Potassium Hydroxide

KOH

(liquid or solid)

D Direct Use Chemical P Precursor Chemical

Inputs to Manufacturing Process: Potassium Chloride

Derivative Water Treatment Chemicals: Potassium Permanganate

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

Understanding Chemical Supply Chains

Map of Suppliers & Manufacturers

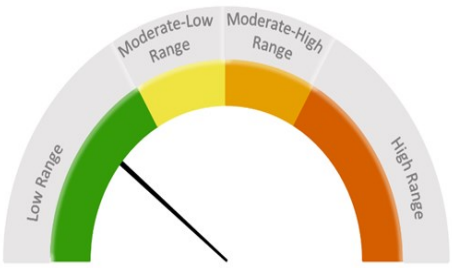
Product Family: Potassium

CAS No.: 1310-58-3

Shelf Life: 12 Months

RISK OF SUPPLY DISRUPTION (Assessed in 2022)

RISK RATING: Low



RISK DRIVERS

Concerns are primarily due to reductions in access to the raw material, potassium chloride, which is primarily imported and in high demand for fertilizers. Potassium hydroxide derivative chemical manufacturing is a primary application, and demand for these chemicals sets demand for potassium hydroxide.

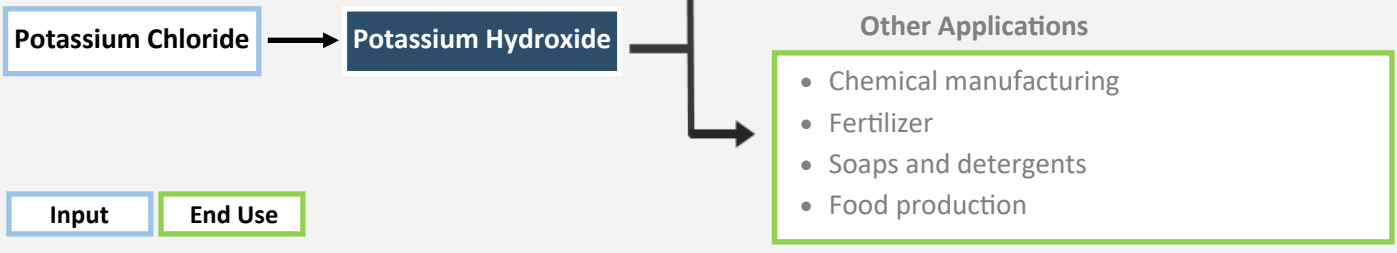
RISK SCORE PARAMETERS

Criticality: Moderate-Low. Application for pH adjustment, though less widely-used than other chemicals. Precursor for production of potassium permanganate.

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

Vulnerability: Moderate-High. Raw material (potassium chloride) is primarily imported and consumed in fertilizer production. Domestic manufacturing is distributed but limited.

MANUFACTURING PROCESS



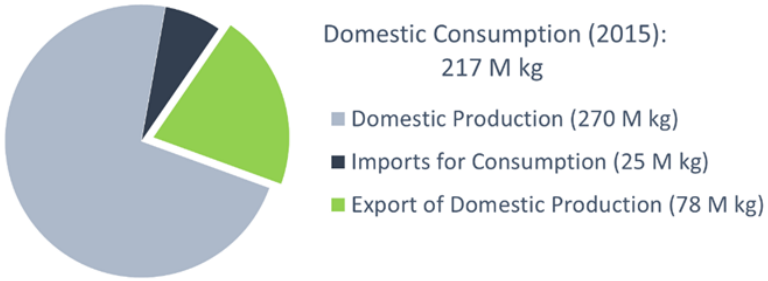
DOMESTIC PRODUCTION AND CONSUMPTION, AND INTERNATIONAL TRADE

Domestic Manufacturing Locations (2015): 14, distributed throughout the U.S.

International Trade (2019)

Primary Trading Partner (Imports): South Korea

Primary Trading Partner (Exports): Belgium



EPA

Product Description

Potassium hydroxide (KOH) is an inorganic, strong base that is used in water treatment for pH adjustment. It is primarily manufactured through chlor-alkali production by electrolysis of a potassium chloride brine, yielding both chlorine and potassium hydroxide. The majority of potassium hydroxide manufactured in the U.S. is used in organic and inorganic chemical production.

