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2005 Minerals Yearbook

VANADIUM

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

January 2007

VANADIUM

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In 2005, reported vanadium consumption in the United States was 3,910 metric tons (t) of contained vanadium, a 3% decrease from that of 2004. The United States imported 11,900 t of ferrovanadium (FeV), measured in vanadium content, 1,370 t of vanadium pentoxide (V_2O_5), and 186 t of other oxides and hydroxides of vanadium, collectively valued at $190 million. Total imports for consumption of these vanadium materials increased by 222% from those of 2004, driven largely by FeV imports. The United States exported 504 t of FeV, 254 t of V_2O_5, and 899 t of other oxides and hydroxides of vanadium valued at $40.2 million. Total exports of these vanadium-bearing materials increased by 49% from those of 2004.

Vanadium was produced in the United States solely by recovery of vanadium from various industrial waste materials, such as vanadium-bearing fly ash, petroleum residues, pig iron slag, and spent catalysts. Fewer than 10 firms, primarily in Arkansas, Louisiana, and Texas, processed these materials to produce V_2O_5, FeV, and vanadium metal. Metallurgical applications in which vanadium was used as an alloying element with iron, steel, and titanium remained the dominant end use. Catalysts represent the leading nonmetallurgical use for vanadium.

Legislation and Government Programs

Ferrovanadium antidumping duties levied against China, Russia, and South Africa, the three leading vanadium producers in the world, continued to be enforced. On July 10, 1995, the U.S. Department of Commerce (DOC) issued an antidumping order on FeV and nitrided vanadium imports from Russia. Following the latest 5-year review, the DOC issued a continuation of the antidumping duty order on these Russian imports, which had been made effective June 7, 2001. The next 5-year review of the antidumping duty order on Russian FeV and nitrided vanadium will be effective May 1, 2006 (U.S. International Trade Commission 2006§[1]).

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 2005, 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.

With the closure of the CS Metals of Louisiana LLC. catalyst recycling facility in Covenant, LA, in December 2004, Strategic Minerals Corp. (Stratcor) made other arrangements for vanadium to replace the 10% of their feedstock that CS Metals had provided. CS Metals had the capacity to recover about 1,800 metric tons per year (t/yr) (4 million pounds per year) of V_2O_5 from spent catalysts, but market sources doubted the company had been operating at above 50% of capacity. Stratcor reopened its Vametco Mine in Britts, South Africa, to supplement other feed sources for its South African ferrovanadium plant. Stratcor's contract for purchase of vanadium-bearing slag from Highveld Steel and Vanadium Corp. Ltd. runs through 2006, and Stratcor had other slag sources as well (Ryan's Notes, 2005a).

Stratcor, Danbury, CT, announced plans to consolidate its vanadium chemicals production operations at a new vanadium-halide facility under construction at its Hot Springs, AR, facility. The new facility, expected to be ready by early 2006, would replace an existing facility at Niagara Falls, NY. The consolidation was expected to streamline chemical operations because the Hot Springs facility already supplied the V_2O_5 feedstock for the Niagara Falls facility. The vanadium halides (vanadium oxytrichloride, vanadium tetrachloride, and vanadium-titanium mixes) are used to make catalysts for the production of polyethylene, synthetic rubber, and other chemicals (Ryan's Notes, 2005b).

Eramet International Group, Paris, France, announced that its subsidiary Gulf Chemical & Metallurgical Corp. acquired 100% of Bear Metallurgical Co. (BMC), Butler, PA. BMC, the leading FeV and the second ranked ferromolybdenum (FeMo) producer in the United States, had operated as a toll converter. Gulf, a catalyst recycler, previously owned 49.5% of BMC (Ryan's Notes, 2005d).

Northwestern Mineral Ventures Inc., Toronto, Ontario, Canada, acquired 100% ownership of the Firefly uranium-vanadium project in Utah's La Sal uranium district. The Firefly project included the Firefly and Gray Duran Mines and 39 mining claims. The Firefly and Gray Duran Mines produced uranium for about 25 years starting in 1953 and coproduced vanadium ore that contained more than 2% V_2O_5. The company's objective was to return the Firefly Mine to production, pending completion of an engineering study and obtaining permits (Platts Metals Week, 2005b).

