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2006 Minerals Yearbook

VANADIUM

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VANADIUM

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In 2006, reported vanadium consumption in the United States was 4,030 metric tons (t) of contained vanadium, a 3% increase from that of 2005. The United States imported 2,140 t of ferrovanadium (FeV), measured in vanadium content, 1,920 t of vanadium pentoxide (V_2O_5), and 129 t of other oxides and hydroxides of vanadium, collectively valued at $139 million. Total imports for consumption of these vanadium materials decreased by 69% from those of 2005, as FeV imports dropped to normal levels. The United States exported 389 t of FeV, 341 t of V_2O_5, and 832 t of other oxides and hydroxides of vanadium valued at $26.3 million. Total exports of these vanadium-bearing materials were about the same as those of 2005.

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

The International Trade Commission (ITC) initiated a 5-year sunset review of the antidumping duty order on Russian FeV and nitrided vanadium in May. The ITC expedited the review in August and decided to maintain the antidumping duty after completing the review in September (Metal-Pages Ltd., 2006b). The U.S. Department of Commerce (DOC) published notice of the continuation of the antidumping duty order on October 19, citing the possibility of "material injury to an industry in the United States within a reasonably foreseeable time." The DOC issued the original order on July 10, 1995. The next 5-year review of the antidumping duty order on Russian FeV and nitrided vanadium will be effective May 1, 2011 (Metal-Pages Ltd., 2006c).

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 2006, 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.

Stratcor Inc. reported the first shipment of vanadium-halide catalysts from its new plant in Hot Springs, AR. In October 2005, Stratcor announced plans to consolidate all its vanadium production operations at the Hot Springs facility. Its former vanadium-halide plant in Niagara Falls, NY, closed in February 2006. In addition to vanadium–halides, the Hot Springs facility will continue to produce ammonium metavanadate, high-purity V_2O_5, and vanadium trioxide, which are used to produce FeV, vanadium-aluminum alloys, and vanadium chemicals (Ryan's Notes, 2006d).

Evraz Group S.A. (Luxembourg) agreed to buy a 73% equity stake in Stratcor Inc. (Danbury, CT) for about $110 million. Stratcor executives previously held the purchased shares, and the remaining shares will continue to be held by Sojitz Corp. (Japan). Evraz, the leading vanadium slag producer in Russia, lacked any processing facilities to recover V_2O_5 from the slag. This acquisition will allow Evraz access to Stratcor's proprietary Nitrovan ferrovanadium production technology at its Britts, South Africa, facility, and also its vanadium chemical production facilities at Hot Springs, AR. The purchase was effective on May 1, 2006, after all necessary approvals were met (Ryan's Notes, 2006a).

Shieldalloy Metallurgical Corp. formed a long-term alliance with Hascor International Group (Mexico) under which ferroalloy powders produced by Hascor at its Tampico, Mexico, facilities would be marketed by Shieldalloy to wear plate, welding electrode, and powder metallurgy producers in Canada and the United States. Hascor was to market the powders to producers of cored wire. Shieldalloy will transfer ferroalloy production equipment from its Newfield, NJ, plant to the Hascor facility. The alliance expanded Hascor's product line and increased its production capacity. Shieldalloy was to continue to produce aluminum alloy products at its Newfield plant (Ryan's Notes, 2006b).

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

Metallurgical applications continued to dominate U.S. vanadium use in 2006, accounting for 92% 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 2006 was 4,030 t, an increase of 3% from that of 2005. This increase in reported vanadium consumption reflected stable demand by steel producers.

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.

Most state-of-the-art lithium batteries use lithium cobalt dioxide cathodes that have reversible (rechargeable) capacity of about 150 milliampere hours per gram (mAh/g). The graphite anode material has a reversible capacity that approaches 300 mAh/g. This imbalance between the capacities of the cathode and anode has limited the development of more powerful lithium-ion batteries. Physical Sciences, Inc. (PSI) (Andover, MA) decided to look for more promising cathode materials and settled on V_2O_5. Researchers experimented by adding conductive polymers to the material, hoping it would make V_2O_5 more conductive so charges could move more readily. When enough conductive polymer was added to improve electrical conductivity, the modified V_2O_5 cathode capacity decreased. Yet when less conductive polymer was added, battery performance improved. The PSI team's discovery yielded a battery based on traditional graphite anode material and the modified V_2O_5 cathode material that stored more energy than traditional lithium-ion batteries. The prototype cells performed 30% better than state-of-the-art lithium ion batteries and potentially have 50% better capacity. PSI arranged for a battery manufacturer to conduct a small production run using current lithium-ion battery manufacturing technology to provide prototypes for further evaluation (Fenton, 2006).