Use in Water Treatment

Potassium hydroxide is used in water treatment for pH adjustment (AWWA, 2017).

Use as a Precursor to Other Water Treatment Chemicals

Potassium hydroxide is used to manufacture potassium permanganate.

Other Applications

Potassium hydroxide is the most common intermediate used to manufacture potassium-based inorganic chemicals. The most common chemical produced from potassium hydroxide is potassium carbonate, which has a wide variety of uses in agriculture and manufacturing. Other significant applications of potassium hydroxide are manufacturing fertilizers and soil amendments, soaps and detergents, food processing, battery production, deicing, and petroleum refining (NCBI, 2021; USDA, 2016).

Primary Industrial Consumers

Historically, production of derivative potassium-based chemicals, primarily potassium carbonate, has been the leading use of potassium hydroxide. Application in fertilizer and soil amendments is another primary use. Potassium chloride is also commonly used to make soaps and detergents, and in food processing (NCBI, 2021).

Manufacturing, Transport, & Storage

Manufacturing Process

Potassium chloride is the primary raw material used to produce potassium hydroxide. The majority of potassium hydroxide is manufactured using the chlor-alkali process, which involves passing a direct electric current through a potassium chloride brine (i.e., electrolysis), converting chloride ions to elemental chlorine at the anode while potassium ions and hydrogen gas collect at the cathode to react and form potassium hydroxide. The general equation for this process is shown in Figure 1. Potassium hydroxide is separated from the solution using the membrane method or the mercury method. The resulting potassium hydroxide solution can be sold for commercial use as a solution or heated and evaporated to produce a solid.

Potassium Chloride Brine	$\rightarrow$	**Chlorine Gas**	+	**Hydrogen Gas**	+	**Potassium Hydroxide**
$2KCl + 2H_2O$	$\rightarrow$	Cl_2		H_2		$2KOH$
		$\downarrow$		$\downarrow$		$\downarrow$
		Anode		Cathode		Cathode

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

An alternative method of potassium hydroxide manufacturing utilizes spent potassium hydroxide recovered from hydrofluoric acid catalyzed alkylation used in petroleum refining. In this process, potassium hydroxide is recovered from the wastewater and recycled, primarily on-site in petroleum refining as a base used to neutralize hydrofluoric acid (U.S. Chamber of Commerce Foundation, 2015).

Product Transport

Potassium hydroxide, listed as a hazardous substance, can be transported in bulk or smaller containers by truck, rail, barge, and ship.

Storage and Shelf Life

Potassium hydroxide is highly reactive and corrosive, and thus should be stored in non-reactive storage vessels at room temperature in a dry, cool place to avoid contact with moisture. When stored properly, potassium hydroxide can have a shelf life of 12 months, depending on storage as a liquid or solid (Puritan Products, 2017).

Domestic Production & Consumption

Domestic Production

Production data was collected from the 2016 EPA Toxic Substances Control Act (TSCA) Chemical Data Reporting (CDR) for the year 2015[1], while trade data was collected from the U.S. International Trade Commission (USITC) Dataweb, as characterized in Table 1. Both production data and trade data are specific to potassium hydroxide.

Table 1. Potassium Hydroxide Production and Trade Data Sources

Production and Trade Data			
Category	**Data Source**	**Identifier**	**Description**
Domestic Production	2016 TSCA Chemical Data Reporting	CAS No.: 1310-58-3	Potassium Hydroxide
Imports and Exports	U.S. International Trade Commission	HS Code: 2815.20	Potassium Hydroxide

Total U.S. domestic manufacturing of potassium hydroxide was approximately 270 million kilograms (M kg) in 2015 (EPA, 2016); however, several manufacturers claimed confidential business information and did not report production volumes to EPA. Leading domestic manufacturers of potassium hydroxide include *Olin Corporation*, *Inneos*, and *ERCO Worldwide*. Domestic commercial manufacture of potassium hydroxide takes place at facilities located throughout the contiguous U.S., though captive consumption may predominate at some of these facilities, and some, as noted in the alternative manufacturing method description, may recover potassium hydroxide from on-site processing. Historically, the domestic production market has been concentrated, with top producers accounting for the majority of domestic production volume (FTC, 2005). The number of domestic manufacturing locations shown in Figure 2 represents operating facilities as of 2015. Supply of NSF/ANSI Standard 60 certified potassium hydroxide for use in drinking water treatment is 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).