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 and/or annual basis. Some

[1] References that include a section mark (§) are found in the Internet References Cited section.

industry estimates indicate that actual domestic consumption is much greater than reported consumption.

Metallurgical applications continued to dominate U.S. vanadium use in 2005, accounting for 93% of reported consumption. Nonmetallurgical applications included catalysts, ceramics, electronics, and vanadium chemicals. The dominant nonmetallurgical use was in catalysts. Based on USGS data, reported domestic vanadium consumption in 2005 was 3,910 t, a decrease of 3% from that of 2004. This slight decline in reported vanadium consumption reflected stable demand by steel producers, with reduced FeV imports from China, Russia, and South Africa, owing to antidumping duties, being offset by imports of FeV from the Czech Republic.

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

Prices

In 2005, the price for domestic FeV, as published in Metal Bulletin, ranged from $22.00 to $61.00 per pound of contained vanadium, compared with $6.20 to $23.00 per pound reported in 2004. The price rose from about $22.00 per pound at the beginning of the year in January, gradually increased to about $43.00 per pound by the end of April, spiked to about $61.00 per pound in May, and then gradually dropped down to $22.00 per pound in December. The European FeV price ranged from $34.00 to $128.00 per kilogram compared with $14.70 to $52.00 per kilogram in 2004. The European price rose gradually from about $48.00 per kilogram at the beginning of the year in January, spiked to about $128.00 per kilogram in April, dropped to about $34.00 per kilogram in August, and rebounded to about $63.00 per kilogram through October before drifting down to $43.00 per kilogram in December.

The Metal Bulletin published price for domestic V_2O_5 ranged between $7.50 and $27.00 per pound in 2005, compared with $2.75 and $9.80 per pound in 2004. The price rose gradually from $9.50 per pound in January to spike at $27.00 per pound in June, then dropped to $7.50 per pound in August, and rose to about $14.00 per pound by November before drifting down to about $10.00 per pound in December.

World Industry Structure

Nearly all of the world's supply of vanadium is 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 nations remained China and South Africa. Japan and the United States were believed 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 Review

Australia.—Precious Metals Australia Ltd. (PMA) won a small victory in its effort to seek damages against Xstrata, Plc. for mothballing the Windimurra Mine in Western Australia in December 2002. Xstrata Alloys (a subsidiary of Xstrata, Plc.) agreed to pay PMA A$10 million to cover royalty payments and final rehabilitation of the Windimurra site and A$5 million in full and final settlement of all outstanding claims by PMA related to Windimurra. In a separate transaction, Xstrata sold the tenements, remaining Windimurra project assets, and all project information to PMA. The transaction was conditional on the Western Australian government approving the transfers and necessary releases within the next 6 months. Industry sources doubted that PMA could reopen Windimurra any time soon (Ryan's Notes, 2005h).

PMA selected The Hatch Group to study the feasibility of reopening the closed Windimurra Mine in Western Australia. The first stage, which was completed in December, identified process and plant design options and estimated capital and operating costs. The second phase, to be completed by May 2006, would finalize the engineering design and update cost estimates. Hatch would also analyze market risks and strategy and prepare a new ore reserve estimate. PMA had previously announced that the reopened Windimurra project would exceed Windimurra's previous capacity of 7,700 t/yr (17 million pounds per year) of V_2O_5 (Platts Metals Week, 2005d).

PMA, West Perth, Australia, raised A$13.3 million (US$10.2 million) to reopen the Windimurra Mine in Western Australia. The funds were raised by placement of 19 million additional shares in the company by international investors. PMA also sought a listing on the London Stock Exchange's Alternative Investment Market. The new funds were for assessment of the feasibility of redeveloping Windimurra, for purchasing plant equipment for redevelopment, and for working capital. PMA planned to add a FeV conversion facility at Windimurra and increase the project's capacity to the equivalent of 10,000 t/yr (20 million to 22 million pounds per year) of V_2O_5 (Platts Metals Week, 2005c).

