

## VANADIUM

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

**Domestic Production and Use:** Seven U.S. firms that comprise the majority of the domestic vanadium industry produced ferrovandium, vanadium pentoxide, vanadium metal, and vanadium-bearing chemicals or specialty alloys by processing materials such as petroleum residues, spent catalysts, utility ash, and vanadium-bearing pig iron slag. Metallurgical use, primarily as an alloying agent for iron and steel, accounted for about 91% of the domestic vanadium consumption in 2007. Of the other uses for vanadium, the major nonmetallurgical use was in catalysts for the production of maleic anhydride and sulfuric acid.

| <b>Salient Statistics—United States:</b>                                 | <b>2003</b> | <b>2004</b> | <b>2005</b> | <b>2006</b> | <b>2007<sup>e</sup></b> |
|--|-------------|-------------|-------------|-------------|-------------------------|
| Production, mine, mill <sup>1</sup>                                      | —           | —           | —           | —           | —                       |
| Imports for consumption:   |             |             |             |             |                         |
| Ash, ore, residues, slag   | 3,060       | 2,350       | 1,690       | 1,000       | 1,050                   |
| Vanadium pentoxide, anhydride  | 474         | 1,040       | 1,370       | 1,920       | 2,240                   |
| Oxides and hydroxides, other   | 74          | 120         | 186         | 129         | 28                      |
| Aluminum-vanadium master alloys (gross weight)                           | 232         | 19          | 1           | 102         | 817                     |
| Ferrovanadium  | 1,360       | 3,020       | 11,900      | 2,140       | 2,260                   |
| Exports:   |             |             |             |             |                         |
| Vanadium pentoxide, anhydride  | 185         | 240         | 254         | 341         | 361                     |
| Oxides and hydroxides, other   | 284         | 584         | 899         | 832         | 582                     |
| Aluminum-vanadium master alloys (gross weight)                           | 677         | 887         | 1,500       | 1,930       | 1,590                   |
| Ferrovanadium  | 397         | 285         | 504         | 389         | 165                     |
| Consumption, reported  | 3,240       | 4,050       | 3,910       | 4,030       | 4,180                   |
| Price, average, dollars per pound V <sub>2</sub> O <sub>5</sub>          | 2.21        | 5.99        | 16.28       | 7.86        | 7.40                    |
| Stocks, consumer, yearend  | 252         | 336         | 371         | 330         | 340                     |
| Employment, mine and mill, number <sup>1</sup>                           | —           | —           | —           | —           | —                       |
| Net import reliance <sup>2</sup> as a percentage of apparent consumption | 100         | 100         | 100         | 100         | 100                     |

**Recycling:** Some tool steel scrap was recycled primarily for its vanadium content, and vanadium was recycled from spent chemical process catalysts, but these two sources together accounted for only a very small percentage of total vanadium consumed. The vanadium content of other recycled steels was lost to slag during processing and was not recovered.

**Import Sources (2003-06):** Ferrovandium: Czech Republic, 77%; Swaziland, 9%; Canada, 6%; Austria, 3%; and other, 5%. Vanadium pentoxide: South Africa, 72%; China, 15%; Russia, 9%; and other, 4%.

**Tariff:** Ash, residues, slag, and waste and scrap enter duty-free.

| Item                                  | Number       | Normal Trade Relations<br><u>12-31-07</u> |
|---------------------------------------|--------------|---|
| Vanadium pentoxide anhydride          | 2825.30.0010 | 5.5% ad val.                              |
| Vanadium oxides and hydroxides, other | 2825.30.0050 | 5.5% ad val.                              |
| Vanadates                             | 2841.90.1000 | 5.5% ad val.                              |
| Ferrovanadium                         | 7202.92.0000 | 4.2% ad val.                              |
| Aluminum-vanadium master alloys       | 7601.20.9030 | Free.                                     |

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

**Government Stockpile:** None.

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**Events, Trends, and Issues:** Preliminary data indicate that U.S. vanadium consumption in 2007 increased about 4% from that of the previous year. Among the major uses for vanadium, production of carbon, full-alloy, and high-strength low-alloy steels accounted for 25%, 30%, and 32% of domestic consumption, respectively. In 2007, U.S. steel production was expected to be 2% to 3% lower than that of 2006.

Vanadium pentoxide prices ranged from \$5.70 to \$8.30 and averaged \$7.40 for the year, about 6% lower than that of 2006. Ferrovandium prices ranged from \$15.25 to \$38.50 and averaged an estimated \$19.60 for the year, about 4% higher than that of 2006. Stable demand in the steel and aerospace industries and increased production of vanadium in Russia and China kept world supply and demand in balance in 2007.

**World Mine Production, Reserves, and Reserve Base:**

|                       | Mine production |                   | Reserves <sup>3</sup> | Reserve base <sup>3</sup> |
|-----------------------|-----------------|-------------------|-----------------------|---------------------------|
|                       | 2006            | 2007 <sup>e</sup> |                       |                           |
| United States         | —               | —                 | 45,000                | 4,000,000                 |
| China                 | 17,500          | 18,500            | 5,000,000             | 14,000,000                |
| Russia                | 15,100          | 16,000            | 5,000,000             | 7,000,000                 |
| South Africa          | 22,000          | 23,000            | 3,000,000             | 12,000,000                |
| Other countries       | 1,100           | 1,100             | NA                    | 1,000,000                 |
| World total (rounded) | 55,700          | 58,600            | 13,000,000            | 38,000,000                |

**World Resources:** World resources of vanadium exceed 63 million tons. Vanadium occurs in deposits of titaniferous magnetite, phosphate rock, and uraniferous sandstone and siltstone, in which it constitutes less than 2% of the host rock. Significant amounts are also present in bauxite and carboniferous materials, such as crude oil, coal, oil shale, and tar sands. Because vanadium is usually recovered as a byproduct or coproduct, demonstrated world resources of the element are not fully indicative of available supplies. While domestic resources and secondary recovery are adequate to supply a large portion of domestic needs, a substantial part of U.S. demand is currently met by foreign material because it is currently uneconomic to mine vanadium in the United States.

**Substitutes:** Steels containing various combinations of other alloying elements can be substituted for steels containing vanadium. Certain metals, such as niobium (columbium), manganese, molybdenum, titanium, and tungsten, are to some degree interchangeable with vanadium as alloying elements in steel. Platinum and nickel can replace vanadium compounds as catalysts in some chemical processes. There is currently no acceptable substitute for vanadium in aerospace titanium alloys.

<sup>e</sup>Estimated. NA Not available. — Zero.

<sup>1</sup>Domestic vanadium mine production stopped in 1999.

<sup>2</sup>Defined as imports – exports + adjustments for Government and industry stock changes.

<sup>3</sup>See Appendix C for definitions.