VANADIUM

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In 2002, vanadium consumption in the United States was 3,080 metric tons (t) of contained vanadium, about a 4% decrease from that of 2001, representing the fifth consecutive year consumption has decreased. The United States imported 2,520 t of ferrovanadium (vanadium content), 406 t of vanadium pentoxide, and 42 t of other vanadium products valued at about $22 million. Total imports of these vanadium materials for consumption decreased about 30% from that of 2001. The United States exported 142 t of ferrovanadium (vanadium content), 453 t of vanadium pentoxide, and 443 t of other vanadium products valued at about $7.4 million. Total exports of these vanadium materials decreased about 8% from that of 2001.

The U.S. production of vanadium was solely by recovery of vanadium values from various industrial waste materials such as vanadium-bearing iron slag, fly ash, petroleum residues, and spent catalysts. Fewer than 10 firms, primarily in Arkansas, Louisiana, and Texas, processed these materials to produce vanadium pentoxide, ferrovanadium, and vanadium metal. Metallurgical applications in which vanadium was used as a minor alloying element with iron, steel, and titanium remained the dominant end use. The largest nonmetallurgical use for vanadium was in catalysts.

Although vanadium has many uses, metallurgical applications account for more than 88% of domestic consumption. Most vanadium is consumed in the form of ferrovanadium, which is used as a means of introducing vanadium into steel where it gives additional strength and toughness. Ferrovanadium is available as alloys containing 45% to 50% and 80% vanadium. The 45% to 50% grade is produced from slag, and other vanadium-containing materials, by the silicothermic reduction of vanadium pentoxide. Most of the 80% grade is produced by the aluminothermic reduction of vanadium pentoxide in the presence of steel scrap or by direct reduction in an electric arc furnace. Vanadium-containing steels can be subdivided into micro alloyed or low-alloy steels, which generally contain less than 0.15% vanadium, and high-alloy steels which contain as much as 5% vanadium. Nonmetallurgical applications include catalysts (the dominant use), ceramics, vanadium chemicals, and electronics.

Legislation and Government Programs

The U.S. Department of Commerce (Commerce) announced final antidumping duties on imports of ferrovanadium from South Africa and China in a November 21, 2002, final ruling (Ryan's Notes, 2002d). Commerce calculated antidumping margins of 116% for Xstrata South Africa (Proprietary) Ltd. (Xstrata), Highveld Steel & Vanadium (Highveld), and other South Africa producers, and margins of 13.03% for Panzhihua Iron & Steel, and 66.71% for other Chinese suppliers. On June 26, 2002, Commerce announced preliminary antidumping duties of 37.29% for Xstrata, 45.58% for Highveld, and 41.72% for all other South African producers (Ryan's Notes, 2002c). However, in September, Xstrata and Highveld refused to allow Commerce to conduct onsite verification of data previously submitted, leading to imposition of higher antidumping duties (Ryan's Notes, 2002g).

The U.S. International Trade Commission (ITC) ruled on December 19, 2002, that ferrovanadium imports from South Africa and China would be subject to antidumping duties of from 13% to 116%, as previously set by Commerce (Platts Metals Week, 2002b). All five U.S. ITC commissioners voted in the affirmative that the U.S. industry was injured by the imports, which Commerce had previously found were dumped at margins of 13.03% to 66.7% in the case of Chinese material and 116% in the case of South Africa. The antidumping petition was filed in November 2001 by five U.S. producers: Bear Metallurgical, Shieldalloy Metallurgical, Gulf Chemical & Metallurgical Corp., U.S. Vanadium Corp., and CS Metals.

In mid-October, The Ferroalloys Association (TFA) requested that Commerce conduct an anticircumvention inquiry to determine whether ferrovanadium converted in third countries using Russian vanadium pentoxide should be included within the scope of the existing dumping order in Russia (Ryan's Notes, 2002l). Commerce had 45 days to decide whether to investigate. On November 25, 2002, the day Commerce was scheduled to make its decision public, the TFA withdrew its application (Ryan's Notes, 2002b). Legal council for the Vanadium Committee of the TFA stated the Committee wanted to consider other alternatives to an antidumping case and might choose an approach that doesn't involve circumvention.