Prices

In 2006, the price for domestic FeV, as published in Metal Bulletin, ranged from $16.00 to $23.00 per pound of contained vanadium, compared with $21.00 to $61.00 per pound reported in 2005. The price averaged about $20.00 per pound in January, gradually decreased to about $18.50 per pound in April, rose to about $21.00 per pound in June, and then gradually decreased to about $16.75 per pound in December. The European FeV price ranged from $33.00 to $49.00 per kilogram compared with $34.00 to $128.00 per kilogram in 2005. The European price averaged about $38.50 per kilogram in January, rose to about $47.00 per kilogram in February, dropped to about $36.50 per kilogram in April, averaged about $40.00 in May and June, dropped to about $36.00 in August, and then rebounded to about $40.00 per kilogram in September before drifting down to $34.00 per kilogram in December.

The Metal Bulletin published price for domestic V_2O_5 ranged between $6.40 and $10.00 per pound in 2006, compared with $7.50 and $27.00 per pound in 2005. The price averaged about $8.40 per pound in January, rose to about $9.30 per pound in February, dropped to about $7.80 per kilogram in April, rebounded to about $8.30 in May, drifted down to about $7.10 in August, and then rebounded to about $7.90 per kilogram in September before drifting down to $6.70 per kilogram in December.

World Review

Nearly all 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, 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.

The world vanadium reserve base, at more than 38 Mt, is sufficient to meet vanadium demand into the next century at the present rate of consumption. This does not account for the increased recovery of vanadium from fly ash, petroleum residues, slag, and spent catalyst that is expected to extend the life of the reserve base significantly.

Australia.—Aurox Resources Limited (Perth, Australia) announced the results of a bankable feasibility study on the Balla Balla vanadium-titanium-iron ore project in Western Australia. The study identified a resource said to be the largest and highest-grade vanadium deposit in Australia, with reserves at 53.9 million metric tons (Mt) and a grade of 0.73% V_2O_5. The production rate was projected to be 4,100 metric tons per year (t/yr) of contained vanadium during a mine life of 25 to 30 years (Platts Metals Week, 2006a). Aurox signed a letter of intent with Thyssenkrup Metallurgie for the sale of 100% of the future FeV production. The agreement would cover a 5-year period commencing the end of 2007 when production was scheduled to start (Metal-Pages Ltd., 2006a).

Noble Group Ltd. (Hong Kong, China) acquired a 10% equity share in the Windimurra Mine (Australia) for $16.3 million. Noble also announced a sales and marketing agreement under which Noble agreed to purchase the entire vanadium output of Windimurra during the first 7 years of operation for the cash cost of production. Noble would exclusively handle all marketing and distribution of Windimurra vanadium products worldwide. Windimurra's plant was expected to have a design capacity of about 9,000 t/yr of V_2O_5, which would be converted into about 6,200 t/yr of FeV (Platts Metals Week, 2006b).

In another vanadium industry development, Australian base metals company Vulcan Resources Ltd. acquired a major vanadium deposit (Syote) and a number of prospects in north central Finland. The site covered about 213 square kilometers and included the former Otanmaki iron-vanadium mine. Geologic records, coupled with past production information, indicated the potential for a massive deposit. Vulcan planned further studies to delineate the potential of the Syote deposit, about 15 kilometers from the Mustavaare Mine, which produced about 10% of the world's vanadium from the 1950s to the 1980s (Platts Metals Week, 2006c).

China.—The V_2O_5 content of vanadium-bearing slag in China was expected to increase 1,500 t to about 14,000 t in 2006 owing to increased raw steel production. Overall Chinese V_2O_5 production was expected to increase 2,000 t to about 16,000 t in 2006. Domestic vanadium consumption, as either V_2O_5 or FeV, was expected to increase 1,000 t to about 9,000 t of V_2O_5 content in 2006 with the remaining vanadium-bearing material available for export (Ryan's Notes, 2006e).

