USGS
science for a changing world

2009 Minerals Yearbook

VANADIUM

U.S. Department of the Interior
U.S. Geological Survey

August 2011

VANADIUM

By Désirée E. Polyak

Domestic survey data and tables were prepared by Barbara J. McNair, statistical assistant, and the world production tables were prepared by Lisa D. Miller, international data coordinator.

In 2009, reported vanadium consumption in the United States was 5,000 metric tons (t) of contained vanadium, a slight decrease from that of 2008 (table 1). The United States exported 672 t of ferrovanadium (FeV), 401 t of vanadium pentoxide (V_2O_5), and 506 t of other oxides and hydroxides of vanadium collectively valued at $25.2 million. Total exports of these vanadium-bearing materials slightly increased from those of 2008. The United States imported (measured in vanadium content) 353 t of FeV; 1,100 t of V_2O_5; and 25 t of other oxides and hydroxides of vanadium collectively valued at $29.7 million. Total imports for consumption of these vanadium materials decreased by 77% from those of 2008. This decrease is attributed to an 87% decrease in FeV imports, a 70% decrease in V_2O_5 imports, and an 83% decrease in imports of other oxides and hydroxides.

Vanadium's primary use is as a hardening agent in steel, in which it is critical in imparting toughness and wear resistance. These properties are especially important in high-strength low-alloy steels. Catalysts represented the leading nonmetallurgical use for vanadium.

Vanadium recovery from various industrial waste materials, such as vanadium-bearing fly ash, petroleum residues, pig iron slag, and spent catalysts was the leading source of U.S. vanadium production. A small amount of vanadium was obtained as a coproduct from the mining of uraniferous sandstones on the Colorado Plateau. Fewer than 10 firms, primarily in Arkansas, Ohio, Pennsylvania, and Texas, processed waste materials to produce V_2O_5, FeV, and vanadium metal.

Production

The major vanadium commodities are aluminum-vanadium master alloys; FeV; vanadium-bearing ash, residues, and slag; vanadium chemicals; and V_2O_5 and other oxides and hydroxides of vanadium. In 2009, companies in the United States produced all of these materials with the exception of vanadium-bearing slag from the manufacture of iron and steel. Vanadium-containing steels can be subdivided into microalloy or low-alloy steels that generally contain less than 0.15% vanadium and high-alloy steels that contain as much as 5% vanadium.

Uranium production from carnotite ores creates a vanadium-bearing waste solution that must be neutralized to have the heavy metals fixed before waste disposal. An alternative treatment is a circuit which extracts vanadium and produces V_2O_5. Denison Mines Corp. (Toronto, Ontario, Canada) owns the White Mesa uranium processing mill near Blanding, UT. It processed feed from Denison's mine properties on the Colorado Plateau as well as uranium/vanadium ores purchased from independent miners. For every 0.45 kilogram (kg) of triuranium octoxide (yellow cake) produced, White Mesa's vanadium coproduct recovery circuit produced approximately 1.8 kg of vanadium in the form of V_2O_5. Approximately 554 t of V_2O_5 was produced in 2008, but output in 2009 was less than 230 t of V_2O_5. The mill was idled in May 2009, but was expected to restart in the first half of 2010. At yearend 2009, a total of 174,000 t of conventional ore containing approximately 16,300 t of V_2O_5 was stockpiled at the mill. Inventory available for sale from U.S. production was 350 t of V_2O_5 and 0.9 t of FeV (Denison Mines Corp., 2010, p. 9).

In 2008, U.S. mills consumed slightly more than 0.08 kg of vanadium per ton of steel produced, according to Strategic Minerals Corp. Inc. (Stratcor). This unit consumption was about 14% more than that of steelmakers in Western Europe, which used slightly more than 0.07 kg of vanadium per ton of steel produced. Chinese mills used only about 0.025 kg of vanadium per ton of steel produced (Metal-Pages, 2009e).