Aurox Resources Limited hoped to become a low-cost vanadium producer by developing the Balla Balla vanadium-titanium-iron ore deposit in northwestern Western Australia. Aurox agreed to pay A$200,000 (US$156,000) for an option on Balla Balla. Identified resources at the site were 75 million metric tons of ore grading 0.8% V_2O_5 with the potential to produce 4,000 t/yr of FeV. Under the terms of the agreement,

Aurox secured an exclusive 6- to 9-month review period prior to deciding whether to proceed with a bankable feasibility study (Platts Metals Week, 2005a).

Canada.—Metallurg Vanadium Corp. announced plans to build a spent-catalyst calcining facility in Alberta, to process spent catalysts from the Alberta tar sands projects. In addition, Metallurg planned to expand its FeV and ferronickel-molybdenum production capability at its Cambridge, OH, processing facility. The Alberta facility would provide additional feed material to the expanded Cambridge operation, although Metallurg did not specify how much additional capacity would be added. Both projects were expected to be completed by the end of 2007 (Ryan's Notes, 2005f).

Gulf also announced plans to build a new catalyst recycling facility in Edmonton, Alberta to process spent catalysts from Canadian oil sands refining. Residues recovered at the new facility would be converted to FeV and FeMo at BMC in Butler, PA, allowing Gulf to quickly double its FeV and FeMo production after the new facility comes online (Ryan's Notes, 2005d).

China.—Chinese vanadium producer Chengde Xinxin Vanadium & Titanium Co., Ltd. produced more than 2,100 t of V_2O_5 in the first half of 2005 from vanadium-bearing slag residues, up by 8% from that of the first half of 2004. The company expected to produce about 6,000 t during the full year owing to increased steel production by its parent company, Chengde Iron & Steel Group Co., Ltd. About two-thirds of the V_2O_5 was used internally in the production of FeV, and the remainder was exported (Ryan's Notes, 2005b).

Six new V_2O_5 smelters were being constructed in the Dunhuang area of northwestern Gansu Province, China, with a reported total capacity of 3,000 t/yr. The smelters were to be supported by the Fangshankou Mine, China's fourth largest vanadium deposit (Metal Pages, 2005b§).

Czech Republic.—Negotiations for the purchase of V_2O_5-to FeV-converter Nikom A.S. started with Russian producer JSC Vanadii-Tulachermet (Tula) and Glencore International AG (which markets production from Xstrata) engaged in talks with Nikom's owners. The majority of Nikom's 3,500-t/yr FeV production capacity was being used by Tula, because Tula did not have sufficient conversion capacity in Russia. Antidumping duties placed on vanadium material imported into the United States from Russia increased the plant's strategic significance to the vanadium market (Metal Bulletin, 2005a).

Japan.—In a joint venture with Mitsubishi Corporation and Kashina Kyodo Power, JFE Material Co., Ltd., announced plans to begin production of 2,000 t/yr of FeV and 2,000 t/yr of FeMo and ferronickel in January 2006. Mitsubishi and Kashina will supply vanadium-bearing spent desulfurization catalysts and boiler residues to the joint venture, Metal Technology Inc., and the FeV and FeMo products will be sold to JFE Steel Corporation and other affiliated specialty steel plants. JFE Material estimated that 140,000 t/yr of these vanadium-bearing wastes was available in Japan and expected to process about 40,000 t/yr in the new plant (Ryan's Notes, 2005e).

Russia.—When it purchased 50% of Nikom for $1.5 million, Tula not only strengthened its position in the vanadium market, it also changed the dynamics of the Russian vanadium industry. The deal gave Tula exclusive rights to convert V_2O_5 to FeV at Nikom's plant, effectively eliminating the possibility of traders converting material for sale on the free market. Tula also announced plans to invest in Nikom to create a reliable warehouse facility in Europe to improve the logistics of supply (Metal Bulletin, 2005b).

Tula is believed to have FeV capacity of 10,700 t/yr. Russian exports of FeV totaled 8,670 t in 2004, up by 50% from those of 2003. Russian exports of V_2O_5 in 2004 totaled 3,000 t, about the same as in 2003 (Ryan's Notes, 2005c).