Japan.—JFE Material Co. Ltd. (Toyama, Japan) began production of 50% FeV from spent desulfurization catalysts and petroleum residues in May and began shipments to JFE Steel Corp. and other JFE group companies in November. JFE Material expected to meet its 2006 production target of 700 to 800 t of vanadium contained in FeV. In addition, the plant expected to recover 350 to 400 t each of molybdenum and nickel metal in 2006 (Ryan's Notes, 2006c).

Kazakhstan.—British Virgin Islands-based Ferro-Alloy Resources, Ltd. (FRL) announced it began construction on a small-scale vanadium recovery plant in southern Kazakhstan in June 2006. The initial plan called for processing 100,000 t of ore by the end of the first quarter of 2007, followed by an evaluation of process efficiency. If successful, FRL would issue an initial public offering in the first half of 2007 to fund construction of the second stage of the project, estimated to cost about $30 million. The company estimated potential annual production capacity of about 7,000 t of V_2O_5 upon full completion of the project (Metal Bulletin, 2006b).

South Africa.—Anglo American Plc. (United Kingdom) agreed to sell its 79% interest in Highveld Steel and Vanadium Corp. Ltd. (South Africa) to Russian steel conglomerate Evraz Group S.A. (Luxembourg) for $687 million. Evraz acquired 24.9% immediately and acquired an equal 24.9% stake held by Credit Suisse through an option agreement, after regulatory approval was received. Evraz also obtained a second option to purchase the final 29.2%. A staged purchase was necessary because once Evraz's ownership stake exceeded 35%, the company was required by South African law to make a purchase offer to all remaining stockholders. In April, Evraz purchased controlling interest in U.S.-based vanadium producer Strategic Minerals Corp., which also has mine and plant operations in South Africa (Metal Bulletin, 2006a). Highveld expected its vanadium production to drop in the second half of 2006 as they proceeded with furnace upgrades to increase steel and vanadium output. In addition, new equipment was being installed to upgrade and de-bottleneck the V_2O_5 plant (Ryan's Notes, 2006f).

Xstrata Plc. (Zug, Switzerland) focused on increased V_2O_5 output by increasing kiln and beneficiation efficiency, and its V_2O_5 output rose 1.3% in the first half of 2006 over 2005 levels. Xstrata considered a brownfield expansion at its Rhovan Mine (South Africa) to increase V_2O_5 production capacity, as carbon steel production, the major market for vanadium, remained strong in 2006 (Ryan's Notes, 2006f). Xstrata completed an environmental assessment of a potential expansion of its Rhovan vanadium operation in mid-2006. V_2O_5 production capacity at Rhovan would be increased from about 9,000 t (20 million pounds) to about 13,000 t (29 million pounds) of V_2O_5. Production costs for V_2O_5 in 2005 increased slightly owing to an overburden removal campaign. Xstrata expected production costs at the Rhovan operation to decrease in 2006 following completion of overburden removal. Xstrata also expected the proposed expansion to further lower production costs through economies of scale (Ryan's Notes, 2006g).

Outlook

Vanadium's primary use was as a hardening agent in steel. Raw steel production in China rose by 20% to 423 Mt in 2006, pushing global raw steel production to 1.24 billion metric tons, an 8% increase from the record-high production of 2005 (Institute of Scrap Recycling Industry, 2008). The USGS estimated that world production of vanadium was about 56,300 t of contained vanadium (220 million pounds of V_2O_5) in 2006, about the same as that of 2005. With the expected growth in steel production for the next 3 to 5 years, strong demand for vanadium was expected to be sustained.

The capacity to recover vanadium from catalysts, petroleum residues, and slag worldwide was estimated to be 83,900 t/yr (185 million pounds per year) of V_2O_5, and primary mines add another 25,000 t/yr (55 million pounds per year) of V_2O_5 capacity (Bunting, 2007). As a result of steel production capacity increases from expansions, and resulting increases in pig iron sleg generation, increased world demand for vanadium is expected to be satisfied from existing resources for the foreseeable future.