Stratcor temporarily shut down vanadium operations at its Hot Springs, AR, and Brits, South Africa, plants in December 2008 because of reduced demand for vanadium products. The Arkansas production facility was reopened at the end of January 2009. The plant was capable of producing approximately 5,400 t of high-purity V_2O_5 but was operating at 60% to 70% of capacity (Metal-Pages, 2009c). The South African operation was reopened at the end of February. In July, the operation was put on extended maintenance until the middle of October. The operation produces FeV and a proprietary nitrided vanadium product, an alloy containing 76% to 81% vanadium. Stratcor markets the product under the name Nitrovan as a replacement for FeV in the steelmaking process (Metal-Pages, 2009d).

Metallurg Vanadium Corp. closed its Cambridge, OH, FeV plant for 6 weeks starting at the end of June owing to the downturn in the world financial markets. According to the company, the plant produced 1,800 metric tons per year (t/yr) of 50% to 60% FeV (Ryan's Notes, 2009b).

Consumption

The U.S. Geological Survey (USGS) derived vanadium consumption data from a voluntary survey of domestic consuming companies. For this survey, more than 80 companies were canvassed on a monthly or annual basis. Based on USGS data, reported domestic vanadium consumption in 2009 was 5,000 t, a slight decrease from that of 2008.

Metallurgical applications continued to dominate U.S. vanadium use in 2009, accounting for 97% of reported consumption. Nonmetallurgical applications included catalysts, ceramics, electronics, and vanadium chemicals. The dominant nonmetallurgical use was in catalysts.

Most vanadium is consumed in the form of FeV, which is used as a means of introducing vanadium into steel, in which it provides additional strength and toughness. FeV is available as alloys containing either 45% to 50%, or 80% vanadium. The

45%- to 50%-grade FeV is produced by silicothermic reduction of V_2O_5 in slag or other vanadium-containing materials. Most of the 80%-grade FeV is produced by aluminothermic reduction of V_2O_5 in the presence of steel scrap or by direct reduction in an electric arc furnace.

Prices

In 2009, the price for domestic FeV, as published in Metal Bulletin, ranged from $7.40 to $35.00 per pound of contained vanadium, compared with $18.00 to $46.00 per pound reported in 2008. In early January, prices were at a high of $35.00 per pound. The price drastically decreased to $18 per pound in mid-January and in mid-February decreased again to $11.75 per pound. Prices continued to gradually decrease to a low of $7.40 per pound in May. Prices gradually increased at the end of May through September but decreased for the remainder of the year to an average of $10.75 per pound in December. The European FeV price ranged from $17.50 to $36.00 per kilogram compared with $26.00 to $93.00 per kilogram in 2008. The European price averaged $26.26 per kilogram in January, gradually decreased to a low of $17.50 per kilogram in May, and increased to a high of $36.00 in late August. The price decreased in September for the remainder of the year to an average of $21.82 per kilogram in December.

The Metal Bulletin published price for domestic V_2O_5 ranged between $3.60 and $7.60 per pound in 2009, compared with $7.20 and $18.40 per pound in 2008. The price averaged about $6.32 per pound in January and decreased to a low of $3.60 per pound in May. Prices increased to an average of $7.28 in September but then gradually decreased in October through December to end the year with an average of $6.91 in December.

World Review

Nearly all the world's supply of vanadium came from primary sources. Five countries recovered vanadium from ores, concentrates, slag, or petroleum residues (table 7). In four of the five countries, the mining and processing of magnetite-bearing ores was an important source of vanadium production. The leading vanadium-producing countries remained China, Russia, and South Africa. Japan and the United States were thought to be the only countries to recover significant quantities of vanadium from petroleum residues.

Recycling of vanadium-containing alloys for recovery of vanadium was negligible and involved mainly a small quantity of tool steel. Vanadium's major end use was as an alloying-element in iron, steel, and titanium-bearing alloys, from which it is lost to slag and not recovered when those metals are recycled. Only small quantities of vanadium were recovered from recycling vanadium-bearing catalysts and that material was reused to make new catalysts.

