Sodium Silicate

$Na_2O·(SiO_2)_x$

(liquid, solid)

D Direct Use Chemical

Inputs to Manufacturing Process:
Silica
Sodium Carbonate Sodium Hydroxide

% of Total Domestic Consumption Attributed to Water Sector:
Less than 6%

Product Family:
Silica

CAS No.: 1344-09-8

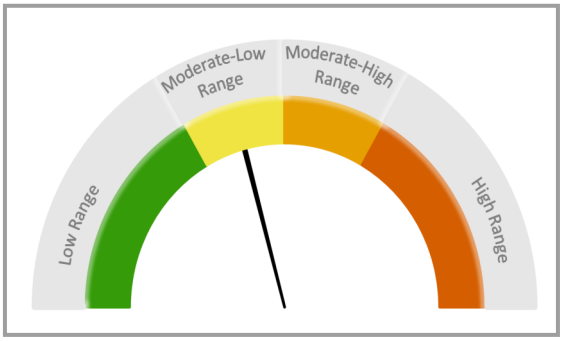
Derivative Water Treatment Chemicals:
None

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

Distributed domestic manufacturing provides some resilience to supply disruptions. However, a key input, sodium carbonate, though domestically produced in large quantities, is only produced in two geographic locations.

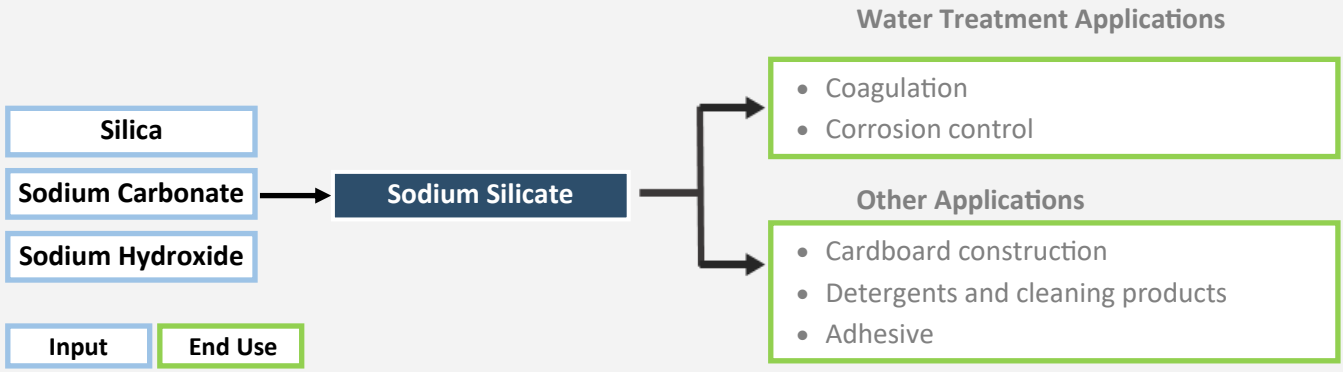
RISK PARAMETERS

Criticality: High. Essential for corrosion control and coagulation.

Likelihood: Low. The water sector did not experience sodium silicate supply disruptions between 2000 and 2022.

Vulnerability: Moderate-Low. Strong domestic manufacturing and distribution, however domestic production of a key input, sodium carbonate, is geographically limited.

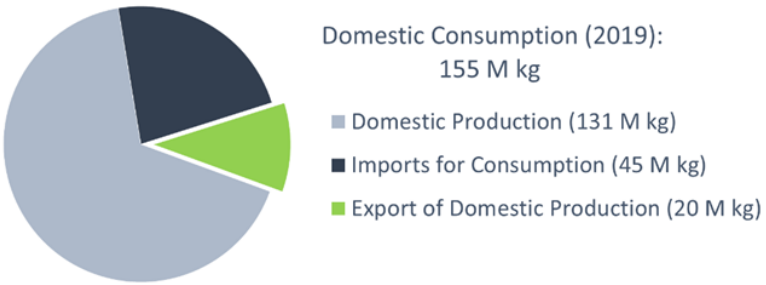
MANUFACTURING PROCESS



DOMESTIC PRODUCTION AND CONSUMPTION, AND INTERNATIONAL TRADE

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

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



EPA

Product Description

Sodium silicates ($Na_2O·(SiO_2)_x$), are a class of alkaline salts with varying formulations widely used across a variety of industries. Sodium silicates are used in water treatment for corrosion control and as a coagulant aid. Sodium silicate is widely used for cardboard construction and formulation of cleaning products and detergents.

