

VANADIUM

(Data in metric tons of vanadium content unless otherwise noted)

Domestic Production and Use: Byproduct vanadium production in Utah from the mining of uraniumiferous sandstones on the Colorado Plateau ceased in the first quarter of 2020 owing to decreasing vanadium prices. An estimated 170 tons of contained vanadium with an estimated value of \$1.4 million was produced in 2020. Secondary vanadium production continued primarily in Arkansas, Delaware, Ohio, Pennsylvania, and Texas, where processed waste materials (petroleum residues, spent catalysts, utility ash, and vanadium-bearing pig iron slag) were used to produce ferrovanadium, vanadium-bearing chemicals or specialty alloys, vanadium metal, and vanadium pentoxide. Metallurgical use, primarily as an alloying agent for iron and steel, accounted for about 94% of domestic reported vanadium consumption in 2020. Of the other uses for vanadium, the major nonmetallurgical use was in catalysts to produce maleic anhydride and sulfuric acid.

Salient Statistics—United States:	2016	2017	2018	2019	2020^e
Production, mine, mill	—	—	—	460	170
Imports for consumption:					
Vanadium ores and concentrates	18	1	330	108	3
Ferrovanadium	1,590	2,810	2,970	2,280	1,600
Vanadium pentoxide, anhydride	2,460	3,400	4,600	3,660	2,800
Oxides and hydroxides, other	660	148	98	105	140
Aluminum-vanadium master alloys	157	288	281	222	180
Ash and residues	2,820	2,540	2,810	2,120	50
Vanadium chemicals ¹	555	607	515	201	230
Vanadium metal ²	33	54	28	45	1
Exports:					
Vanadium ores and concentrates	260	37	29	57	30
Ferrovanadium	394	229	575	295	200
Vanadium pentoxide, anhydride	5	126	563	423	80
Oxides and hydroxides, other	81	148	53	750	80
Aluminum-vanadium master alloys	53	132	90	29	30
Ash and residues	123	322	287	256	60
Vanadium metal ²	19	59	39	27	20
Consumption:					
Apparent ³	7,360	8,780	9,980	7,350	4,800
Reported	4,610	4,670	5,640	4,840	4,400
Price, average, vanadium pentoxide, ⁴ dollars per pound	3.38	7.61	16.4	12.2	6.7
Stocks, yearend ⁵	207	227	250	257	220
Net import reliance ⁶ as a percentage of apparent consumption	100	100	100	94	96

Recycling: The quantity of vanadium recycled from spent chemical process catalysts was significant and may compose as much as 40% of total vanadium catalysts.

Import Sources (2016–19): Ferrovanadium: Austria, 47%; Canada, 25%; Russia, 14%; Japan, 5%; and other, 9%. Vanadium pentoxide: Brazil, 41%; South Africa, 37%; China, 11%; Taiwan, 5%; and other, 6%.

Tariff:	Item	Number	Normal Trade Relations 12–31–20
	Vanadium ores and concentrates	2615.90.6090	Free.
	Vanadium bearing ash and residues	2620.40.0030	Free.
	Vanadium bearing ash and residues, other	2620.99.1000	Free.
	Chemical compounds:		
	Vanadium pentoxide, anhydride	2825.30.0010	5.5% ad val.
	Vanadium oxides and hydroxides, other	2825.30.0050	5.5% ad val.
	Vanadium sulfates	2833.29.3000	5.5% ad val.
	Vanadates	2841.90.1000	5.5% ad val.
	Hydrides and nitrides of vanadium	2850.00.2000	5.5% ad val.
	Ferrovanadium	7202.92.0000	4.2% ad val.
	Vanadium metal	8112.92.7000	2.0% ad val.
	Vanadium and articles thereof ⁷	8112.99.2000	2.0% ad val.

Depletion Allowance: 22% (domestic), 14% (foreign).

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Government Stockpile: None.

Events, Trends, and Issues: U.S. apparent consumption of vanadium in 2020 decreased by 35% from that of 2019. Among the major uses for vanadium, production of carbon, full-alloy, and high-strength low-alloy steels accounted for 18%, 45%, and 33%, respectively, of domestic consumption. The estimated average Chinese vanadium pentoxide price in 2020 decreased by 45% compared with the 2019 price, and the estimated United States ferrovanadium price decreased by 53% to \$10.40 per pound in 2020 compared with that in 2019.

The implementation of the new high-strength rebar standards by the Standardization Administration of China continued to be enforced inconsistently. Larger mills in China began implementation in 2018; however, smaller mills have been slower to implement the new rebar standards. In addition, substitution of ferroniobium for ferrovanadium has caused lasting effects on mills, and mills were unlikely to switch back to using ferrovanadium owing to costly technical changes already incurred.

A vanadium processing facility in South Africa reopened in early 2020 under new management and began processing stockpiled materials. A producer in Brazil that started production in 2014 continued to be on track to reach vanadium production guidance for 2020 despite production delays caused by the global COVID-19 pandemic. However, some vanadium producers have reported that they were unlikely to reach their original anticipated production guidance and were unsure of the continuing effects of the pandemic.

World Mine Production and Reserves:

	Mine production		Reserves⁸ (thousand metric tons)
	2019	2020^e	
United States	460	170	45
Australia	—	—	⁹ 4,000
Brazil	5,940	6,600	120
China	54,000	53,000	9,500
Russia	18,400	18,000	5,000
South Africa	<u>8,030</u>	<u>8,200</u>	<u>3,500</u>
World total (rounded)	86,800	86,000	22,000

World Resources:⁸ World resources of vanadium exceed 63 million tons. Vanadium occurs in deposits of phosphate rock, titaniferous magnetite, and uraniferous sandstone and siltstone, in which it constitutes less than 2% of the host rock. Significant quantities are also present in bauxite and carboniferous materials, such as coal, crude oil, oil shale, and tar sands. Because vanadium is typically recovered as a byproduct or coproduct, demonstrated world resources of the element are not fully indicative of available supplies. Although domestic resources and secondary recovery are adequate to supply a large portion of domestic needs, almost all of U.S. demand is currently met by foreign sources.

Substitutes: Steels containing various combinations of other alloying elements can be substituted for steels containing vanadium. Certain metals, such as manganese, molybdenum, niobium (columbium), titanium, and tungsten, are to some degree interchangeable with vanadium as alloying elements in steel. Platinum and nickel can replace vanadium compounds as catalysts in some chemical processes. Currently, no acceptable substitute for vanadium is available for use in aerospace titanium alloys.

^eEstimated. — Zero.

¹Includes vanadium chlorides, hydrides, nitrides, and sulfates, as well as vanadates of vanadium.

²Includes waste and scrap.

³Defined as production + imports – exports + adjustments for industry stock changes.

⁴Price for 2016 is the U.S. annual average vanadium pentoxide price. The 2017 annual average vanadium pentoxide price includes U.S. monthly averages for January to June 2017 and China monthly average prices for July to December 2017. The prices for 2018–2020 are the China annual average vanadium pentoxide prices.

⁵Includes chlorides, ferrovanadium, vanadates, vanadium-aluminum alloy, other vanadium alloys, vanadium metal, vanadium pentoxide, and other specialty chemicals.

⁶Defined as imports – exports + adjustments for industry stock changes.

⁷Aluminum-vanadium master alloy consisting of 35% aluminum and 64.5% vanadium.

⁸See Appendix C for resource and reserve definitions and information concerning data sources.

⁹For Australia, Joint Ore Reserves Committee-compliant reserves were 1.1 million tons.