World vanadium reserves at more than 13 million metric tons (Mt) are sufficient to meet vanadium demand into the next century at the present rate of consumption. Increased recovery of vanadium from fly ash, petroleum residues, slag, and spent catalyst is not taken into account and is expected to extend the life of the reserves significantly. If China increased its vanadium consumption to match the average seen throughout the Western world, vanadium requirements could potentially increase by approximately 52,600 t/yr of V_2O_5 (Denison Mines Corp., 2009, p. 9).

Australia.—In February, Windimurra Vanadium Ltd. (West Perth) announced that it had been placed in receivership, and its vanadium mine in Western Australia was put on care-and-maintenance status owing to the economic downturn. In late December 2008, Windimurra acknowledged that it needed an additional $81 million for construction labor costs and pushed the operational date back to the second quarter of 2009. Windimurra has been in and out of legal disputes since former owner Xstrata Alloys Ltd. bought a 40% stake from Precious Metals Australia Ltd. and then shut down production in 2004, citing global oversupply (Ryan's Notes, 2009c). The Windimurra vanadium project, owned 90% by Windimurra and 10% by Noble Resources Ltd. (Hong Kong), included an open pit mine, processing plant, and ancillary facilities. When in full operation, the mine was expected to produce approximately 5,600 t/yr of contained vanadium (Windimurra Vanadium Ltd., 2008).

Australian junior mining company NiPlats Australia Ltd. (Perth) announced that it completed an initial beneficiation study of a potential open pit development at the Speewah vanadium project in Western Australia. The study estimated mineral resources of 851 Mt at 0.32% V_2O_5. The company announced that further studies were required to examine the cost competitiveness of the proposed operation (NiPlats Australia Ltd., 2009).

Brazil.—Largo Resources Ltd. (Toronto, Ontario, Canada) announced that it may have gained access to one of the world's largest known vanadium deposits outside of China, after it signed a 20-year lease agreement with Brazil's Companhia Baiana de Pesquisa Mineral. The property is located in the municipality of Campo Alegre de Lourdes, State of Bahia. Under the terms of the deal, Largo was expected to take a 100% stake in the property following an initial payment of approximately $250,000, payable in 5 installments during 10 months (Metal-Pages, 2009b).

Canada.—Apella Resources Inc. (Vancouver, British Columbia) commenced the next phase of exploration on its 100% owned Iron-T iron-vanadium-titanium project, which was expected to include a 10-hole diamond drilling program and detailed mapping of the Bell River Complex, near Matagami, Quebec (Apella Resources Inc., 2009).

China.—China's V_2O_5 exports decreased 71.5% to 4,296 t, while exports of FeV decreased 57.3 % to 2,503 t from that of 2008 owing to weak demand from steelmakers (Metal-Pages, 2010). The largest producing region in China is the Panzhihua area of Sichuan Province, where China's Panzhihua New Steel and Vanadium Co., Ltd. (a subsidiary of Panzhihua Iron and Steel Group) is the main operation. In 2008, an expansion increased the operations FeV production capacity to 9,000 t/yr and V_2O_5 production capacity to 18,000 t/yr, making it the world's largest-capacity vanadium operation (Metal-Pages, 2008).

The second leading vanadium producer in China is the Chengde Xinxin Vanadium & Titanium Co., Ltd., which is

associated with the steel and vanadiferous slag production at Chengde Iron and Steel Group Co., Ltd. in Hebei Province. Chengde also made significant expansions in processing capacity between 2003 and 2008 and became a significant supplier to the world market. In September, the China Securities Regulatory Commission approved the merger of Tangshan Iron & Steel Co. with Handan Iron & Steel Ltd. and Chengde Xinxin Vanadium, paving the way for Hebei Iron and Steel Group Co. Ltd., their parent company, to become China's second largest steelmaker (Zhang, 2009).

India.—The Indian Ferro Alloy Producers Association urged the Indian Finance Ministry to reconsider the 7.5% import tax on V_2O_5. They have asked that the tax be reduced to 2%, which would then be similar to the tax rate on raw materials such as chrome and manganese ore (Metal-Pages, 2009a).