Use in Water Treatment

Sodium silicate is used directly in water treatment as a component of activated silica coagulant aids, for corrosion control, and for iron and manganese stabilization (AWWA, 2008).

Use as a Precursor to Other Water Treatment Chemicals

Sodium silicate is not used as a precursor in the commercial manufacture of other water treatment chemicals.

Other Applications

Sodium silicates are most commonly used in detergent and cleaning product formulations and cardboard construction. Other applications include use in hydraulic fracturing well stabilization, soil stabilization, concrete manufacturing, silica gels, paints and coatings, as an adhesive, and as a food additive (NCBI, 2021; PQ, 2004a; PQ, 2021).

Primary Industrial Consumers

Cardboard construction and detergent and cleaning product formulations are the primary applications of sodium silicates. Use as an adhesive and as a drilling fluid and well stabilizer are other significant applications. Water treatment, including industrial water treatment, is estimated as 6% of overall sodium silicate consumption (NCBI, 2021).

Manufacturing, Transport, & Storage

Manufacturing Process

A significant quantity of sodium silicate produced in the U.S. starts with silica and sodium carbonate and utilizes the furnace process. The other significant production method utilizes sodium hydroxide instead of sodium carbonate in order to produce alkali silicates.

Sodium silicate is a generic term for a variety of compounds containing silicon, oxygen, and sodium. Sodium silicate compounds are represented by the formula $Na_2O·(SiO_2)_x$, where x is the ratio of silicon dioxide (SiO_2) to sodium oxide (Na_2O) by weight. The ratio determines the physical and chemical properties of the product, resulting in various applications for sodium silicate. The commercial ratio for liquid sodium silicates ranges from 1.8 to 3.75 and the commonly used ratio for sodium silicate in water treatment is 3.2 (AWWA, 2008; PQ, 2021).

The most common sodium silicate manufacturing process proceeds in several steps, the overall equation for this process is outlined in Figure 1. Measured proportions of silica sand and sodium carbonate are fused in a furnace at high heat. The product from the first phase, which is an amorphous glass called sodium silicate lumps or cullet is dissolved in water at elevated temperature and pressure to produce a silicate solution. The silicate solution is then filtered to yield the final product. The ratio may be adjusted at this stage by adding sodium hydroxide to obtain the desired ratio of silicon dioxide to sodium oxide (Fawer et al., 1999; PQ, 2004b).

Sodium Carbonate	+	Silica	→	Sodium Silicate	+	Carbon Dioxide
Na_2CO_3	+	$xSiO_2$	→	$Na_2O{\cdot}(SiO_2)_x$	+	CO_2

Figure 1. Chemical Equation for the Reaction to Manufacture Sodium Silicate

Product Transport

Sodium silicate, 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. When transported as a solution, transportation costs due to high water content may increase the cost of the delivered product (PQ, 2004a; PQ 2021).

Storage and Shelf Life

Sodium silicate, should be stored in a tightly closed container and kept in a cool place away from direct sunlight. When stored properly, sodium silicate can have a shelf life of approximately 12 months, depending on storage conditions and size of storage container (PQ, 2004b).

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 sodium silicate.

Table 1. Sodium Silicate Production and Trade Data Sources

Production and Trade Data			
Category	**Data Source and Date**	**Identifier**	**Description**
Domestic Production	2020 TSCA Chemical Data Reporting	CAS No.: 1344-09-8	Sodium Silicate
Imports and Exports	U.S. International Trade Commission	HS Code: 2839.19	Sodium Silicate

Total U.S. domestic manufacturing of sodium silicate reported under the CDR was approximately 155 million kilograms (M kg) in 2019 (EPA, 2020). Evonik indicated production of approximately 64% of total domestic production, though a considerable number of manufacturers claimed confidential business information for production volumes, including leading domestic manufacturer *PQ Corporation*. The number of domestic manufacturing locations shown in Figure 2 represents operating facilities as of 2015 (EPA, 2016). Supply of NSF/ANSI Standard 60 certified sodium silicate 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).