Production

The major vanadium commodities are vanadium pentoxide, ferrovanadium, aluminum-vanadium master alloys, vanadium chemicals, and vanadium-bearing iron slags. Companies in the United States produced all of these materials in 2002 with the exception of vanadium bearing iron slags.

Strategic Minerals Corp. (Stratcor) discontinued vanadium-aluminum production at its Niagara Falls, NY, plant on February 28, 2002, and is moving production to a new plant being built by International Specialty Alloys in New Castle, PA (Ryan's Notes, 2002h). The new plant began production in April. Stratcor and International Specialty Alloys formed an alliance to supply master alloys for the titanium and aerospace industries in September 2001. Stratcor will continue to market vanadium-aluminum and other master alloys produced by International Specialty Alloys.

Stratcor's investment focus shifted to specialty vanadium products as it implemented a "reinvention plan" undertaken in response to the oversupplied vanadium market (Ryan's Notes, 2002i). Stratcor established a wholly owned subsidiary (Stratcor Performance Materials, Inc.) that will focus on performance-based materials. The new subsidiary, based in Pittsburgh, PA, will market high-purity vanadium oxides, halides, and master alloys used in chemicals, batteries, and titanium, respectively. It will also market Nitrovan vanadium, a proprietary additive to strengthen high-strength, low-alloy steels. Stratcor increased its output of Nitrovan by 10% at its Vametco subsidiary in Britts, South Africa, and could increase production an additional 25% to 30% through process improvements to meet future demand.

In September, Stratcor agreed to sell its 50% interest in CS Metals to its joint venture partner (CRI Metal Products) a subsidiary of Royal Dutch Shell (Ryan's Notes, 2002j). The CS Metals plant started operation in October 2000, in Convent, LA, and was to recover 4 million pounds per year (Mlb/yr) of vanadium pentoxide, 4 Mlb/yr of molybdenum oxide, and 5 Mlb/yr of nickel from spent catalysts. Stratcor will continue to market vanadium units produced by CS Metals and will also provide technical assistance.

The Vanadium Division of Shieldalloy began doing business as Metallurg Vanadium, effective May 1, 2002 (Ryan's Notes, 2002k). The name change was made so that investors could more easily identify the different parts of Metallurg, Inc., the parent company. Metallurg Vanadium planned to complete a $12 million capital spending program that would enable the company to recover vanadium and other metals from spent catalysts.

Consumption

Metallurgical applications continued to dominate U.S. vanadium use in 2002, accounting for more than 88% of total consumption. Nonmetallurgical applications included catalysts, ceramics, vanadium chemicals, and electronics. The dominant nonmetallurgical use was in catalysts. Based on United States Geological Survey (USGS) surveys, 2002 domestic vanadium consumption was 3,080 t, a decline of about 4% from that of 2001. The decline reflected reduced demand by steel producers.

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

Prices

In 2002, the price for domestic ferrovanadium, as published in Ryan's Notes, ranged from $3.45 to $4.49 per pound of contained vanadium, similar to the $3.60 to $4.50 range reported for 2001 (Ryan's Notes, 2002f). The price was level from January through April and then rose to reach its high in August. It remained at this level through September before declining as demand from steel producers decreased. The European ferrovanadium price rose slowly throughout the year and reached a peak in June before sliding downward through November. In December, it spiked to reach its high for the year. The European price ranged from $6.20 to $9.90 per kilogram compared with $6.25 to $8.70 per kilogram in 2001.

Ryan's Notes published price for domestic vanadium pentoxide ranged between $1.25 and $1.70 per pound in 2002. The price rose steadily throughout the year and remained at its peak from August through December. In 2001, the vanadium pentoxide price ranged from $1.10 to $1.50 per pound.

World Review

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 foreign countries, the mining and processing of magnetite-bearing ores was an important source of their vanadium production. The largest vanadium-producing nations remain 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.

Xstrata stated the combined capacity of its Rhovan and Vantech mines in South Africa and its Windimurra mine in Australia was 46 Mlb/yr of vanadium pentoxide but estimated its output for 2002 at about 41 million pounds (Ryan's Notes, 2002m). The company estimated that vanadium consumption grew 7% during the past 10-year period.

