Manganese Ore

Raw Material

MnO_2 (solid)

Source of Raw Material: Naturally occurring ore

% of Total Domestic Consumption Attributed to Water Sector: Less than 1%

Product Family: Manganese

CAS No.: 7439-96-5

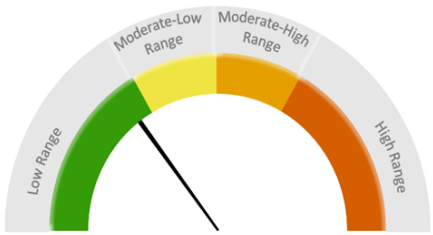
Derivative Water Treatment Chemicals: Potassium Permanganate

Understanding Chemical Supply Chains

Shelf Life: 60+ Months

RISK OF SUPPLY DISRUPTION (Assessed in 2022)

RISK RATING: Low



RISK DRIVERS

Iron and steel manufacturing is the primary (90%) domestic use of manganese. Fluctuations in this industry may drive domestic demand, which is entirely dependent on imports. Imports are primarily from a small number of countries, but worldwide resources are abundant.

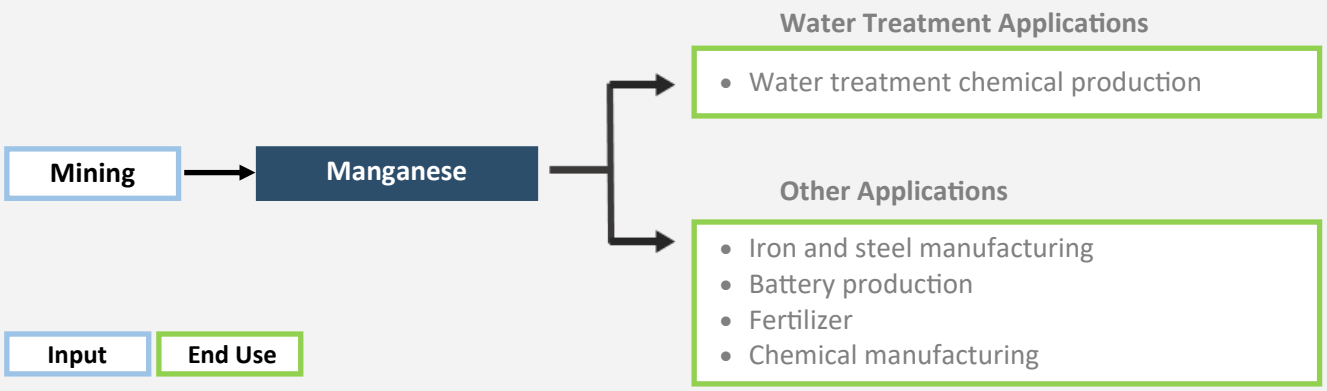
RISK PARAMETERS

Criticality: High. Essential for production of potassium permanganate.

Likelihood: Low. No identified manganese supply disruptions between 2000 and 2022.

Vulnerability: Moderate-High. The U.S. is entirely reliant on imports of manganese for all applications. There are abundant worldwide resources, which may provide some resilience to supply disruptions.

PRODUCTION PROCESS



DOMESTIC PRODUCTION AND CONSUMPTION, AND INTERNATIONAL TRADE

Domestic Production Locations (2019):
1 mining location in South Carolina: production of ultra-low-grade manganese.

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

Product Description

Manganese ore, primarily in the form manganese dioxide (MnO_2), is a widely occurring natural ore which is essential to steel manufacturing. It is not used directly in water treatment but serves as a key input in manufacturing potassium permanganate. The U.S. imports all manganese required for manufacturing derivative chemicals. The U.S. Government has maintained a stockpile of manganese ore since 1916.

Use in Water Treatment

None.

Use as a Precursor to Other Water Treatment Chemicals

Manganese is used to manufacture potassium permanganate.

Other Applications

Manganese is used widely in a range of applications. All applications of manganese require processing and refining of the ore. Most manganese ore is smelted to produce alloys which are used in the production of iron and steel. In non-metallurgical applications, manganese ore is used in the production of dry cell batteries (including those for electric vehicles), fertilizers, animal feed, chemicals for water treatment and as a colorant for various applications (IMnI, n.d.; USGS, 2014; USGS 2022).

Primary Industrial Consumers

In 2018, approximately 90% of manganese consumed in the U.S. was used in iron and steel production. The remaining manganese was consumed in production of battery cathodes, electronics, fertilizers, animal feed, water treatment chemicals, and other chemicals (USGS 2014; USGS 2022).

Manufacturing, Transport, & Storage

Manufacturing Process

Deposits of manganese-bearing ore are found throughout the world though in varying grades that determine profitability of extraction. Manganese is extracted by surface and underground mining techniques. The mined ore requires beneficiation steps before further processing. The majority of manganese ore supplied to the market is smelted to ferromanganese to be used in the production of steel, while the majority of manganese chemical compounds are produced directly from processed manganese ore. For chemical manufacturing applications, crushed manganese ore is processed in a kiln using a reducing gas to form manganese oxide. The manganese oxide is crushed and used directly in chemical manufacturing (EPA, 1985; IMnI, n.d.; USGS, 2014).