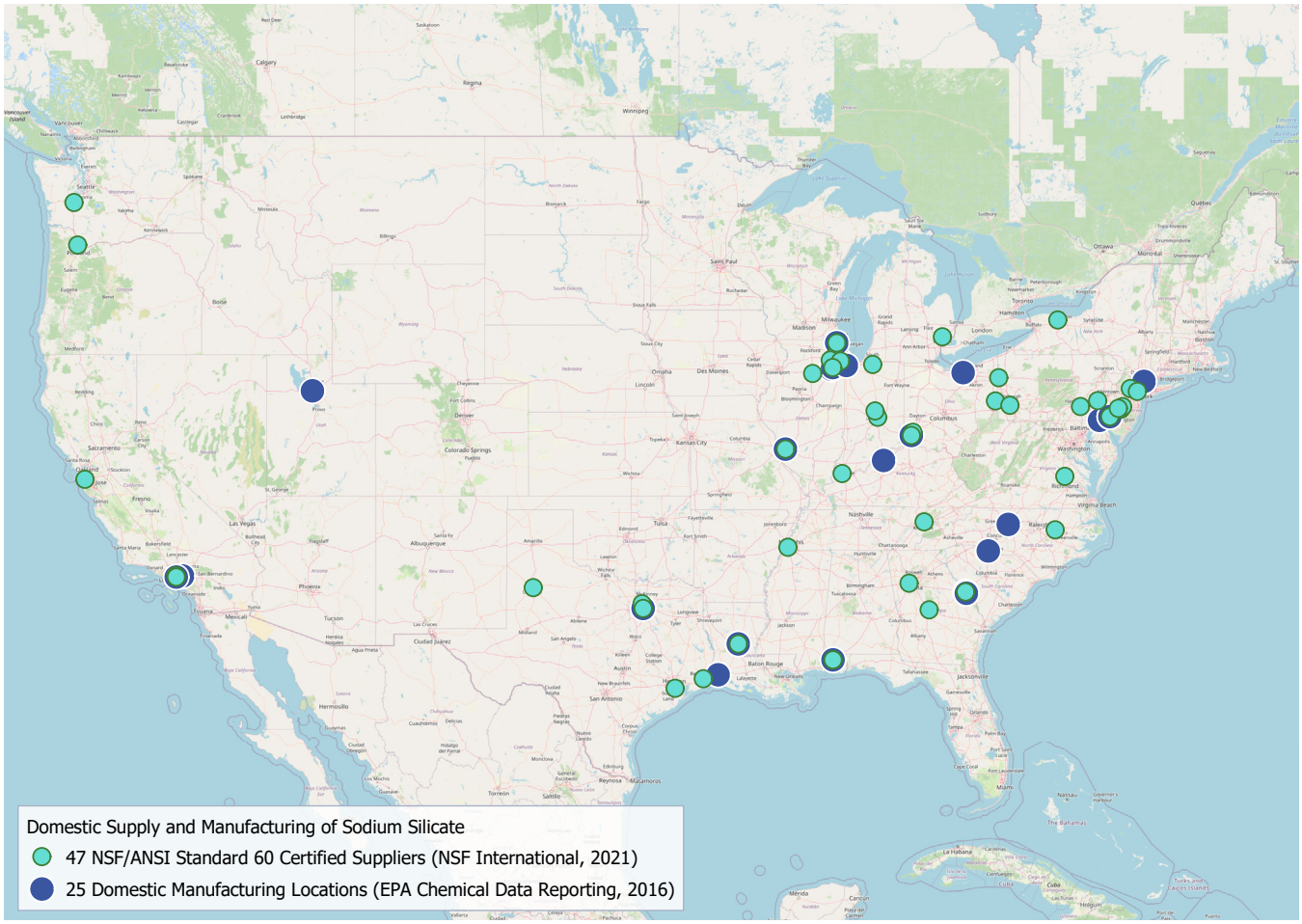


Figure 2. Domestic Supply and Manufacturing of Sodium Silicates

Domestic Consumption

U.S. consumption of sodium silicate in 2019 is estimated at 155 M kg. This includes production of 131 M kg, import of 45 M kg, minus export of 20 M kg (EPA, 2020; USITC, 2022a), as shown in Figure 3.