South Africa.—Vanadium producers agreed that plant and mine closures, along with a surge in demand, helped boost prices in 2004. With prices elevated, some producers explored ways to increase output. Highveld Steel and Vanadium Corp. Ltd. reported that all three of its kilns at its Vanchem facility near Witbank operated during 2004, with stoppages only for annual maintenance. The company started a capital improvement program aimed at upgrading plant and equipment in the kiln and oxide areas to improve efficiencies and debottleneck. Highveld announced plans to increase vanadium production capacity by 30% by the end of 2006 from 10,000 t/yr of contained vanadium (Metal Pages, 2005c§).

Xstrata told analysts that its fully integrated Rhovan vanadium operation was well positioned to capitalize on future expansion options. Sources believe that Xstrata increased production at Rhovan to compensate for lost production when it permanently closed its Vantech V_2O_5 plant in South Africa in 2004. Rhovan's production capacity is about 10,000 t/yr of V_2O_5 and 7,800 t/yr of FeV (Ryan's Notes, 2005g).

Current Research and Technology

McKenzie Bay International Ltd., owner of North America's largest vanadium deposit, hired Brooks, Houghton & Co. Inc. to look at options for its Lac Dore Mining Inc., subsidiary. Potential options included sale of the company, the 443 contiguous mining claims for the Lac Dore deposit, and proprietary refining technology developed during the feasibility study (Metal Pages, 2005a§). McKenzie Bay decided to focus on its WindStor renewable-energy generation, storage, and distribution system and would use any funds generated by the sale for the pending commercialization of WindStor. The WindStor system combines Dermond Inc.'s vertical axis wind turbine, called the WindStor Wind Turbine (WWT), with a vanadium-base battery storage system and a proprietary system integrator to provide stored electricity to users (McKenzie Bay International Ltd., 2004§).

Outlook

Vanadium's primary use was as a hardening agent in steel. Raw steel production in China rose by 25% to 350 million metric tons (Mt) in 2005, pushing global raw steel production to 1.13 billion metric tons, a 6% increase compared with the 2004 record-high production (Advanced Steel News, 2006§). The surge in global steel production increased demand for vanadium and drove prices for domestic V_2O_5 to a record $27.00 per pound in May. World production of vanadium rose by more than 13%

to 59,000 t of contained vanadium (230 million pounds of V_2O_5) in 2005. With steel production expected to be strong for the next 3 to 5 years, strong demand for vanadium should be sustained.

The capacity to recover vanadium from catalysts, petroleum residues, and slag worldwide was estimated to be 81,700 t/yr (180 million pounds per year) of V_2O_5, and primary mines add another 24,500 t/yr (54 million pounds per year) of V_2O_5 capacity (Ryan's Notes, 2004). As a result of production capacity increases from expansions, increased world demand is expected to be satisfied from existing resources for the foreseeable future.

Because of abundant resources and adequate production capacity in China, Russia, and South Africa, world producers are expected to readily meet future vanadium requirements. Increased recovery of vanadium from fly ash, petroleum residues, slag, and spent catalyst is also expected.

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TABLE 1
SALIENT VANADIUM STATISTICS[1]

(Metric tons of contained vanadium, unless otherwise specified)

	2001	2002	2003	2004	2005
United States:					
Production, ore and concentrate:					
Recoverable vanadium:[2]					
Value thousand dollars	--	--	--	--	--
Vanadium oxide recovered from ore[3]	--	--	--	--	--
Consumption	3,210	3,080	3,240	4,050	3,910
Exports:					
Ferrovanadium	70	142	397 r	285	504
Vanadium pentoxide (anhydride)	71 r	91 r	185 r	240 r	254
Other oxides and hydroxides of vanadium	63 r	203 r	284 r	584 r	899
Imports for consumption:					
Ferrovanadium	2,550	2,520	1,360 r	3,020 r	11,900
Ore, slag, ash, residues	1,670	1,870	3,060 r	2,350 r	1,690
Vanadium pentoxide (anhydride)	600	406	474 r	1,040 r	1,370
Other oxides and hydroxides of vanadium	57	66	74	120 r	186
Stocks:					
Ferrovanadium	239	212 r	213 r	320 r	343
Oxide	6 r	7 r	6	6	2
Other[4]	13 r	14 r	33 r	10 r	26
World, production from ore, concentrate, slag	41,800 r	51,000 r	47,900 r	51,900 r	58,800 e

eEstimated. rRevised. -- Zero.

