

## VANADIUM

*By Peter S. Mitchell*

*Highveld Steel & Vanadium Corp, Kent, UK*

**T**he steel industry, the major customer for vanadium, is reported by the International Iron and Steel Institute to have manufactured 945.1 Mt in 2003. This represents another record tonnage and was driven by a 21.2% increase in steel production in China. Steel production in Europe and the US. exhibited little change from 2002, and in Japan and the CIS increases of 2.6% and 6.0%, respectively, were recorded. Consequently, it has been estimated that vanadium consumption in 2003 was equivalent to 82,100 t of  $V_2O_5$ .

The price of  $V_2O_5$  commenced the year relatively weak at US\$1.60/lb, strengthened to US\$2.65/lb by mid March, declined to US\$1.83/lb in mid-year and then strengthened, to end the year at US\$2.78/lb, the highest level for some time. Ferrovandium exhibited a similar trend, commencing the year at US\$10.15/kg, increasing to US\$13.25/kg by March, declining to US\$10/kg in mid-year, before strengthening to US\$14.85/kg by the end of the year. These prices reflected the oversupply of vanadium prevalent at the start of the year, a reduction in supply owing to suspension of production and other problems observed during the year, as well as the significant increase in steel production during 2003.

### **Supply**

South Africa remained the world's leading provider of primary vanadium units and was responsible for 44% of the global supply during 2003. Highveld Steel and Vanadium Corp, the world's leading supplier, continued to produce vanadium-containing slag,  $V_2O_5$ , vanadium chemicals, ferrovanadium and ferrovanadium nitride at its plants near Witbank. The start-up of Highveld's joint venture with Nippon Denko and Mitsui, for ferrovanadium manufacture, took place in the second half of the year. Highveld also continued to supply vanadium-containing slag to Vametco, a subsidiary of US company Stratcor, based in Brits.

Xstrata plc, the other major producer of primary vanadium units in South Africa, continued to supply  $V_2O_5$ , vanadium chemicals and ferrovanadium from its Rhovan and Vantech plants. Towards the end of the year, Xstrata announced the suspension of supply from Vantech, which had a production capability of 6,140 t of  $V_2O_5$ . The reasons cited were that the ore-body had reached the end of its natural life, along with weak vanadium prices, in conjunction with a strong rand. This latter reason made it uneconomic to develop the Steelpoortdrift ore-body further, and therefore this project has been deferred until more favourable circumstances arise.

Both Highveld and Xstrata produce vanadium products using titaniferous magnetite ore as feedstock.

Primary vanadium production in North America amounted to 11.7% of world supply. During the year McKenzie Bay Resources acquired from Soquem Inc, the 20% share it did not already own in the Lac Dore vanadium project. The company also indicated a desire to commence construction towards the latter part of the year. Additionally, a number of US vanadium producers, including Gulf Chemical and Metallurgical, Shieldalloy Metallurgical and US Vanadium Corp, informed the US International Trade Commission that a planned free-trade agreement between the US and five southern African nations, including South Africa, would threaten their future, citing the delicate state of the vanadium industry in the US. The main producers of  $V_2O_5$  in North America remain CS Metals, Gulf Chemical and Metallurgical Corp and Stratcor, their main feedstocks being spent catalysts and other residues. Bear Metallurgical, Masterloy and Metallurg Vanadium continue to be the main suppliers of ferrovanadium, and Metallurg Vanadium, Reading Alloys and Stratcor/ISA produce aluminium-vanadium master alloys.

In Western Europe, primary vanadium production amounted to 3% of the world's supply, obtained mainly from spent catalysts and other residues. The only producer of primary vanadium units, Orbit Metallurgical in the UK, closed in mid-year. Nikom, in the Czech Republic and Treibacher Industrie AG, in Austria, continued to manufacture ferrovanadium. In Germany, both Treibacher and GfE, which is owned by the Safeguard International Fund, continued to produce vanadium chemicals, and GfE also produced aluminium-vanadium master alloys.

The Russian Federation was responsible for 18% of the world supply of primary vanadium units in 2003. In June, Eastlink Lanker sold its interest in Vanady Tula to Tulachermet, the ironworks in Tula. The sale took place after a lengthy dispute, which affected Vanady Tula's ability to produce vanadium-containing materials. It was also reported that Balausa, a Kazakh company, was seeking finance to mine a vanadium deposit containing 2 Mt of vanadium, in central Kazakhstan. It was envisaged that the vanadium would be recovered as ammonium meta-vanadate and then transported to the Vostokredmet plant in Tajikistan for processing to  $V_2O_5$ , ferrovanadium and Al-V master alloys. Within Russia both Nizhny Tagil and Chusovskoi remained the main producers of vanadium-containing slag, from titaniferous magnetite ore feedstocks, and Chusovskoi and Vanady Tula were the main producers of vanadium-containing products.

China was responsible for 18.4% of the world supply of primary vanadium units. Panzhihua Iron and Steel (Group) Co significantly increased its capacity for the manufacture of a vanadium-nitrogen alloy. Both Panzhihua and Chengde Iron and Steel Co, the other main producer of primary vanadium units in China, continued to produce vanadium slag,  $V_2O_5$ , ferrovanadium and vanadium chemicals. The main feedstock, in both cases, was titaniferous magnetite ore.

The remainder of the Far East, including Australia and Japan, produced 4.7% of the world supply of primary vanadium units. This relatively low figure reflects the fact that Xstrata suspended operations at its Windimurra mine in

Australia at the start of the year, primarily as a result of the depressed price for vanadium products and oversupply of  $V_2O_5$ , at the time. In Japan, it was expected that the commissioning of the Highveld/Nippon Denko/Mitsui joint venture would lead to the closure of Nippon Denko's vanadium recovery plant. Mitsui also announced the liquidation of its Awamura plant, which had been closed since 2001. New Zealand steel continued to produce vanadium slag. Both Taiyo Koko, in Japan and Full Yield, in Taiwan, continued to recover  $V_2O_5$  from spent catalysts and residues. Taiyo Koko also continued to manufacture vanadium chemicals, ferrovanadium and Al-V master alloys.

### **Uses of Vanadium**

Around 85% of vanadium is consumed by the steel industry in a wide range of uses. These uses cover everything from low-carbon flat-rolled steels, through high-strength plates and structural steels, line-pipe, reinforcing bar, forging steels, rail steels, spring steels and tool steels. During 2003, it was reported that researchers in Japan had developed a heat-resistant steel which, as a result of vanadium nitride precipitation, would enable the efficiency of steam turbines to be increased by 5%, resulting in a significant reduction in greenhouse gas emissions. Vanadium is also being increasingly used in China for the manufacture of high-strength, weldable, earthquake-resistant reinforcing bars.

The second most important nonferrous market for vanadium last year was in Ti-Al-V alloys as a  $\beta$ -phase stabiliser, widely used in aerospace applications. The use of vanadium in battery applications continued to grow at a steady rate. Vanadium usage also continued in a range of other applications, including catalysts, pigments, health preparations etc.

Vanitec, the industry's technical committee, continued to support work on the role of vanadium in hard materials, grain-refining mechanisms, weldability, reinforcing steel for cold climates, line-pipe steels, high temperature cracking and TRIP steels. It continued to support student projects in China and a major demonstration project in the US involving the use of vanadium steels.