While U.S. ferrovanadium producers actively tried to block imports through trade actions, Japan's industry invested in offshore production facilities to meet domestic demand (Ryan's Notes, 2002e). Nippon Denko completed a feasibility study, in conjunction with Highveld, on building a 3,500 Mlb/yr ferrovanadium plant in South Africa. The company planned to commission the plant in early 2003 with the output primarily earmarked for Japan. When the new plant comes online, Nippon Denko will suspend production at its 1,700 Mlb/yr ferrovanadium production facility in Japan.

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

Current Research and Technology

McKenzie Bay Planning To Begin Vanadium Production.—McKenzie Bay International Ltd. (MKBY) announced plans to build a vanadium "pilot" commercial production facility in Canada (McKenzie Bay International, Ltd., 2002§[1]). Initially, the pilot production plant will produce vanadium pentoxide ranging from technical grade which is >99.6% purity to a high-purity > 99.9% pure product that will be used to make vanadium electrolyte for vanadium redox batteries. The high-purity vanadium pentoxide will also be used to make vanadium cathodes for lithium batteries. Pilot-plant production is planned at 4 Mlb/yr, for all products combined, with expansion possibilities. Production was planned to start late in 2003.

Lithium Car Battery Makers Team Up.—Lithium Technology Corp. (LTC) has signed a share-exchange

[1]A reference that includes a section mark (§) is found in the Internet Reference Cited section.

agreement in December that will give LTC a 100% interest in GAIA GmbH, a privately held German lithium-polymer battery company (Platts Metals Week, 2002a). LTC is currently providing customers with sample lithium-based, prototype rechargeable batteries for automotive, stationary power, and national security applications. The batteries will carry the GAIA brand name and trademark. One of the principal targets is the 42-volt automotive battery, which is gaining increased acceptance in Japan, Europe, and the United States. One of the company's prototypes was being tested under the auspices of the European "Astor" consortium of seven auto manufacturers assessing new power sources.

Chinese Lithium Batteries in Production.—A project designed to produce 30 million units per year of lithium batteries has recently gone into production in Qingdao, Shandong Province (Platts Metals Week, 2002c). Aucma, a leading Chinese household appliance producer made an initial investment of $24 million in the project, which is designed to produce 45 types of high-quality lithium batteries for various applications.

Outlook

Vanadium remains in chronic oversupply due largely to the 43 Mlb/yr of new capacity that was added since 1998 (Ryan's Notes, 2002a). In 2002, Windimurra in Australia, operated at a rate of 12 Mlb/yr of vanadium pentoxide rather than its design capacity of 16 Mlb/yr and CS Metals in the United States, operated at a rate of 4 Mlb/yr rather than its design capacity of 6 Mlb/yr. World consumption of vanadium in 2002 was estimated at 160 Mlb/yr while the supply was estimated at 170 Mlb/yr, a 10-Mlb/yr surplus (Ryan's Notes, 2002c). However, the capacity to recover vanadium from slag, catalysts, and petroleum residues worldwide was estimated to be at least 180 Mlb/yr and primary mines add another 80 Mlb/yr of capacity. The world supply and demand will not come into balance without major reductions in capacity and/or increases in demand.

According to International Mining Consultants, Xstrata made provision for possibly closing its Vantech plant in South Africa in 2003, but its Rhovan plant is slated for expansion (Ryan's Notes, 2002a). Xstrata wrote down the value of the Windimurra plant to $28 million after taking an impairment charge of $45 million and also reported losses in 2001 of $41.6 million. In addition, the favorable off-take agreement, under which Glencore International AG is committed to purchase 7-Mlb/yr of vanadium pentoxide production from Windimurra at $3.65 per pound, will expire at the end of 2002 leaving the Windimurra plant's economic future further in doubt.