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

[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]Produced directly from all domestic ores and ferrophosphorous slag; includes metavanadates.

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

TABLE 2
U.S. CONSUMPTION OF VANADIUM, BY END USE AND FORM[1]

(Kilograms of contained vanadium)

	2004	2005
End use:		
Steel:		
Carbon	1,300,000	1,170,000
Full alloy	1,060,000	1,010,000
High-strength low-alloy	1,160,000	974,000
Stainless and heat resisting	60,000	60,000
Tool	239,000	402,000
Total	3,820,000	3,620,000
Cast irons	W	W
Superalloys	16,600	35,600
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	215,000 r	259,000
Grand total	4,050,000 r	3,910,000
Form:		
Ferrovanadium	3,610,000 r	3,290,000
Oxide	269,000	344,000
Other[3]	180,000	274,000
Total	4,050,000 r	3,910,000

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:				
2004	19,100	$66,700	31,200	$1,710,000
2005:				
China	1,000	2,370	--	--
Germany	--	--	44,500	2,490,000
Mexico	--	--	379	3,120
Russia	--	--	9,920	1,310,000
United Kingdom	10	13,100	1	2,310
Total	1,010	15,500	54,800	3,800,000
Exports:				
2004	14,600,000 r	32,200,000 r	522,000	7,760,000
2005:				
Australia	105,000	436,000	901	51,800
Austria	--	--	8,950	389,000
Barbados	270	3,500	--	--
Belgium	49,400	802,000	5,000	185,000
Brazil	55,800	289,000	--	--
Canada	1,930,000	6,590,000	1,850	51,900
China	27,900	303,000	--	--
Denmark	702	9,130	--	--
France	23,800	80,900	5,320	381,000
Germany	4,780	96,200	2,950	498,000
Guatemala	1,080	11,800	--	--
Hong Kong	683	8,890	--	--
India	125,000	354,000	--	--
Ireland	1,740	22,700	--	--
Israel	--	--	35	41,800
Italy	1,510	7,850	--	--
Japan	514,000	7,540,000	108,000	5,330,000
Korea, Republic of	18,800	119,000	150	9,950
Malaysia	14,900	117,000	--	--
Mexico	11,500,000	25,300,000	2,980	188,000
Spain	4,700	52,000	--	--
Switzerland	906	11,300	3	13,600
Taiwan	124,000	581,000	--	--
Thailand	389,000	1,830,000	--	--
United Kingdom	165,000	1,030,000	156,000	9,250,000
Total	15,100,000	45,600,000	293,000	16,400,000

