Parameter Ratings and Drivers		
Criticality: High	**Likelihood: Low**	**Vulnerability: Low**
Ammonium hydroxide is essential to the water sector and has widespread application in drinking water treatment for secondary disinfection.	The water sector has not experienced ammonium hydroxide supply chain disruptions between 2000 and 2022.	Though the majority of ammonium hydroxide is intended for use in fertilizer manufacturing, strong domestic manufacturing capabilities and a distributed manufacturing base provide some resilience to supply disruptions.
Risk Rating: Low		



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