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## FEATURES

## Vanadium vantage

01 March 2007 11:50

As work to re-open Australia's dedicated vanadium mine at Windimurra moves into the construction phase, Roderick Smith, managing director of the mine's majority owner, briefly reviews progress and outlines the shape of world vanadium production and demand.

When Western Australia's Windimurra vanadium mine was closed by Xstrata in mid-2004, then holders of a substantial controlling stake in the project, vanadium prices were low, flaws had been found in the original plant design, and disagreements with the mine's other owners remained unresolved.

Just under 15 months later, in August 2005, Xstrata completed the sale of its share in the mine to its current owner – and former project partner – Precious Metals Australia Limited. After a thorough review of the project and the steps needed to revive it, PMA is well on the way to re-opening the open-pit mine, situated 650 km north-east of Perth, and to restarting production in January next year.

At the time of writing, a Theiss Promet joint venture is working on the engineering design of the ore treatment plant's crushing-to-beneficiation section, Proteus Engineers were awarded the front-end design and engineering for the magnetite-to-final-product section, while South Africa's Drytech International were awarded a contract to design and supply the equipment for ferro-vanadium production – Windimurra's final product. Production capacity is expected to reach 6,200 tpy of ferro-vanadium, or about 8% of world demand.

Orders have also been placed for long-lead-time equipment, including high-pressure grinding rolls and a gas-turbine power station. The old refractory lining of the 126-metre long rotary kiln has been removed and its replacement put out to tender. The Windimurra village has been reactivated with new dwellings for 140 permanent staff plus accommodation under construction for an additional 160 construction workers.

Hong Kong's Noble Group acquired a 10% stake in the project for A\$13.5m last September. PMA has a sales and marketing agreement with the group for all of the mine's output, under which the commodity trader will pay the higher of the current market price for ferro-vanadium or the cash cost of production for the first seven years. Completion of a A\$48.5m share placement towards the end of last year topped up the company's cash resource to over half of the A\$200m needed to redevelop the project, and project loans will provide the rest.

## Vanadium demand climbs

But given Windimurra's past closure, owing at least in part to poor market conditions, why does the market need another mine now? Put simply, because PMA estimates that global vanadium consumption is now running ahead of supply, stockpiles have diminished, and demand looks set to rise at a healthy 5-7% per year as steel production grows.

Accounting for close to 90% of consumption, carbon (38%), high-strength low-alloy (20%), full-alloy (19%), and tool and stainless (10%) steels dominate vanadium usage. Imparting strength, hardness and wear resistance to quality



The old refractory lining of Windimurra's 126-metre-long rotary kiln has been removed and its replacement put out to tender.

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steels, vanadium's intensity of use is increasing in regions where it was formerly low – notably Asia. In China alone, the production of speciality steels containing vanadium increased by 22.5% during the first six months of last year, significantly outpacing the growth of total steel production.

Consuming most of the balance of world output, Ti-Al-V alloys usually contain 5-6% vanadium to improve strength and high-temperature performance in their multiple aerospace applications. By some estimates Ti-Al-V alloy consumption will double over the next ten years, lifting demand for the high-purity vanadium pentoxide which alloy producers need to make them.

Steel will undoubtedly remain the dominant end-use for vanadium, but growth in aerospace alloys, and the emergence of new uses for titanium-vanadium, will see those uses increase the fastest.

When its price is high, vanadium is sometimes replaced by niobium but, pound-for-pound, its strengthening effect in high-grade rebar, for example, is only around 60% of ferro-vanadium's. Historically, the ferro-vanadium price that triggered replacement by ferro-niobium has been around US\$25/kg, but as prices for ferro-niobium itself increased to levels above that threshold in late-2006 – actually surpassing the prevailing ferro-vanadium price – current market conditions are in vanadium's favour. In 2006 China used over 11,500 tonnes of ferro-niobium, which PMA believes is consumption that will come back to ferro-vanadium below the substitution price.