Japan.—Japan's FeV output in the first quarter of 2009 decreased 71% to 305 t compared with 1,067 t in the same quarter of 2008, reflecting the sharp drop in demand from specialty steel, especially steels used in construction and machine tools. Producers cut production in the fourth quarter of 2008 because of the global economic downturn. Japanese production increased moderately in April (197 t) and May (129 t) but was still low compared with the 2008 monthly average of 290 t (Ryan's Notes, 2009a). Japan was expected to raise its standard for the amount of vanadium added to its rebar steel, which would increase its vanadium consumption in 2010.

Madagascar.—Uranium Star Corp. (Toronto, Ontario, Canada) announced that it signed an agreement with Madagascar Minerals and Resources (MMR) to purchase the remaining 25% of the Green Giant vanadium project in southwestern Madagascar from MMR for the sum of $100,000. Once the sale is completed, Uranium Star will have 100% ownership of the 194-square-kilometer (76-square-mile) property (Uranium Star Corp., 2009). Uranium Star announced plans to spend $10 million to conduct environmental, geotechnical, and metallurgical studies, as well as complete a feasibility study on its Green Giant vanadium project. The Green Giant deposit is a continuous 18-kilometer (11-mile) mineralized trend of vanadium spanning the length of the property. Uranium Star recently built a licensed airstrip on the property making it accessible year-round using private aircraft (Resource World, 2009).

Russia.—Russia is the third leading producer of vanadium worldwide and has extraction, mining, smelting, and downstream master alloy production in addition to significant users of vanadium metal. Nizhny Tagil Iron and Steel Works [a subsidiary of Evraz Group S.A. (Moscow)], completed the acquisition of OAO Vanady-Tula, the leading Russian FeV producer. Vanady-Tula accounted for 70% of Russia's 2009 vanadium production (SteelOrbis, 2009).

South Africa.—South African steel producer Highveld Steel and Vanadium Corp. Ltd. (Witbank), in which Russia's Evraz Group has a controlling stake, announced in April that Umnotho weSizwe Investment Holdings Ltd. (Johannesburg) would take a 26% interest in the Mapochs Mine, in Mpumalanga, under the country's Black Economic Empowerment program. The Mapochs Mine produces lumpy titaniferous magnetite ore, which is supplied exclusively to Vanchem Vanadium Products Pty. Ltd. (Witbank) operations to produce a variety of vanadium products. Vanchem, an independently managed division of Highveld, was expected to be transferred into Mapochs Newco (a subsidiary of Highveld). Also under the terms of the deal, a 23% equity stake in Mapochs Newco was expected to be sold to Lashka 81 Ltd., which was to change its name to Umnotho Iron and Vanadium Ltd., a subsidiary of Umnotho weSizwe (Creamer, 2009).

Outlook

Vanadium consumption is heavily influenced by steel production, high strength steel grades in particular. High strength steels are growing in use as the construction, energy, and transportation industries seek to maximize the strength and minimize the weight of their products. There is growth potential in vanadium's other end use industries as well. Aerospace applications are rapidly expanding, and vanadium consumption has been increasing with the introduction of the next generation commercial aircraft. The quest for fuel efficiency is key in the aerospace industry but also extends to automobiles, high-speed drilling, powerplants, and rail cars.

There are several different battery technologies in the process development and early commercialization stages. One technology showing promise in stabilizing energy distribution in renewable systems is the vanadium redox battery (VRB), which consists of an assembly of power cells in which two vanadium-based electrolytes are separated by a proton exchange membrane. The main advantages of the VRB are that it can offer almost unlimited capacity simply by using sequentially larger storage tanks, it can be left completely discharged for long periods of time with no ill effects, it can be recharged by replacing the electrolyte if no power source is available to charge it, and the battery suffers no permanent damage if the electrolytes are accidentally mixed (Johnstone, 2008). The VRB has also been shown to have the least ecological impact of all energy storage technologies.

There were no major new production facilities completed in 2009. Cancellation of Windimurra Mine redevelopment was the most prominent example of the impact of the economic downturn in the vanadium industry. Steel output declined by approximately 8% in 2009, causing vanadium consumption to decline sharply as well. However, the World Steel Association has predicted that steel production will increase by 8% in 2010 and approximately 6% in 2011. Given the strong outlook for global steel production, vanadium demand was expected to increase in 2010.

