

Research Group



Info Mine 

Association of Independent Consultants and Experts
in the Field of Mineral Resources, Metallurgy and Chemical Industry

Vanadium and Ferrovandium in CIS

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Summary

In the nearest future Russian vanadium production will remain competitive and will keep its position on the world market mainly due to comparatively low prices for home energy resources, workforce and low cost of environment protection measures.

At the same time, Russian vanadium complex is characterized by heavy wearing-out of production capacities, for supporting of which large investment is required, and recently, Russian enterprises started first steps in this direction: after sharp rising of prices for vanadium products, the enterprises got means for modernization.

At that, creating new production capacities (project of “NTMK”) will lead to considerable increasing competition between Russian manufacturers. Overall, conditions for competitors are stable on that market, and due to influence of some factors (complexity in arranging production, high cost of equipment, lack of qualified personnel for this field, etc.), their considerable change is only possible within a large period.

Volumes of export of vanadium products will remain at quite a high level in Russia in the nearest years.

The demand for vanadium is limited on the home market, consuming industries are developing slower than manufacturing ones, and nevertheless, increase of demand is expected: because of the difficulties of sales of steel for common use, some manufacturers can switch to production of vanadium-alloyed steel.

Home consumption of vanadium will rise and, according to forecasts, should increase by 2008, mainly due to expanding production of low-alloyed steel for fuel and energy complex, metal for railways. However, this will occur if prices for vanadium products considerably decrease.

According evaluation of “InfoMine”, in 2007-2008, consumption of vanadium pentoxide in Russia will be at least 3.6-4 kt; consumption of ferrovandium can reach 7.5-8 kt.

Prospects of increasing production of ferrovandium in Russia are closely connected with increasing production at “ChMZ” and JSC “Vanady-Tula”. In the nearest three years, there will appear no new manufacturers: putting aside the plans of “Yevrazkholding”, arranging production of ferrovandium and finishing the technology is rather long process, the result of which nobody can forecast.

In 2004, “ChMZ” produced 5.4 kt of ferrovandium (converted for FVd 38). Increase is planned for 2005 up to 6.1 kt; theoretically, production capacities allow output up to 7.5 kt of the product per year. However, considering that the most part of ferrovandium is exported from the enterprise, and a tendency exists on the world market of forcing out FVd50 produced at “ChMZ” in the favor of FVd80, sharp increase of production is not expected.

The situation can only change after modernization and, at the same time, increasing capacities up to 10.5 kt per year, and setting production of FVd80 and bringing its share to 70% in the production structure. However, modernization of the ferroalloy shop is closely connected with updating the whole steelmaking capacities of the enterprise. Besides, it is probable that “OMK”, comprising “Chusovskoy” works, will make a decision of selling of the works, and, in this case, its modernization will be suspended.

As experts of “InfoMine” say, output of “ChMZ” will reach 6.5 kt by 2008 on condition of remaining of favorable situation on the world market of vanadium.

“Vanady-Tula” has sharply increased production of ferrovanadium recently, in 2003, it produced 8.8 kt (+40%), and in 2004, 11.6 kt (+32%). At that, production capacities of the enterprise are evaluated as 15 kt.

It is very probable that there will be no such a sharp increase any more, however, the enterprise announced intention for further growth of production volume at favorable world market situation. The situation of the company is more attractive on the world market: it controls 20% of the market, producing FVd80 and FVd50, in 2005, the enterprise reduced output of 50% alloy and increased the share of the 80% one. As management of the enterprise says, in future, “Vanady-Tula” plans to completely reprocess all vanadium pentoxide into ferrovanadium, but that is probable, that capacities of Nikom, a purchased Czech works for production ferrovanadium, are taken into account, which now receives raw materials from Tula on commission. According to experts of “InfoMine”, in 2005 production of ferrovanadium will remain on the level of 2004, i. e. 11.5-11.6 kt. In 2006-2008, there can be an increase up to 12 kt.

Introduction

Demand for vanadium has risen during recent years, along with increasing the consumption of alloyed steel. As is known, steel containing this metal possesses increased elasticity and strength. Such steel is used for producing especially important parts of automobiles, rockets, nuclear reactors, tubes for oil and gas pipelines for exploiting in very close climate conditions (the latter is very important for Russia).

In the former USSR, there were considerable co-operative relations among enterprises producing vanadium-containing products (in Russia, Tajikistan, Ukraine, and Kazakhstan). At present, a part of these connections is broken, but that has not had any effect on Russia, which was, and remains, the principal manufacturer of that product. At that, production volume in Russia is high enough for influencing the world market.