[1] Although 2019 CDR data is available, reporting is less complete when compared to 2015 data due to an increase in the number of companies claiming confidential business information (CBI). In both instances, CBI may account for a significant volume of potassium hydroxide produced that is not reflected in CDR reporting.

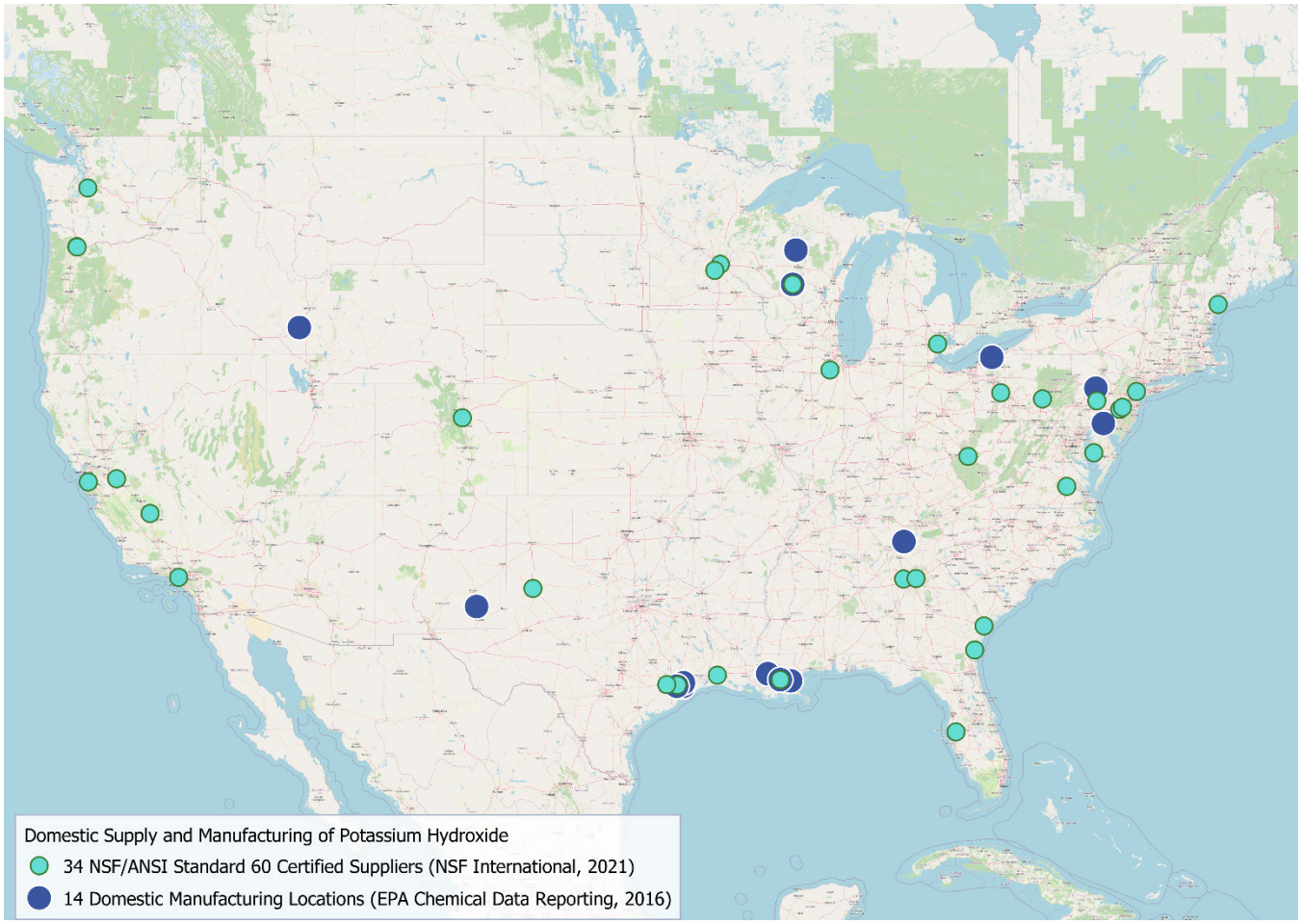


Figure 2. Domestic Supply and Manufacturing of Potassium Hydroxide

Domestic Consumption

U.S. consumption of potassium hydroxide in 2015 is estimated at 217 M kg. This includes production of 270 M kg, import of 25 M kg, minus export of 78 M kg (EPA, 2016; USITC, 2021), as shown in Figure 3.