References Cited

Apella Resources Inc., 2009, Iron-T iron-vanadium-titanium project diamond drilling to commence: Vancouver, British Columbia, Canada, Apella Resources Inc., October 5. (Accessed June 6, 2010, at http://www.apellaresources.com/news/archive/200910.)

Creamer, Terence, 2009, Highveld unveils R540m empowerment deal for Mapochs Mine: Engineering News, April 9. (Accessed October 30, 2009, via http://www.engineeringnews.co.za.)

Denison Mines Corp., 2010, Annual report 2009: Toronto, Ontario, Canada, Denison Mines Corp., March 11, 64 p.

Johnstone, Bob, 2008, The element that could change the world: Discover, October. (Accessed August 5, 2009, at http://discovermagazine.com/2008/oct/29-the-element-that-could-change-the-world.)

Metal-Pages, 2008, Pangang completes vanadium expansion: Metal-Pages, September 29. (Accessed July 29, 2009, via http://www.metal-pages.com/news/.)
Metal-Pages, 2009a, India mulls vanadium pentoxide import tax cut: Metal-Pages, September 18. (Accessed July 29, 2010, via http://www.metal-pages.com/news/.)
Metal-Pages, 2009b, Largo hails new Brazil vanadium site deal: Metal-Pages, May 21. (Accessed June 29, 2010, via http://www.metal-pages.com/news/.)
Metal-Pages, 2009c, Stratcor reopens US vanadium pentoxide operations: Metal-Pages, January 27. (Accessed May 14, 2010, via http://www.metal-pages.com/news/.)
Metal-Pages, 2009d, Stratcor reopens Vametco vanadium operations: Metal-Pages, February 24. (Accessed May 14, 2010, via http://www.metal-pages.com/news/.)
Metal-Pages, 2009e, US steel production ranks highest in vanadium content: Metal-Pages, December 29. (Accessed June 1, 2010, via http://www.metal-pages.com/news/.)
Metal-Pages, 2010, Chinese vanadium prices slip back as demand absent: Metal-Pages, January 27. (Accessed July 21, 2010, via http://www.metal-pages.com/news/.)
NiPlats Australia Ltd., 2009, High grade vanadium concentrate produced at Speewah: Perth, Australia, NiPlats Australia Ltd., March 24, 4 p. (Accessed October 15, 2009, at http://www.niplats.com.au/images/stories/announcements/2009/nip_asx00000058_-_high_grade_vanadium.pdf.)
Resource World, 2009, Uranium Star discovers extensive vanadium mineralization: Resource World, September 2009. (Accessed January 6, 2010, at http://www.uraniumstar.com/resource_world.pdf.)
Ryan's Notes, 2009a, Ferroalloy notes: Ryan's Notes, v. 15, no. 29, July 20, p. 5.
Ryan's Notes, 2009b, Ferroalloy notes: Ryan's Notes, v. 15, no. 26, June 29, p. 4.
Ryan's Notes, 2009c, Windimurra placed on care and maintenance: Ryan's Notes, v. 15, no. 8, February 23, p. 1.
SteelOrbis, 2009, Evraz acquires Russia's largest vanadium producer Vanady-Tula: SteelOrbis, December 16. (Accessed August 5, 2010, at http://www.steelorbis.com/steel-news/latest-news/evraz-acquires-russias-largest-vanadium-producer-vanady_tula-503193.htm.)
Uranium Star Corp., 2009, Uranium Star acquires remaining 25% interest in Green Giant vanadium deposit in Madagascar: Toronto, Ontario, Canada, Uranium Star Corp., August 6. (Accessed December 11, 2009, at http://www.uraniumstar.com/news/index.php?&content_id=72.)
Windimurra Vanadium Ltd., 2008, Market update: Perth, Australia, Windimurra Vanadium Ltd., December 23, 3 p. (Accessed May 8, 2009, at http://www.pmal.com.au/aurora/assets/user_content/File/081223 Market Update.pdf.)
Zhang Qi, 2009, CSRC approves Hebei Steel merger plan: China Daily, September 22. (Accessed August 3, 2010, at http://www.chinadaily.com.cn/cndy/2009-09/22/content_8718382.htm.)