Vanadium occurs in titanium containing, phosphate ores, uranium-containing sandstone and siltstone, in which its content does not exceed 2%. Some vanadium is present in bauxites and carbonic materials, such as raw oil, carbon and tar sand. Vanadium is usually extracted as accompanying product.

1. Overview of the World Market of Vanadium

All over the world, vanadium is extracted from vanadium-containing slag (68% of the whole production volume), vanadium ores (23%), oil-processing wastes and other lateral materials (9%).

The main source of raw materials for producing vanadium materials are complex iron ores containing vanadium, mainly titanium-magnetite ones.

The leaders as to extraction and reserves of titanium-magnetite ores are *SAR*, *Russia* and *CPR*. Australia, the USA, Canada, and some other countries, also possess some reserves of such ores. However, vanadium-containing minerals nowhere form any deposits rich enough for economically effective extraction, so vanadium is usually extracted together with other materials as lateral product or by-product.

As *US Bureau of Mines* evaluated in 1991, recoverable reserves of vanadium ores were 4268.3 kt all over the world, as to content of vanadium. At the present level of extraction, those reserves will suffice for over 100 years. Explored reserves of vanadium-containing ores are over 16 million tons all over the world.

According to data from *the US Geological Service* (USGS), world natural reserves and base of reserves of vanadium were characterized by the following indices at the end of 2004 (see Table 1):

Table 1. World Reserves of Vanadium Ores, kt

	Reserves	Reserve Base
Total	13000	38000
CPR	5000	14000
Russia	5000	7000
SAR	3000	12000
USA	45	4000
Other countries		1000

Source: USGS

Geological Service of the USA evaluates world extraction volume of vanadium, converted to content of the metal, as follows (see Table 2):

Table 2. World Extraction Volume of Vanadium (kt converted to content of V)

	2003	2004
Total	41	44
SAR	18	20
CPR	13.2	13.2
Russia	8.5	10
Other countries	1	1

Source: USGS

As is seen from the data presented, in 2004, extraction of vanadium in the form of ore rose by 7.3% as compared with 2003, at that, the largest increase of extraction was in SAR (+2 kt of vanadium in the form of ore) and Russia (+1.5 kt of vanadium in the form of ore).

Considerable reserves of vanadium are concentrated in bituminous shale, raw oil and oil-bearing sands, phosphate rock etc. In various countries, a role is being rising of man-caused raw material for producing vanadium out of the products of oil processing, slag and ashes. For example, *in the USA*, wastes are actively used of processing and burning oil and derivatives, at that, the share of vanadium obtained through this way is a half of the total consumption volume of this metal in the country. One ton of oil of heavy sorts contains up to 300 g of vanadium and about 40 g of nickel. For bitumen, these indices are 7-10-fold higher. At burning or distillation of oil and derivatives, content of vanadium in vat residue or ashes increases 100-1000-fold. *In Russia*, these resources of vanadium are not widely used, though they have rather good prospective.

Production of **vanadium pent-oxide** is carried out in a small number of countries all over the world. According to information obtained from all sources available on production volume, the following indices may be supposed: 44-46% in SAR, 20-22% in Russia, 10-13% in the USA, 10% in Australia, 8% in China, 4% in New Zealand, 2% in Kazakhstan, 1% in Japan, about 2% in all other countries.

Level of consumption of vanadium has steadily increased during recent decades. In 1960, only 9 kt of vanadium were consumed annually all over the world, but in 40 years this index reached a value of 39.3 kt. Economic crises of 1998 (Asia) and 2001 (the USA and EC) were a considerable obstacle for the process and noticeably decreased the prices for vanadium. In 2002, world consumption of vanadium was only 34.7 kt. In 2003, however, the demand for vanadium started growing at advanced rates. The reasons are the following:

- general increase in steel production (according to data from the International Institute of Steel and Iron (IISI), world production of steel rose by 100 million tons during two years, or by about 12%. as about 85% of vanadium materials are used for producing high-quality steel, the demand for ferrovanadium also rose and is still keeping rising),
- advanced increase in manufacturing structural, stainless and special steels, especially in China,
- reducing production of vanadium in Australia and SAR, delay in introducing new capacities in Canada,
- rapid growth of prices for a range of steel ligatures (in the first place for nickel-containing) and searching for their substitutes,
- besides, as some experts say, the prices for vanadium materials did not reflect the real market situation and were subject to speculating and manipulation from the part of lots of traders involved into operations with vanadium.