The United States and the world demand for vanadium will continue to fluctuate in response to changes in steel production. However, the overall trend for consumption is expected to increase as vanadium use in crude steel, which accounts for 85% of world consumption, continues to grow at a rate higher than the 2% to 3% annually in steel production (Ryan's Notes, 2002a). There are opportunities to increase the amount of vanadium consumed in micro-alloyed steels. In addition, China produces more steel than the United States but only uses about one-half the vanadium. If China doubled its consumption, that alone could boost demand by an additional 15 Mlb/yr. Finally, new applications, such as the vanadium redox battery, have the potential of lifting consumption by as much as 20 Mlb/yr.

The world vanadium reserve base, at more than 27 million metric tons, 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 spent catalyst, fly ash, and petroleum residues that will extend the life of the reserve base significantly.

References Cited

Platts Metals Week, 2002a, Chinese lithium batteries in production: Platts Metals Week, v. 73, no. 49, December 9, p. 3.

Platts Metals Week, 2002b, FeV imports injured, dutiable-US: Platts Metals Week, v. 73, no. 51, December 23, p. 13.

Platts Metals Week, 2002c, Lithium car battery makers team up: Platts Metals Week, v. 73, no. 49, December 9, p. 3.

Ryan's Notes, 2002a, Chronic oversupply colors vanadium market: Ryan's Notes, v. 8, no. 46, November 18, p. 2.

Ryan's Notes, 2002b, Circumvention case on FeV withdrawn: Ryan's Notes, v. 8, no. 48, December 2, p. 1.

Ryan's Notes, 2002c, Commerce assesses preliminary dumping margins: Ryan's Notes, v. 8, no. 26, July 1, p. 1.

Ryan's Notes, 2002d, Final FeV duties of 116% on South Africa: Ryan's Notes, v. 8, no. 47, November 25, p. 1.

Ryan's Notes, 2002e, Japan's reliance on FeV imports grows: Ryan's Notes, v. 8, no. 42, October 21, p. 3.

Ryan's Notes, 2002f, Ryan's Notes 2002 proprietary prices: Ryan's Notes, p. 16, 21.

Ryan's Notes, 2002g, South Africans refuse on-site inspections: Ryan's Notes, v. 8, no. 40, October 7, p. 1.

Ryan's Notes, 2002h, Stratcor discontinued vanadium-aluminum: Ryan's Notes, v. 8, no. 9, March 4, p. 5.

Ryan's Notes, 2002i, Stratcor to focus on specialty V products: Ryan's Notes, v. 8, no. 11, March 18, p. 2.

Ryan's Notes, 2002j, Stratcor to sell 50% stake in CS Metals: Ryan's Notes, v. 8, no. 36, September 9, p. 1.

Ryan's Notes, 2002k, The Vanadium Division of Shieldalloy: Ryan's Notes, v. 8, no. 19, March 13, p. 3.

Ryan's Notes, 2002l, TPA pursues anticircumvention case: Ryan's Notes, v. 8, no. 41, October 14, p. 1.

Ryan's Notes, 2002m, V producers see surplus, do little: Ryan's Notes, v. 8, no. 8, February 25, p. 3.

Internet Reference Cited

McKenzie Bay International, Ltd., 2002 (December 3), McKenzie Bay planning to begin vanadium production in 2003, News release, accessed March 19, 2003, via URL http://www.mckenziebay.com/news/021203.htm.

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications
Vanadium. Ch. in Mineral Commodity Summaries, annual.
Vanadium. Mineral Industry Surveys, monthly.
Vanadium. International Strategic Minerals Inventory Summary Report, Circular 930-K, 1992.

Other

Chemical & Engineering News.
Engineering and Mining Journal.
Metal Bulletin.
Metal Bulletin Monthly.
Roskill Information Services Ltd. reports.

TABLE 1
SALIENT VANADIUM STATISTICS[1]

(Metric tons of contained vanadium unless otherwise specified)