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

Vanadium. Ch. in Metal Prices in the United States Through 1998, 1999.
Vanadium. Ch. in Mineral Commodity Summaries, annual.
Vanadium. Ch. in United States Mineral Resources, Professional Paper 820, 1973.
Vanadium. International Strategic Minerals Inventory Summary Report, Circular 930–K, 1992.
Vanadium. Mineral Industry Surveys, monthly.

Other

Chemical & Engineering News.
Engineering & Mining Journal.
Metal Bulletin.
Metal Bulletin Monthly.
Roskill Information Services Ltd.
Vanadium. Ch. in Mineral Facts and Problems, U.S. Bureau of Mines Bulletin 675, 1985.

TABLE 1

SALIENT VANADIUM STATISTICS[1]

(Metric tons of contained vanadium, unless otherwise specified)

	2005	2006	2007	2008	2009
United States:					
Production, ore and concentrate:					
Recoverable vanadium	--	--	--	W [r]	W
Recoverable vanadium[2]: value thousand dollars	--	--	--	W	W
Consumption, reported	3,910	4,030	4,970	5,170 [r]	5,000
Exports:					
Ferrovanadium	500 [r]	389	154	281	672
Vanadium pentoxide (anhydride)	247 [r]	341	327	249	401
Other oxides and hydroxides of vanadium	821 [r]	832	626	1,040	506
Imports for consumption:					
Ferrovanadium	712 [r]	685 [r]	1,440 [r]	2,720 [r]	353
Ash and residues[3]	1,070 [r]	637 [r]	1,000 [r]	1,040 [r]	791
Vanadium pentoxide (anhydride)	1,370	1,920	2,390	3,700	1,120
Other oxides and hydroxides of vanadium	186	129	42	144	25
Stocks:					
Ferrovanadium	343	275	253	234	232
Oxide	2	6	22	24	24
Other[4]	26	49	48	76	58
World, production from ore, concentrate, slag[5]	56,400	57,900	58,500	56,400 [r]	54,100

[r]Revised. W Withheld to avoid disclosing company proprietary data. -- Zero.

[1]Data are rounded to no more than three significant digits.

[2]Recoverable vanadium contained in uranium and vanadium ores and concentrates received at mill, plus vanadium recovered from ferrophosphorous slag derived from domestic phosphate rock.

[3]Ash and residues from the manufacture of iron and steel.

[4]Consists principally of vanadium-aluminum alloy, small quantities of other vanadium alloys, vanadium metal, and ammonium metavanadate.

[5]Excludes U.S. production.

TABLE 2

U.S. CONSUMPTION OF VANADIUM, BY END USE AND FORM[1]

(Kilograms of contained vanadium)

	2008	2009
End use:		
Steel:		
Carbon	1,010,000 r	832,000
Full alloy	2,030,000 r	1,920,000
High-strength low-alloy	W r	W
Stainless and heat resisting	116,000	119,000
Tool	152,000 r	418,000
Total	3,310,000 r	3,290,000
Cast irons	W	W
Superalloys	39,000 r	12,800
Alloys (excluding steels and superalloys):		
Welding and alloy hard-facing rods and materials	W	W
Other alloys[2]	W	W
Chemical and ceramic uses:		
Catalysts	W	W
Pigments	W	W
Miscellaneous and unspecified	1,830,000 r	1,700,000
Grand total	5,170,000 r	5,000,000
Form:		
Ferrovanadium	4,190,000 r	3,910,000
Oxide	92,500 r	358,000
Other[3]	893,000 r	732,000
Total	5,170,000 r	5,000,000

rRevised. W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous and unspecified."

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Includes magnetic alloys.

[3]Consists principally of vanadium-aluminum alloy, small quantities of other vanadium alloys, vanadium metal, and ammonium metavanadate.