Product Transport

Manganese ore, commonly sold as a ground solid, is routinely transported by ship, rail, and truck (Ghana Manganese Company Limited, n.d.; IMnI, n.d.).

Storage and Shelf Life

Ground manganese is stable and non-reactive over a wide range of temperatures. When stored properly and kept dry, manganese can have a shelf life exceeding 60 months (Millipore Sigma, 2013).

Domestic Production & Consumption

Domestic Production

Production data was collected from USGS, 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 manganese.

Table 1. Manganese Production and Trade Data Sources

Production and Trade Data			
Category	**Data Source**	**Identifier**	**Description**
Domestic Production	U.S. Geological Survey	CAS No.: 7439-96-5	Manganese
Imports and Exports	U.S. International Trade Commission	HTS Code: 2602.00	Manganese Ores and Concentrates

Total U.S. domestic production of manganese is historically negligible, and production of ultra-low-grade manganese takes place at one mine in South Carolina. The manganese content of the clays and schists produced from this mine is low, and the primary use of the extracted manganese is for brick coloration. While the U.S. does have several manganese deposits, the larger manganese deposits have inferior quality that makes processing either economically or technically impractical. Though several manufacturers list domestic production of manganese in the 2016 EPA Toxic Substances Control Act (TSCA) Chemical Data Reporting (CDR) dataset, company information for two of the manufacturers claiming domestic production, *Umicore* and *Novelis*, indicates that the origin of the manganese is from recycling of a variety of manganese-containing products. The U.S. has not produced any significant quantity of ore with manganese content greater than 20% since 1973, and is 100% reliant on imports for manganese ore and alloys. Worldwide, South Africa, Australia, Gabon, and Brazil accounted for approximately 73% of 2020 manganese ore production (IMnI, 2021).

Domestic Consumption

U.S. consumption of manganese in 2019 is estimated at 433 M kg. This estimate includes negligible production (amount considered confidential business information and not reported), import of 434 M kg, and export of 1 M kg (USGS, 2020), as shown in Figure 1.

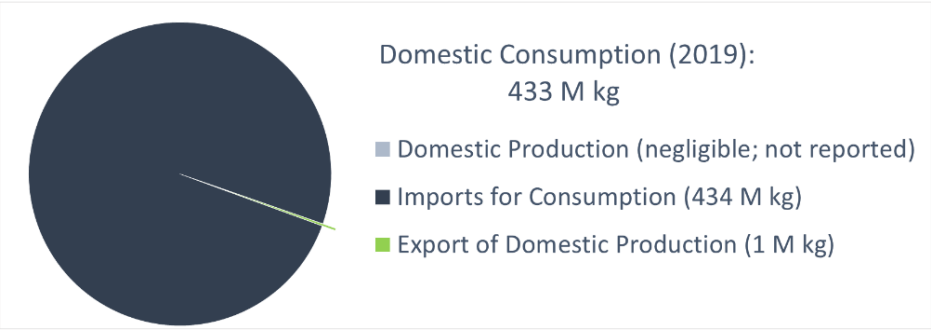


Figure 1. Domestic Production and Consumption of Manganese Ores and Concentrates in 2019

Trade &Tariffs

Worldwide Trade

Worldwide import and export data for manganese are reported through the World Bank's World Integrated Trade Solutions (WITS) software, as a category for manganese ores and concentrates. In 2021, the U.S. ranked 33rd worldwide in total exports and ninth in total imports of manganese ores and concentrates. In 2021, South Africa ranked first worldwide in total exports and China ranked first worldwide in total imports (WITS, 2022), as shown in Table 2. The quantity of manganese ores and concentrates exported by Gabon, a country with significant production and a primary source of imports for the U.S., was not reported through WITS in 2021.

Table 2. WITS Worldwide Export and Import of Manganese Ores and Concentrates in 2021

2021 Worldwide Trade Manganese Ores and Concentrates (HS Code 2602.00)			
Top 5 Worldwide Exporters		Top 5 Worldwide Importers	
South Africa	22,321 M kg	China	29,958 M kg
Brazil	1,724 M kg	India	5,970 M kg
Malaysia	615 M kg	Russian Federation	1,394 M kg
Zambia	221 M kg	South Korea	1,325 M kg
Poland	139 M kg	Malaysia	1,073 M kg

Domestic Imports and Exports

Domestic import and export data are reported by USITC in categories specific to manganese ores and concentrates. Figure 2 summarizes imports for consumption[1] and domestic exports[2] of manganese ores and concentrates between 2015 and 2020. During this period, the overall quantity of imports varied over the five-year period with a high in 2015. The volume of exports was negligible. Over this five-year period, Canada was the primary recipients of domestic exports while the primary source of imports was Gabon (USITC, 2021).