	1998	1999	2000	2001	2002
United States:					
Production, ore and concentrate:					
Recoverable vanadium[2]	W	W	--	--	--
Value thousand dollars	W	W	--	--	--
Vanadium oxide recovered from ore[3]	W	W	--	--	--
Consumption	4,380	3,620	3,520	3,210	3,080
Exports:					
Ferrovanadium	579	213	172	70	142
Vanadium pentoxide (anhydride)	681	747	653	670 r	453
Other oxides and hydroxides of vanadium	232	70	100	385 r	443
Imports for consumption:					
Ferrovanadium	1,620	1,930	2,510	2,550	2,520
Vanadium pentoxide (anhydride)	847	208	902	600	406
Other oxides and hydroxides of vanadium	33	--	14	1,080	42
Ore, slag, ash, residues	2,400	1,650	1,890	2,980 r	3,330
Stocks:					
Ferrovanadium	324	328	278	239	197
Oxide	8	5	5	5	5
Other[4]	4	15	20	7 r	19
World, production from ore, concentrate, slag[5]	42,700 r	51,900 r	56,300 r	57,400 r	60,200 e

eEstimated. rRevised. 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 ferrophosphorus slag derived from domestic phosphate rock.

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

[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)

	2001	2002
End use:		
Steel:		
Carbon	1,030,000	731,000
Stainless and heat resisting	W	37,500
Full alloy	689,000 r	748,000
High-strength low-alloy	797,000 r	900,000
Tool	146,000	270,000
Total	2,660,000	2,690,000
Cast irons	W	W
Superalloys	17,600	12,400
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	523,000	382,000
Total	3,210,000	3,080,000
Form:		
Ferrovanadium	2,760,000	2,730,000
Oxide	98,300 r	208,000
Other[3]	345,000 r	141,000
Total	3,210,000	3,080,000

See footnotes at end of table.

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

[r]Revised. 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]

(Kilograms, gross weight)

	Aluminum-vanadium master alloy		Vanadium metal, including waste and scrap	
	Quantity	Value	Quantity	Value
Imports for consumption:				
2001	10,100	$45,100	50,000	$639,000
2002:				
Canada	78,600	147,000	--	--
Germany	--	--	23,800	752,000
Netherlands	19,000	59,500	--	--
Russia	--	--	8,500	522,000
Total	97,500	206,000	32,300	1,270,000
Exports:				
2001	363,000	6,990,000	26,300	380,000
2002:				
Australia	410	4,190	--	--
Austria	--	--	173	153,000
Belgium	18,200	216,000	--	--
Canada	241,000	6,410,000	3,280	69,700
China	113	3,340	--	--
Ecuador	218	6,420	--	--
France	--	--	10	5,490
Germany	5,600	66,900	9,680	86,000
Hong Kong	44,300	865,000	--	--
India	350	8,260	--	--
Indonesia	897	26,400	--	--
Israel	6,320	104,000	--	--
Italy	1,000	18,400	--	--
Japan	144,000	2,390,000	4,040	250,000
Korea, Republic of	4,070	86,200	848	15,600
Mexico	37,800	1,040,000	--	--
Netherlands	--	--	557	7,040
New Zealand	4,750	61,800	--	--
Norway	4,230	54,900	--	--
Philippines	502	14,700	--	--
Russia	--	--	9,620	87,500
Singapore	5,330	144,000	--	--
Spain	--	--	1,970	24,600
Taiwan	5,400	128,000	19	3,420
United Kingdom	3,880	97,600	19,000	196,000
Total	529,000	11,700,000	49,200	898,000

-- 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]

(Kilograms, contained vanadium)