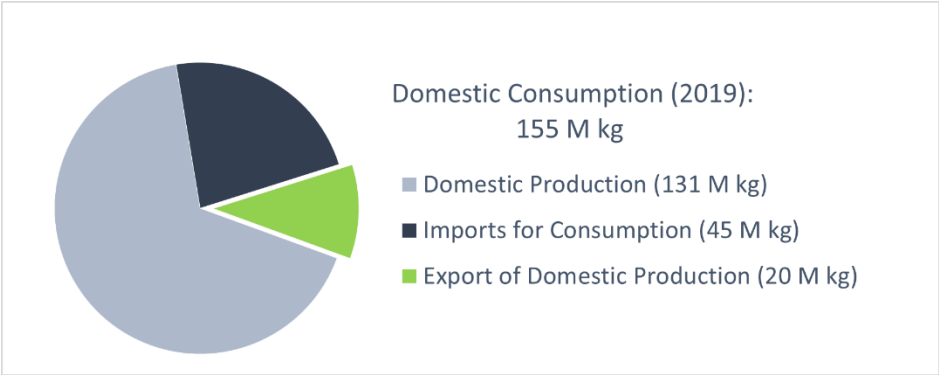


Figure 3. Domestic Production and Consumption of Sodium Silicate in 2019

Trade & Tariffs

Worldwide Trade

Worldwide import and export data for sodium silicate are reported through the World Bank's World Integrated Trade Solutions (WITS), as sodium silicates. In 2021, the U.S. ranked 14th worldwide in total exports and third in total imports of sodium silicates. In 2021, China ranked first worldwide in total exports and South Korea first in total imports (WITS, 2022), as shown in Table 2.

Table 2. WITS Worldwide Export and Import of Sodium Silicates in 2021

2021 Worldwide Trade Sodium Silicates (HS Code 2839.19)			
Top 5 Worldwide Exporters		Top 5 Worldwide Importers	
China	309 M kg	South Korea	126 M kg
Poland	207 M kg	Netherlands	121 M kg
Germany	121 M kg	**United States**	**100 M kg**
Egypt	60 M kg	France	90 M kg
Ukraine	52 M kg	Japan	62 M kg

Domestic Imports and Exports

Domestic imports and export data are reported by USITC in a category specific to sodium silicates. Figure 4 summarizes imports for consumption[1] and domestic exports[2] of sodium silicates between 2015 and 2020. During this period, the overall quantity of exports and imports varied with no clear pattern. Over this five-year period, Canada was the primary recipient of domestic exports and the primary source of imports (USITC, 2022a).