### **Supply follows slowly**

Most vanadium comes from the tiny proportion of iron ores that are vanadiferous magnetites. Low levels are also found in coal or oil, and a little is recovered from uranium ores. While there is abundant vanadium in the Earth's crust, reserves of vanadium economically recoverable at average prices are not plentiful.

Three important primary vanadium producers – extracting the metal directly from vanadiferous magnetite mined solely for its vanadium content – are based in South Africa: Xstrata's Rhovan mine; Highveld's Vanchem plant, in which Russian steelmaker Evraz has an interest; and Vametco, a subsidiary of the USA's Strategic Minerals Corporation (Stratcor), which is now majority-owned by Evraz. These primary mines' exact circumstances differ, and while they have some potential for increasing output, exploiting it would need either a significant investment in new processing equipment, or greater productivity from existing plant, or an increased supply of ore or slag feed.

Beyond these big primary producers, which produce over 25,000 tpy of vanadium pentoxide between them, over 200 small producers have sprung up in China in the last three years, since Windimurra shut down. They produced over 6,000 tonnes of vanadium from magnetite and stone coal in 2005, but central government pressure to limit small-scale metal production and reduce pollution, a new resource tax on primary vanadium mines introduced in September last year, and a return to long-term average prices are likely to significantly curb output from this source.

Other vanadium suppliers include co-producers, who produce a vanadium-containing slag as a co-product of making iron from vanadiferous titanomagnetite, and recyclers, who extract vanadium from wastes such as fly ash, oil residues or spent catalysts.

Just five steel plants and one pig iron producer worldwide extract vanadium as co-producers, but they account for over half of current global vanadium production. Of these, South Africa's Highveld Steel and Vanadium is the world's largest producer, with an output of around 70,000 tpy of slag, grading 22% vanadium pentoxide. Around two-thirds is shipped to Treibacher in Austria, and the balance is usually split between Stratcor's Vametco plant and Highveld's Vantech primary vanadium plant.

The other co-producers are: Panzihua Iron & Steel and Chenggang, in Sichuan and Hebei provinces, China, respectively; two Russian producers (United Metallurgical Chusovskoy and Tulachermet); and New Zealand Steel.

The idea that co-producers effectively get their vanadium for free is a myth, not

least because, upstream, the titanomagnetite ore that contains the vanadium they extract is a low-grade source of iron (usually 15-30% Fe) and requires special treatment to deal with its titanium content. Co-production of vanadium from steelmaking slag is likely to remain an important source of vanadium, but it is not likely to grow significantly in the future as vanadium prices retreat to long-term historical levels. A rationalisation is more likely, in which producers of slag, such as Highveld and Evraz, might treat more of it themselves to retrieve vanadium, rather than sell it on to others.

Recycling of products containing vanadium, such as catalysts used by the petrochemical and chemical industries, is another source of the element, but has limited scope for expansion.

### **A balance reversed**

Vanadium supply increased in 2000-01, just as steel production and titanium alloy consumption faltered, generating a surplus and depressing prices. Inventories grew and some production closures followed, just as demand took off again in 2004-05 with a predictable dramatic increase in price, which spiked at nearly US\$60/lb for ferro-vanadium in the European and US free markets.

Today, ferro-vanadium prices in Europe have hit a two-year low, dipping below \$30/kg duty-paid delivered (70-80% vanadium content), according to Metal Bulletin Research data. But in the longer term, given the major influences on supply and demand outlined, PMA is confident that the outlook for vanadium is a bright one.

Roderick Smith is managing director of Precious Metals Australia (PMA). This article was adapted and updated from his presentation "Vanadium demand and supply trends", made at Metal Bulletin's 22nd International Ferro-alloys conference in November last year.



Precious Metals Australia is well on the way to re-opening Windimurra's open-pit mine, which was last mined in 2003.

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