TABLE 3
U.S. IMPORTS AND EXPORTS OF ALUMINUM-VANADIUM MASTER ALLOY AND VANADIUM METAL, INCLUDING WASTE AND SCRAP[1]

	Aluminum-vanadium master alloy		Vanadium metal, including waste and scrap	
	Quantity, gross weight (kilograms)	Value	Quantity, gross weight (kilograms)	Value
Imports for consumption:				
2008	618,000	$2,760,000	4,600	$409,000
2009:				
Belgium	34,600	158,000	3	6,890
Canada	--	--	312	110,000
China	--	--	38	18,400
Germany	--	--	21,300	805,000
Mexico	194,000	592,000	--	--
Netherlands	53,400	230,000	--	--
Total	282,000	979,000	21,700	940,000
Exports:				
2008	21,900,000	76,200,000	57,100	3,740,000
2009:				
Belgium	16,300	475,000	--	--
Brazil	3,790	77,800	--	--
Canada	1,800,000	4,940,000	--	--
China	6,190	64,300	--	--
Egypt	2,170	28,200	--	--
France	1,270	16,500	10	8,420
Germany	2,030	29,400	--	--
Guyana	8,180	50,200	--	--
India	649	1,580	--	--
Ireland	5,170	50,300	--	--
Israel	2,540	37,400	--	--
Japan	13,500	382,000	20,900	919,000
Kuwait	--	--	764	30,000
Malaysia	273	1,580	--	--
Mexico	9,190,000	20,200,000	--	--
Philippines	292	1,580	--	--
Russia	--	--	1,060	81,900
Saudi Arabia	350	9,550	--	--
Singapore	735	17,000	--	--
South Africa	194	1,580	--	--
Spain	291	20,500	--	--
United Kingdom	111,000	1,310,000	--	--
Total	11,200,000	27,800,000	22,700	1,040,000

-- Zero

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

Source: U.S. Census Bureau.

TABLE 4
U.S. IMPORTS AND EXPORTS OF FERROVANADIUM, VANADIUM PENTOXIDE (ANHYDRIDE), AND OTHER OXIDES AND HYDROXIDES OF VANADIUM[1]

	Ferrovanadium		Vanadium pentoxide (anhydride)[2]		Other oxides and hydroxides of vanadium	
	Quantity, V content (kilograms)	Value	Quantity, V content (kilograms)	Value	Quantity, V content (kilograms)	Value
Imports for consumption:						
2008	2,720,000 r	$158,000,000	3,700,000	$115,000,000	144,000	$4,320,000
2009:						
Australia	--	--	--	--	8,390	231,000
Austria	48,800	1,160,000	8,380	148,000	16,800	320,000
Brazil	535	48,700	--	--	--	--
Canada	197,000	7,390,000	--	--	--	--
China	--	--	174,000	3,130,000	--	--
Germany	2,020	133,000	126	9,840	--	--
India	2,620	106,000	--	--	--	--
Kazakhstan	395	14,200	--	--	--	--
Korea, Republic of	101,000	3,780,000	--	--	--	--
Russia	--	--	322,000	4,000,000	--	--
South Africa	--	--	581,000	8,540,000	--	--
Sweden	196	7,020	--	--	--	--
Taiwan	--	--	33,700	668,000	--	--
United Kingdom	--	--	2,500	38,500	--	--
Total	353,000	12,600,000	1,120,000	16,500,000	25,200	551,000
Exports:						
2008	281,000	12,600,000	249,000	5,650,000	1,040,000	11,300,000
2009:						
Argentina	66,400	713,000	3,100	58,500	1,200	8,380
Austria	--	--	3,270	45,400	--	--
Brazil	23,700	580,000	61,600	774,000	14,300	127,000
Canada	139,000	3,670,000	--	--	144,000	1,310,000
China	87,100	1,650,000	37,100	330,000	12,000	107,000
France	30,700	594,000	17,900	277,000	--	--
Germany	--	--	11,200	191,000	12,100	167,000
India	54,400	1,440,000	--	--	19,000	290,000
Italy	--	--	14,400	337,000	--	--
Japan	81	4,820	16,000	243,000	11,800	122,000
Korea, Republic of	86,900	2,000,000	19,200	165,000	18,300	214,000
Mexico	53,500	1,420,000	3,100	57,300	--	--
Netherlands	121,000	2,570,000	82,800	1,310,000	273,000	2,920,000
Saudi Arabia	--	--	10,800	184,000	--	--
Singapore	--	--	--	--	362	3,230
South Africa	--	--	76,800	324,000	--	--
Spain	--	--	25,500	292,000	--	--
Trinidad and Tobago	--	--	13,900	242,000	--	--
United Kingdom	--	--	36	4,430	--	--
Venezuela	8,610	307,000	4,010	136,000	--	--
Total	672,000	15,000,000	401,000	4,970,000	506,000	5,270,000