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TABLE 1
SALIENT VANADIUM STATISTICS[1]

(Metric tons of contained vanadium, unless otherwise specified)

	2002	2003	2004	2005	2006
United States:					
Production, ore and concentrate:					
Recoverable vanadium[2], value thousand dollars	--	--	--	--	--
Vanadium oxide recovered from ore[3]	--	--	--	--	--
Consumption	3,080	3,240	4,050	3,910	4,030
Exports:					
Ferrovanadium	142	397	285	500	389
Vanadium pentoxide (anhydride)	91	185	240	247	341
Other oxides and hydroxides of vanadium	203	284	584	821	832
Imports for consumption:					
Ferrovanadium	2,520	1,360	3,020	11,900	2,140
Ore, slag, ash, residues	1,870	3,060	2,350	1,690	997
Vanadium pentoxide (anhydride)	406	474	1,040	1,370	1,920
Other oxides and hydroxides of vanadium	66	74	120	186	129
Stocks:					
Ferrovanadium	212	213	320	343	275
Oxide	7	6	6	2	6
Other[4]	14	33	10	26	49
World, production from ore, concentrate, slag[e]	51,000	47,900	51,900	56,400 [r]	56,300

[e]Estimated. [r]Revised. -- 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]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)

	2005	2006
End use:		
Steel:		
Carbon	1,170,000	1,210,000
Full alloy	1,010,000	1,030,000
High-strength low-alloy	974,000	1,020,000
Stainless and heat resisting	60,000	61,400
Tool	402,000	323,000
Total steel	3,620,000	3,650,000
Cast irons	W	W
Superalloys	35,600	39,500
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	259,000	335,000
Grand total	3,910,000	4,030,000
Form:		
Ferrovanadium	3,290,000	3,410,000
Oxide	344,000	264,000
Other[3]	274,000	354,000
Total	3,910,000	4,030,000

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:				
2005	1,010	$15,500	54,800	$3,800,000
2006:				
Belgium	--	--	124	11,500
Brazil	102,000	312,000	--	--
Canada	--	--	787	9,870
China	--	--	120	5,500
Germany	--	--	98,000	3,870,000
Russia	--	--	21,400	1,320,000
United Kingdom	--	--	283	56,600
Total	102,000	312,000	121,000	5,270,000
Exports:				
2005	15,100,000	45,600,000	293,000	16,400,000
2006:				
Australia	2,970	44,000	1,740	91,300
Austria	--	--	21,800	665,000
Belgium	231,000	4,280,000	15,400	525,000
Brazil	102,000	558,000	2,390	70,400
Cameroon	--	--	959	37,000
Canada	3,250,000	10,000,000	454	13,600
China	277,000	1,400,000	114,000	199,000
Dominican Republic	4	8,300	--	--
France	3,380	42,200	1	14,100
Germany	13,800	197,000	54,900	1,550,000
Guatemala	10,800	166,000	--	--
Guyana	1,680	4,680	--	--
Hong Kong	211	2,750	--	--
Hungary	400	4,150	--	--
India	119,000	604,000	--	--
Israel	--	--	17	3,220
Italy	2,560	73,800	92	3,540
Japan	1,310,000	7,560,000	88,500	3,360,000
Korea, Republic of	4,330	24,100	--	--
Malaysia	22,000	135,000	--	--
Mexico	1,030,000	23,900,000	--	--
Netherlands	231	3,000	--	--
Norway	--	--	15,500	360,000
Poland	1,590	11,100	--	--
Saudi Arabia	--	--	980	95,600
South Africa	10,900	56,500	--	--
Spain	243	3,160	--	--
St. Helena	270,000	608,000	--	--
Sweden	--	--	504	25,400
Taiwan	39,000	198,000	--	--
Thailand	688,000	3,090,000	--	--
United Kingdom	263,000	1,530,000	174,000	6,140,000
Total	7,650,000	54,500,000	491,000	13,200,000