rRevised. -- 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:						
2004	3,020,000 r	$62,100,000	1,040,000 r	$8,600,000	120,000 r	$1,650,000
2005:						
Australia	19,000	916,000	40,300	1,450,000	--	--
Austria	86,500	6,560,000	16,600	856,000	67,500	4,700,000
Canada	194,000	12,000,000	--	--	--	--
China	100,000	168,000	209,000	9,040,000	--	--
Czech Republic	11,000,000	88,900,000	--	--	--	--
Germany	974	73,100	166	12,400	5,340	178,000
Japan	32,700	735,000	182	39,200	--	--
Korea, Republic of	74,000	5,130,000	--	--	--	--
Russia	--	--	25,100	647,000	--	--
South Africa	--	--	1,050,000	40,000,000	113,000	1,660,000
Swaziland	356,000	16,500,000	--	--	--	--
Sweden	400	16,900	--	--	--	--
Taiwan	--	--	27,300	858,000	--	--
United Kingdom	1,200	135,000	--	--	--	--
Total	11,900,000	131,000,000	1,370,000	52,900,000	186,000	6,540,000
Exports:						
2004	285,000	9,210,000	240,000 r	4,350,000 r	584,000 r	6,230,000
2005:						
Australia	170	8,450	--	--	--	--
Austria	17,200	989,000	4,060	157,000	24,400	217,000
Argentina	--	--	100	4,790	--	--
Belgium	--	--	22,400	606,000	--	--
Brazil	35,800	4,510,000	--	--	11,500	160,000
Canada	109,000	2,470,000	--	--	452,000	4,310,000
China	63,700	3,590,000	--	--	19,300	244,000
Denmark	--	--	327	11,300	--	--
France	--	--	11,200	102,000	--	--
Germany	--	--	12,500	424,000	15,000	1,080,000
Italy	--	--	109,000	2,190,000		
Japan	--	--	--	--	708	6,300
Latvia	--	--	18,000	580,000	--	--
Mexico	206,000	5,070,000	9,360	121,000	--	--
Netherlands	49,400	1,940,000	--	--	37,000	560,000
New Zealand			320	11,900		
Russia	--	--	7,680	218,000	306,000	8,540,000
South Africa	--	--	4,130	36,000	--	--
Spain	--	--	18,800	549,000	--	--
Trinidad and Tobago	--	--	28,400	307,000	11,400	88,000
United Kingdom	--	--	--	--	8,510	75,700
Venezuela	21,800	728,000	8,000	156,000	13,500	139,000
Total	504,000	19,300,000	254,000	5,470,000	899,000	15,400,000

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, RESIDUES, AND SLAG[1]

Material and country	2004 Quantity, V_2O_5 content (kilograms)[r]	2004 Value	2005 Quantity, V_2O_5 content (kilograms)	2005 Value
Ash and residues:				
Canada	2,110,000	$1,920,000	1,200,000	$1,100,000
Guatemala	50,500	89,400	--	--
Mexico	946,000	8,430,000	1,060,000	9,820,000
South Africa	277	4,950	--	--
United Kingdom	16,300	80,800	--	--
Total	3,120,000	10,500,000	2,270,000	10,900,000
Slag, from the manufacture of iron and steel, South Africa[2]	1,080,000	1,290,000	756,000	1,510,000

[r]Revised. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]As adjusted by the U.S. Geological Survey.

Source: U.S. Census Bureau.

TABLE 6
U.S. IMPORTS FOR CONSUMPTION OF MISCELLANEOUS VANADIUM CHEMICALS[1, 2]

Material and country	2004 Quantity, V content (kilograms)	2004 Value	2005 Quantity, V content (kilograms)	2005 Value
Sulfates:				
China	500	$19,100	--	--
South Africa	--	--	35,000	$77,000
Total	500	19,100	35,000	77,000
Vanadates:				
Canada	4,260 [r]	178,000	--	--
China	--	--	49	3,530
Germany	4,870 [r]	223,000	27,100	808,000
Japan	178 [r]	31,900	118	22,800
Korea, Republic of	--	--	11,800	76,800
Russia	--	--	4	2,640
South Africa	65,400 [r]	718,000	46,000	1,880,000
Switzerland	--	--	1	2,010
Total	74,700 [r]	1,150,000	85,100	2,800,000

[r]Revised. -- 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.

Source: U.S. Census Bureau.

TABLE 7

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

(Metric tons of contained vanadium)

Country	2001	2002	2003	2004	2005
Production from ores, concentrates, slag:[3]					
Australia	2,660 [4]	3,060 [4]	160 [4]	150 [r, 4]	100
China[5]	12,000	13,200	13,200	16,000 [r]	17,000
Kazakhstan	1,000	1,000	1,000	1,000	1,000
Russia	7,500	8,000	5,800	10,900 [r]	15,100
South Africa	18,184 [4]	25,227 [r, 4]	27,172 [r, 4]	23,302 [r, 4]	25,000
Total	41,300	50,500 [r]	47,300 [r]	51,400 [r]	58,200
Production from petroleum residues, ash spent catalysts:[6]					
Japan	499 [r]	499 [r]	560 [r]	560 [r]	560
Grand total	41,800 [r]	51,000 [r]	47,900 [r]	51,900 [r]	58,800

[r]Revised.

[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 June 7, 2006.

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

[4]Reported figure.

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

[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.