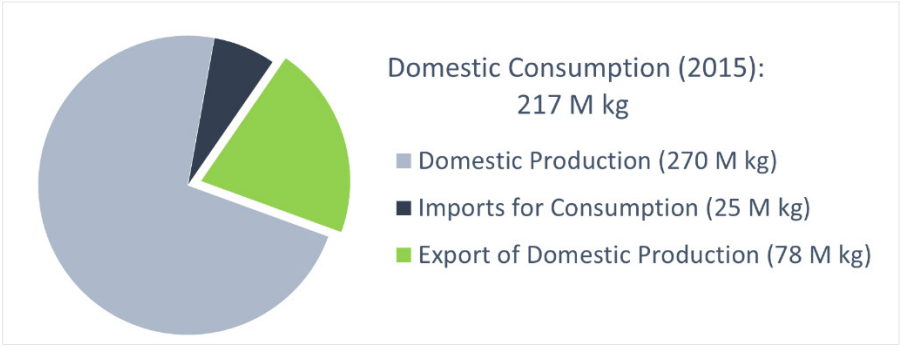


Figure 3. Domestic Production and Consumption of Potassium Hydroxide in 2015

Trade & Tariffs

Worldwide Trade

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

ranked third worldwide in total exports and tenth in total imports of potassium hydroxide. In 2021, Belgium ranked first worldwide in total exports and Germany ranked first worldwide in total imports (WITS, 2022), as shown in Table 2.

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

2021 Worldwide Trade Potassium Hydroxide (HS Code 2815.20)			
Top 5 Worldwide Exporters		Top 5 Worldwide Importers	
Belgium	403 M kg	Germany	152 M kg
South Korea	218 M kg	France	97 M kg
United States	**111 M kg**	Malaysia	75 M kg
Czech Republic	91 M kg	Spain	67 M kg
Germany	90 M kg	Belgium	55 M kg

Domestic Imports and Exports

Domestic import and export data are reported by USITC in categories specific to potassium hydroxide. Figure 4 summarizes imports for consumption[2] and domestic exports[3] of potassium hydroxide between 2015 and 2020. During this period, the overall quantity of exports have varied with a high in 2018 while the quantity of imports has remained relatively steady. Domestic exports have consistently exceeded imports for consumption. Over this five-year period, through 2017 Canada was the primary recipient of domestic exports , and since 2018 Belgium has been the leading recipient of domestic exports. South Korea and Belgium have been the primary sources of imports (USITC, 2021).