	Ferrovanadium		Vanadium pentoxide (anhydride)[2]		Other oxides and hydroxides of vanadium	
	Quantity	Value	Quantity	Value	Quantity	Value
Imports for consumption:						
2001	2,550,000	$20,500,000	600,000	$3,460,000	57,200 r	$510,000
2002:						
Austria	236,000	1,960,000	--	--	--	--
Belgium	151,000	1,240,000	--	--	--	--
Canada	591,000	4,650,000	--	--	1	10,000
China	49,500	330,000	9,520	63,700	--	--
Czech Republic	1,190,000	8,750,000	--	--	--	--
France	2,750	28,600	--	--	--	--
Germany	12,200	97,000	519	38,400	22,600	235,000
Israel	--	--	--	--	5,890	68,400
Italy	--	--	--	--	159	11,700
Korea, Republic of	13,600	136,000	--	--	--	--
Mexico	15,800	149,000	144,000	162,000	50	2,600
South Africa	200,000	1,540,000	252,000	1,730,000	--	--
Switzerland	14,200	152,000	--	--	--	--
Trinidad and Tobago	--	--	--	--	4,690	79,400
United Arab Emirates	--	--	--	--	2	2,510
United Kingdom	48,100	310,000	--	--	8,900	151,000
Total	2,520,000	19,400,000	406,000	1,990,000	42,300	560,000
Exports:						
2001	70,000	768,000	670,000 r	2,850,000 r	385,000 r	2,760,000
2002:						
Belgium	--	--	356,000	1,440,000	22,800	148,000
Canada	50,600	589,000	--	--	310,000	2,860,000
Chile	--	--	--	--	60,300	279,000
Colombia	376	4,650	--	--	--	--
France	--	--	26,100	154,000	--	--
Germany	--	--	57	5,000	--	--
India	--	--	--	--	8,970	110,000
Israel	--	--	420	8,360	--	--
Italy	--	--	20,400	126,000	--	--
Japan	--	--	1,560	14,800	9,910	105,000
Korea, Republic of	--	--	6,070	57,600	907	10,800
Mexico	91,300	983,000	5,570	59,300	--	--
Netherlands	--	--	--	--	9,070	73,800
New Zealand	--	--	185	3,590	--	--
Singapore	--	--	--	--	388	3,450
South Africa	--	--	--	--	20,600	118,000
Spain	--	--	34,300	165,000	--	--
Trinidad and Tobago	--	--	2,480	30,500	--	--
Total	142,000	1,580,000	453,000	2,070,000	443,000	3,710,000

rRevised. -- Zero.

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

[2]May include catalysts containing vanadium pentoxide.

Source: U.S. Census Bureau.

TABLE 5
U.S. IMPORTS FOR CONSUMPTION OF VANADIUM-BEARING ASH, RESIDUES, AND SLAG[1]

(Kilograms of vanadium pentoxide content)

Material and country	2001		2002	
	Quantity	Value	Quantity	Value
Ash and residues:				
Canada	178,000	$108,000	2,010,000	$1,360,000
Italy	188,000	508,000	--	--
Mexico	867,000	604,000	1,050,000	447,000
Spain	18,600	27,600	51,700	49,800
United Kingdom	729,000	760,000	216,000	219,000
Venezuela	3,510	219,000	--	--
Total	1,980,000	2,230,000	3,330,000	2,080,000
Slag, from the manufacture of iron and steel, South Africa[2]	4,160,000 r	1,170,000	--	--

rRevised. -- 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]

(Kilograms, vanadium content)

Material and country	2001		2002	
	Quantity	Value	Quantity	Value
Sulfates:				
Canada	--	--	68	$6,030
India	--	--	11	7,590
South Africa	--	--	14,000	376,000
Total	--	--	14,100	390,000
Vanadates:				
China	4,350	$46,500	--	--
Germany	6,050	126,000	1,340	80,000
Japan	26	73,400	370	83,200
South Africa	83,400	377,000	46,400	292,000
Total	93,800	623,000	48,100	455,000

-- 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.

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

(Metric tons of contained vanadium)

Country	1998	1999	2000	2001	2002[e]
Production from ores, concentrates, slag:[3]					
Australia	--	--	NA	NA	NA
China, in vanadiferous slag product[e]	15,500	26,000	30,000	30,000	33,000
Hungary[e]	100	--	--	--	--
Kazakhstan[e]	1,000	1,000	1,000	1,000	1,000
Russia[e]	7,000 [r]	7,000 [r]	7,000 [r]	8,000 [r]	8,000
South Africa	18,868	17,612	18,021	18,184 [r]	18,000
United States, recoverable vanadium	W	W	--	--	--
Total	42,500 [r]	51,600 [r]	56,000 [r]	57,200 [r]	60,000
Production from petroleum residues, ash spent catalysts, Japan[e, 4]	245	245	245	245	245
Grand total	42,700 [r]	51,900 [r]	56,300 [r]	57,400 [r]	60,200 [e]

[e]Estimated. [r]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; not included in "Total." -- Zero.

[1]World totals, U.S. data, 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, United States, and several other European countries, but available information is insufficient to make reliable estimates. Table includes data available through June 7, 2003.

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

[4]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.