-- 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:						
2005	11,900,000	$131,000,000	1,370,000	$52,900,000	186,000	$6,540,000
2006:						
Austria	143,000	5,700,000	21,000	638,000	6,940	440,000
Canada	254,000	12,500,000	--	--	--	--
China	531	23,600	428,000	12,400,000	--	--
Czech Republic	1,460,000	61,000,000	--	--	--	--
Germany	412	36,600	3,230	140,000	--	--
Hong Kong	--	--	995	25,700	--	--
Israel	--	--	--	--	8,380	142,000
Japan	--	--	1,120	105,000	--	--
Korea, Republic of	239,000	9,230,000	--	--	--	--
Mexico	75	10,500	9,930	165,000	2,360	104,000
Russia	--	--	425,000	7,000,000	--	--
South Africa	--	--	1,030,000	24,400,000	96,000	2,450,000
Switzerland	48,300	1,990,000	--	--	--	--
Taiwan	--	--	7,230	244,000	--	--
Trinidad and Tobago	--	--	--	--	4,030	68,200
United Kingdom	--	--	5	5,220	11,300	159,000
Total	2,140,000	90,500,000	1,920,000	45,200,000	129,000	3,370,000
Exports:						
2005	500,000 r	19,300,000	247,000	5,470,000	821,000	15,400,000
2006:						
Australia	1,120	54,500	--	--	450	4,960
Austria	--	--	4,810	171,000	--	--
Argentina	8,000	294,000	--	--	--	--
Belgium	--	--	36,000	732,000	--	--
Brazil	8,090	348,000	--	--	13,600	200,000
Canada	188,000	4,530,000	--	--	540,000	4,810,000
China	11,000	121,000	--	--	9,500	146,000
Denmark	--	--	920	6,150	--	--
France	--	--	--	--	7,280	111,000
Germany	--	--	13,500	303,000	65,200	579,000
Italy	504	16,800	103,000	2,180,000	57,900	238,000
Mexico	68,800	2,030,000	4,110	158,000	27,100	97,000
Netherlands	97,900	3,730,000	18,000	387,000	36,600	596,000
Peru	1,330	73,200	--	--	--	--
Russia	--	--	41,000	818,000	73,300	984,000
Saudi Arabia	--	--	125	7,750	--	--
Spain	--	--	52,900	898,000	--	--
Taiwan	--	--	2,950	28,000	--	--
Trinidad and Tobago	--	--	7,510	177,000	--	--
United Kingdom	--	--	40,000	882,000	910	8,100
Venezuela	3,950	218,000	17,000	397,000	--	--
Total	389,000	11,400,000	341,000	7,150,000	832,000	7,780,000

[r]Revised. -- 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	2005 Quantity, V_2O_5 content (kilograms)	2005 Value	2006 Quantity, V_2O_5 content (kilograms)	2006 Value
Ash and residues:				
Canada	1,200,000	$1,100,000	1,130,000	$1,110,000
Mexico	1,060,000	9,820,000	637,000	7,320,000
United Kingdom	--	--	11,500	21,600
Total	2,270,000	10,900,000	1,780,000	8,450,000
Slag, from the manufacture of iron and steel, South Africa[2]	756,000	1,510,000	--	--

-- 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	2005 Quantity, V content (kilograms)	2005 Value	2006 Quantity, V content (kilograms)	2006 Value
Sulfates:				
India	--	--	4,300	$25,800
South Africa	35,000	$77,000	--	--
Total	35,000	77,000	4,300	25,800
Vanadates:				
Austria	--	--	299	5,370
China	49	3,530	--	--
Germany	27,100	808,000	23,300	935,000
Japan	118	22,800	2,220	42,500
Korea, Republic of	11,800	76,800	4,640	25,500
Netherlands	--	--	2,460	78,600
Russia	4	2,640	--	--
South Africa	46,000	1,880,000	75,400	2,180,000
Switzerland	1	2,010	--	--
United Kingdom	--	--	6,690	68,200
Total	85,100	2,800,000	115,000	3,330,000

-- 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.

Source: U.S. Census Bureau.

TABLE 7

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

(Metric tons of contained vanadium)

Country	2002	2003	2004	2005	2006
Production from ores, concentrates, slag:[3]					
Australia	3,060 [4]	160 [4]	150 [4]	100	100
China[5]	13,200	13,200	16,000	17,000	17,500
Kazakhstan	1,000	1,000	1,000	1,000	1,000
Russia	8,000	5,800	10,900	15,100	15,100
South Africa	25,227 [4]	27,172 [4]	23,302 [4]	22,604 [r, 4]	22,000
Total	50,500	47,300	51,400	55,800 [r]	55,700
Production from petroleum residues, ash spent catalysts[6], Japan	499	560	560	560	560
Grand total	51,000	47,900	51,900	56,400 [r]	56,300

[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 1, 2007.

[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.