VANADIUM

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

Domestic Production and Use: In 2017, 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 pentoxide, vanadium metal, and vanadium-bearing chemicals or specialty alloys. In 2009–13, small quantities of vanadium were produced as a byproduct from the mining of uraniferous sandstones on the Colorado Plateau. All byproduct vanadium production has been suspended since 2014. Metallurgical use, primarily as an alloying agent for iron and steel, accounted for about 94% of domestic vanadium consumption in 2017. Of the other uses for vanadium, the major nonmetallurgical use was in catalysts for the production of maleic anhydride and sulfuric acid.

Salient Statistics—United States:	**2013**	**2014**	**2015**	**2016**	**2017[e]**
Production, mine, mill	591	—	—	—	—
Imports for consumption:					
Ferrovanadium	3,710	3,230	1,980	1,590	3,000
Vanadium pentoxide, anhydride	2,040	3,410	2,870	2,460	2,700
Oxides and hydroxides, other	205	104	94	660	150
Aluminum-vanadium master alloys (gross weight)	169	431	204	235	480
Ash and residues	4,190	6,160	8,210	5,030	4,800
Sulfates	30	19	13	12	7
Vanadates	276	197	173	313	330
Vanadium metal[1] (gross weight)	35	161	182	45	46
Exports:					
Ferrovanadium	299	253	122	400	270
Vanadium pentoxide, anhydride	90	201	356	5	77
Oxides and hydroxides, other	407	350	100	81	120
Aluminum-vanadium master alloys (gross weight)	347	443	229	95	230
Ash and residues	4,000	2,300	370	1,100	2,700
Vanadium metal[1] (gross weight)	58	32	5	19	94
Consumption:					
Apparent[2]	6,130	10,100	12,500	8,600	7,900
Reported	3,980	4,070	3,930	3,830	3,000
Price, average, dollars per pound vanadium pentoxide	6.04	5.61	4.16	3.38	5.20
Stocks, yearend[3]	166	170	166	168	170
Net import reliance[4] as a percentage of apparent consumption	90	100	100	100	100

Recycling: The quantity of vanadium recycled from spent chemical process catalysts was significant and may compose as much as 40% of total vanadium catalysts. Some tool steel scrap was recycled primarily for its vanadium content, but this only accounted for a small percentage of total vanadium used.

Import Sources (2013–16): Ferrovanadium: Czechia, 32%; Austria, 22%; Canada, 19%; Republic of Korea, 18%; and other, 9%. Vanadium pentoxide: South Africa, 48%; Russia, 26%; China, 10%; Switzerland, 9%, and other, 7%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–17**
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.
Ferrovanadium	7202.92.0000	4.2% ad val.
Vanadium metal	8112.92.7000	2.0% ad val.
Vanadium and articles thereof[5]	8112.99.2000	2.0% ad val.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: None.

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VANADIUM

Events, Trends, and Issues: U.S. apparent consumption of vanadium in 2017 decreased by 8% from that of 2016. Among the major uses for vanadium, production of carbon, full-alloy, and high-strength low-alloy steels accounted for 16%, 44%, and 36%, respectively, of domestic consumption. U.S. imports for consumption of vanadium in 2017 increased by 10% from those of the previous year. The main increase was in imports of ferrovanadium. U.S. exports more than doubled from those of the previous year. The main increase was in exports of vanadium-bearing ash and residues.

An iron and vanadium mine in South Africa remained closed and left South Africa with only two major producers of vanadium. A company in Austria, which also received raw material from the mine in South Africa, was expected to acquire feedstock from an alternative source. The vanadium products produced at this company included aluminum-vanadium, ferrovanadium, vanadium chemicals, and vanadium oxides.

Few new vanadium operations have been commissioned in recent years, with the exception of a producer in Brazil. The producer achieved full rampup of capacity in 2017, creating new material for the market.

Research in vanadium redox battery (VRB) technology continued as VRB system installations developed worldwide. Installations were concentrated in China, Japan, North America, and Europe.

Vanadium pentoxide prices slowly increased throughout 2017. In September 2017, vanadium pentoxide prices were $5.05 per pound. Vanadium pentoxide prices in 2017 averaged $5.20 compared with $3.38 per pound in 2016. Ferrovanadium prices however, increased more substantially. In September 2017, ferrovanadium prices averaged $21.10 per pound. Prices had not been this high since November 2008. Increased environmental inspections in China have continued to temporarily, or in some cases permanently, close some vanadium producers. As availability of vanadium pentoxide has decreased, prices have increased and many major ferrovanadium producers in China have been forced to reduce production, causing ferrovanadium prices to increase.

World Mine Production and Reserves:

	Mine production		Reserves[6]
	2016	2017[e]	(thousand metric tons)
United States	—	—	45
Australia	—	—	[7]2,100
Brazil	8,000	8,400	NA
China	45,000	43,000	9,000
Russia	16,000	16,000	5,000
South Africa	10,000	13,000	3,500
World total (rounded)	79,000	80,000	20,000

World Resources: 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, 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.

[e]Estimated. NA Not available. — Zero.
[1]Vanadium metal includes waste and scrap.
[2]Defined as production + imports – exports + adjustments for industry stock changes.
[3]Includes chlorides, ferrovanadium, vanadates, vanadium-aluminum alloy, other vanadium alloys, vanadium metal, vanadium pentoxide, and other specialty chemicals.
[4]Defined as imports – exports + adjustments for industry stock changes.
[5]Aluminum-vanadium master alloy consisting of 35% aluminum and 64.5% vanadium.
[6]See Appendix C for resource and reserve definitions and information concerning data sources.
[7]For Australia, Joint Ore Reserves Committee-compliant reserves were about 1.3 million tons.