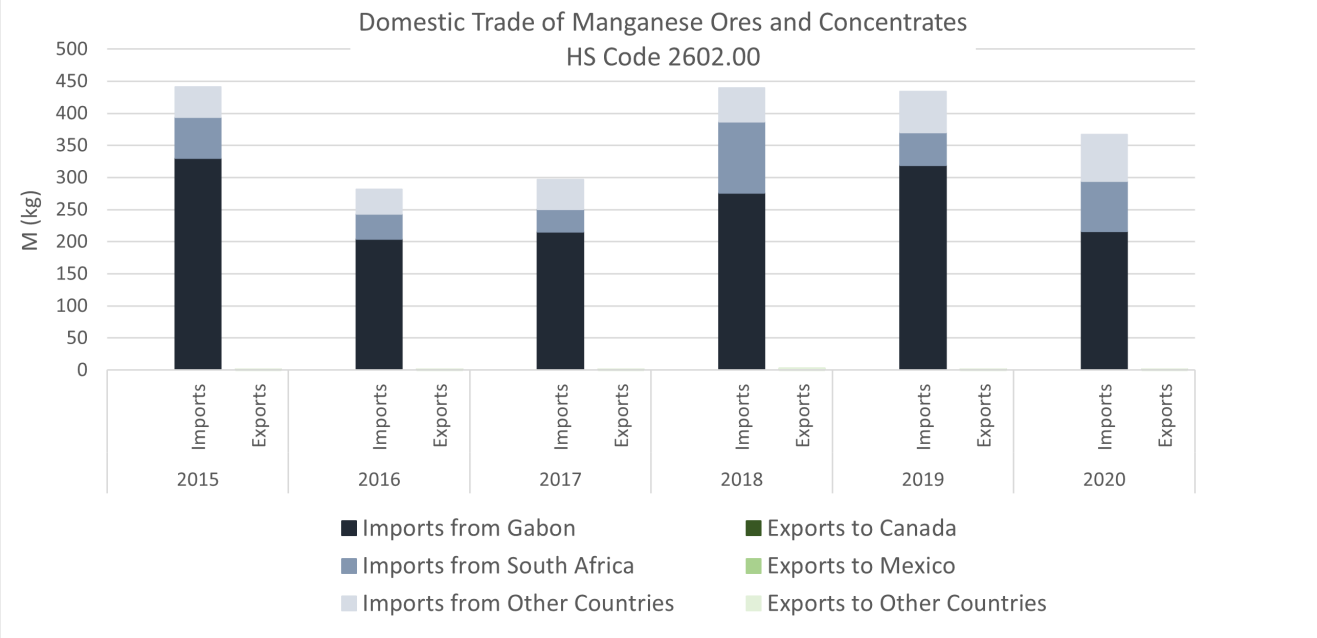


Figure 2. USITC Domestic Import and Export of Manganese Ores and Concentrates between 2015 and 2020

[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, additional duty, or special duties for import of manganese ores and concentrates (USITC, 2022), as summarized in Table 3.

Table 3. 2021 Domestic Tariff Schedule for Manganese Ores and Concentrates

HS Code	General Duty	Additional Duty – China (Section 301 Tariff List)	Special Duty
2602.00	None	None	None

Market History & Risk Evaluation

History of Shortages

The demand for manganese is tightly tied to demand from the steel industry, and production of manganese ore follows steel production. Reductions in steel manufacturing have historically led to significant cutbacks in manganese ore production. Manganese is essential to a number of domestic industrial processes, and the lack of viable substitute and complete reliance on imports makes this mineral commodity vulnerable to supply disruptions. While manganese is widely available from a global perspective, mineable deposits are not evenly distributed, and this has historically been noted as a national security concern.

Risk Evaluation

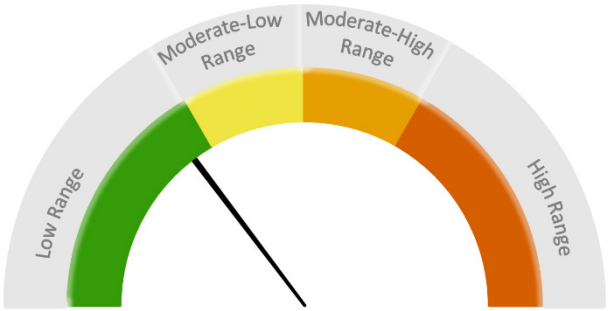
The complete risk assessment methodology is described in *Understanding Water Treatment Chemical Supply Chains and the Risk of Disruptions* (EPA, 2022). The risk rating is calculated as the product of the following three risk parameters:

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 Manganese Ore

Risk Parameter Ratings and Drivers		
Criticality: High	**Likelihood: Low**	**Vulnerability: Moderate-High**
Manganese is essential to production of potassium permanganate which is widely used in drinking water and wastewater treatment.	There were no identified disruptions to the domestic supply of manganese between 2000 and 2022.	The U.S. is entirely reliant on imports of manganese for all uses and derivative chemicals. However the U.S. has multiple sources of imports, which provides some resilience to supply disruptions.
Risk Rating: Low		



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