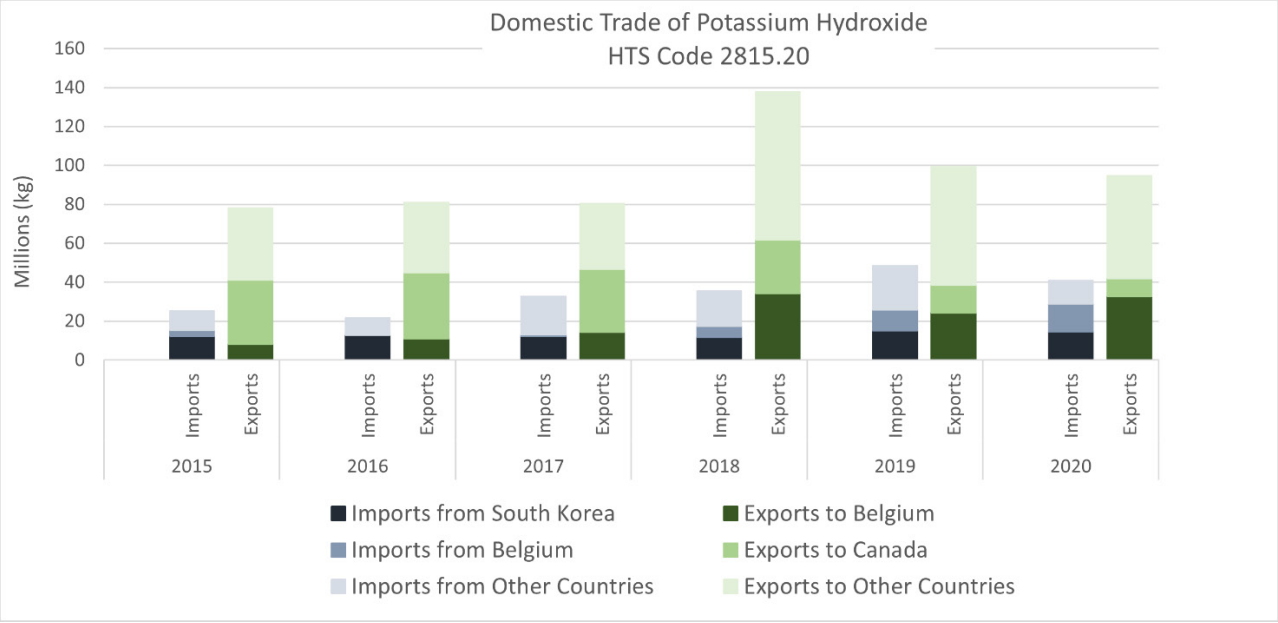


Figure 4. USITC Domestic Import and Export of Potassium Hydroxide between 2015 and 2020

[2] 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.

[3] 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 potassium hydroxide (USITC, 2022), as summarized in Table 3. Imports from China, historically one of the top five countries of origin for potassium hydroxide imports, have decreased by an estimated 85% since 2018. There is an additional 25% tariff on imports from China.

Table 3. Domestic Tariff Schedule for Potassium Hydroxide in 2022

HS Code	General Duty	Additional Duty – China (Section 301 Tariff List)	Special Duty
2815.20	None	25%	None

Market History & Risk Assessment

History of Shortages

While chlor-alkali producers utilizing sodium chloride as a raw material generally set chlor-alkali production around demand for chlorine, demand for potassium hydroxide derivative chemicals tends to set demand for chlor-alkali production using potassium chloride as a raw material. Direct landfall of Hurricane Ida in Louisiana in August 2021 resulted in a temporary closure of the largest domestic production facility in Louisiana, causing a temporary loss of significant production capacity. In 2022, reductions in worldwide supply of the primary raw material, potassium chloride, have led to significant price increases for this raw material on the international market.

Risk Evaluation

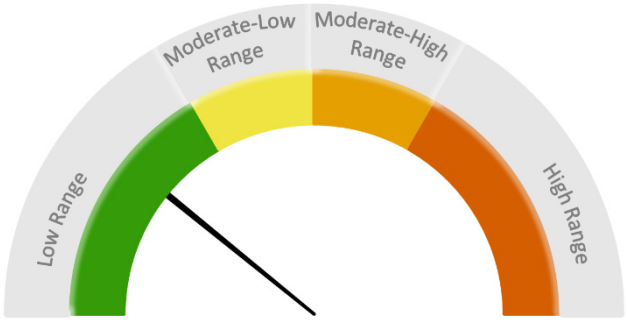
The complete risk assessment methodology is described in *Understanding Water Treatment Chemical Supply Chains and the Risk of Disruptions* (EPA, 2022b). The risk rating is calculated as the product of the following three risk parameters:

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 Potassium Hydroxide

Risk Parameter Ratings and Drivers		
Criticality: Moderate-Low	**Likelihood: Low**	**Vulnerability: Moderate-High**
Potassium hydroxide has application for pH adjustment, though less widely-used than other chemicals. It is a precursor in the production of potassium permanganate.	The water sector has not experienced potassium hydroxide supply disruptions between 2000 and 2022.	Supply of the raw material, potassium chloride, is largely import-dependent, and primarily from one geographic region (Saskatchewan, Canada). Consumption of the raw material is dominated by demand for use in fertilizer. Domestic manufacturing of potassium hydroxide is limited.
Risk Rating: Low		



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