rRevised. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]May include catalysts that contain vanadium pentoxide.

Source: U.S. Census Bureau.

TABLE 5

U.S. IMPORTS FOR CONSUMPTION OF VANADIUM-BEARING ASH AND RESIDUES[1]

Material and country	2008 Quantity, V_2O_5[2] content (kilograms)	2008 Value	2009 Quantity, V_2O_5[2] content (kilograms)	2009 Value
Ash and residues:[3]				
Canada	13,200	$4,700	2,250	$4,850
Mexico	1,030,000	18,000,000	788,000	12,300,000
United Kingdom	--	--	120	2,210
Total	1,040,000	18,000,000	791,000	12,300,000

-- Zero

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]V_2O_5 Vanadium pentoxide.

[3]Ash and residues from the manufacture of iron and steel.

Source: U.S. Census Bureau.

TABLE 6

U.S. IMPORTS FOR CONSUMPTION OF MISCELLANEOUS VANADIUM CHEMICALS[1, 2]

Material and country	2008 Quantity, V[3] content (kilograms)	2008 Value	2009 Quantity, V[3] content (kilograms)	2009 Value
Sulfates:				
China	2,010	$88,800	16,500	$182,000
India	150	30,500	--	--
Total	2,160	119,000	16,500	182,000
Vanadates:				
China	3,280	97,700	167	3,250
Germany	659	37,700	12,500	473,000
India	99	13,800	137	12,100
Japan	395	43,400	--	--
South Africa	160,000	3,800,000	182,000	2,550,000
United Kingdom	23,000	240,000	19,800	352,000
Total	187,000	4,230,000	214,000	3,390,000

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Comprises vanadium ore and miscellaneous vanadium chemicals.

[3]Vanadium.

Source: U.S. Census Bureau.

TABLE 7
VANADIUM: ESTIMATED WORLD PRODUCTION, BY COUNTRY[1, 2]

(Metric tons, vanadium content)

Country	2005	2006	2007	2008	2009
Production from ores, concentrates, slag:[3]					
Australia	100	--	--	--	--
China[4]	17,000	17,500	19,000	20,000	21,000
Kazakhstan	1,000	1,000	1,000	1,000	1,000
Russia	15,100	15,100	14,500	14,500	14,500
South Africa	22,604 [5]	23,780 [5]	23,486 [5]	20,295 [r, 5]	17,000
Total	55,800	57,400	58,000	55,800 [r]	53,500
Japan, petroleum residues, ash, and spent catalysts[6]	560	560	560	560	560
Grand total	56,400	57,900	58,500	56,400 [r]	54,100

[r]Revised. -- Zero.

[1]World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]In addition to the countries listed, vanadium is also recovered from petroleum residues in Germany and several other European countries, but available information is insufficient to make reliable estimates. Table includes data available through May 27, 2010.

[3]Production in this section is credited to the country that was the origin of the vanadiferous raw material.

[4]Estimated 40% of vanadium recovered from vanadiferous slag.

[5]Reported figure.

[6]Production in this section is credited to the country where the vanadiferous product is extracted; available information is inadequate to permit crediting this output back to the country of origin of the vanadiferous raw material.