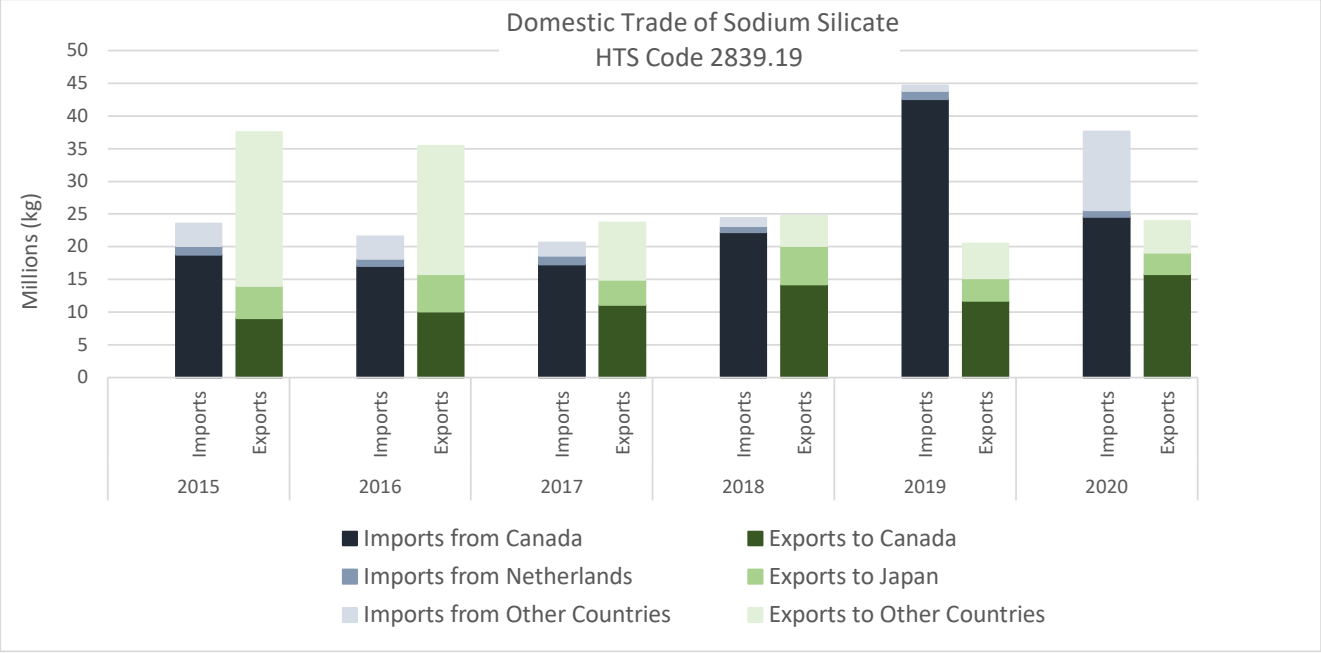


Figure 4. USITC Domestic Import and Export of Sodium Silicates between 2015 and 2020

[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 a 1.1% general duty for import of sodium silicate and an additional 25% duty on imports from China (USITC, 2022b), as summarized in Table 3.

Table 3. 2021 Domestic Tariff Schedule for Sodium Silicates

HS Code	General Duty	Additional Duty - China (Section 301 Tariff List)	Special Duty
2839.19	1.1%	25%	Free (A, AU, BH, CL, CO, D, E, IL, JO, KR, MA, OM, P, PA, PE, S, SG)[3]

Market History & Risk Evaluation

History of Shortages

There were no identified sodium silicate 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, 2022b). The risk rating is calculated as the product of the following three risk parameters:

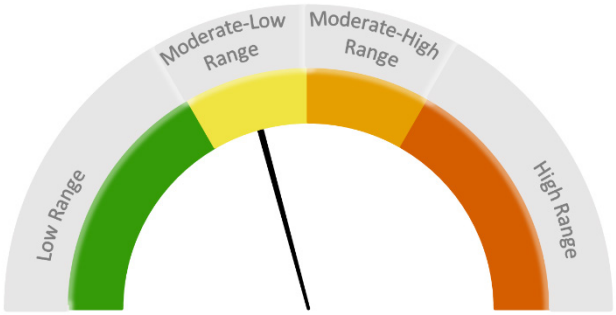
Risk = Criticality x Likelihood x Vulnerability	
Criticality	Measure of the importance of a chemical to the water sector
Likelihood	Measure of the probability that the chemical will experience a supply disruption in the future, which is estimated based on past occurrence of supply disruptions
Vulnerability	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.

[3] Symbols used to designate the various preference programs and trade agreements. A full list of special trade agreements and associated acronyms can be found at https://help.cbp.gov/s/article/Article-310?language=en_US and the General Notes Section of the Harmonized Tariff Schedule https://hts.usitc.gov/current

Table 4. Supply Chain Risk Evaluation for Sodium Silicate

Risk Parameter Ratings and Drivers		
Criticality: High	**Likelihood: Low**	**Vulnerability: Moderate-Low**
Sodium silicate is essential to the water sector for coagulation and corrosion control.	The water sector has not experienced sodium silicate supply disruptions between 2000 and 2022.	Strong domestic manufacturing capabilities and a distributed manufacturing base provide some resilience to supply disruptions. However, a key input, sodium carbonate, though produced in large quantities in the U.S., is limited to domestic manufacturing in only two geographic locations.
Risk Rating: Moderate-Low		



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