Excess of vanadium-containing product, which took place at the end of the 90s and beginning of the 2000s, decreased in 2003 due to closure of Windimurra Mine, in Australia, and Vantec Mine, in SAR, mines, as well as due to decreasing production at “Vanady-Tulachermet” works in Russia. Collected between 1999 and 2003 considerable store-house reserves of vanadium were gradually consumed in 2003, which led, in 2004, according to data from the Geological Service of the USA, to balancing the market, and according to data from Rare Metals News, to shortage in deliveries of the metal (see Table 3).

**Table 3. Characteristics of the World Market of Vanadium
(kt converted to V₂O₅)**

Production	2003	2004	2005*
SAR	33.6	35.8	37.2
APR	17.9	18.6	22.2
Europe/CIS	10.9	15	17
USA	9.3	10.4	12.2
Total	71.6	79.8	88.7
Demand**			
North America	17.2	17.7	19.1
Western Europe	17.7	18.6	19.1
China	8.6	14.5	18.1
Japan	8.6	9.1	9.5
CIS	6.4	7	7.7
Other countries	14.1	15.6	16.8
Total	76.4	86.9	95
Balance	-4.8	-7.1	-6.3

* forecast

** taking into account losses at processing, which were evaluated as 3.8 kt in 2003, 4.3 kt in 2004, 4.8 kt in 2005

Source: Roskill's Letters from Japan

As *Roskill's Letters from Japan* says, referring to *Rare Metal News*, a deficit is forecast in the world market of vanadium deliveries in 6.3 kt, converted to V₂O₅, in 2005. The world production of the metal, at that, will rise by 11%, approximately up to 88.7 kt, converted to V₂O₅, mainly due to increasing production in SAR, Russia and CPR. The share of CPR in the total production of vanadium will rise up to 20%, but, due to a heavy demand for the product in the home market, the country will become a net importer of the product.

World demand for V₂O₅ will increase, according to the forecast, by 9% in 2005, approximately up to 95.0 kt. As to the rate of growth of demand, CPR will be the leading country; the growth of demand is expected to be over two-fold as compared with the level of 2003, i. e. from 8.6 to 18.1 kt of V₂O₅. The principal growing branch consuming vanadium is production of steel for building industry. In Europe and the

USA, an important field for using vanadium is production of titanium alloys (Ti-6Al-4V) for aircraft and space industry.

Table 4 shows the structure of world consumption of vanadium. Up to 87% of vanadium is used in ferrous metallurgy as an effective alloying addition at production of steel of various assortments. About 8% are used in non-ferrous metallurgy, mainly in the form of aluminium-vanadium alloys for alloying structural titanium-based materials used in aircraft construction and space equipment production. The rest is used in chemical industry, in particular, for production of accumulator batteries.

Table 4. Structure of Consumption of Vanadium All Over the World

Consuming branches	Share, %
Carbon steel	38
High-strength low-alloyed steel	20
Alloyed steel	19
Tool and forming steel	10
Titanium alloys	8
Chemical products	5

Source: Issues of the IX All-Russian Conference on "Vanadium: Chemistry, Technology and Usage"

The most common vanadium-containing products are vanadium pentoxide (V_2O_5) and ferrovanadium (FeV 80%).

Consumption of vanadium is expected to rise in the nearest 5-10 years due to expanding its usage for producing high-strength low-alloyed steel and polymeric lithium-vanadium accumulator batteries. In the nearest future, five kt of vanadium will be used for producing such batteries per annually, and the share of the world production of vanadium-containing steel will rise from 5-10 to 20-30%.

China is becoming the leading vanadium-consumer country, the usage of vanadium for production a ton of steel being increasing. It is known that the consumption of vanadium in China rose by 54% in 2002 as compared with the level of 2001. China is now considered the third manufacturer of *vanadium raw materials*, following SAR and Russia. China is also one of the leading world manufacturers of *vanadium products*; its share of the world production volume was about 15% at the beginning of the 1990s.

The USA is both one of the leading manufacturers of vanadium raw materials and consumers of vanadium products. In 2004, on the total, eight companies manufactured vanadium products in the USA, including ferrovanadium, vanadium pentoxide, metallic vanadium, vanadium-containing chemicals and special alloys, processing, at that, such materials as oil-processing wastes, dead catalysts, ashes and vanadium-containing slag. About 90% of vanadium used in the country was consumed by metallurgical industry. Among non-metallurgical field of consumption, production should be noted of catalysts for chemical industry.

In 2005, a plant for producing vanadium pentoxide of **CM Metals** Company stopped operation in Louisiana, but the major part of market participants does not suppose that that event will have any considerable influence on the American market. **Stratcor** Company, the leading American manufacturer of ferrovanadium in Connecticut, previously buying vanadium pentoxide from CS Metals, switched to purchasing the material from alternative suppliers. As Stratcor's representative assured, deliveries of vanadium pentoxide from CS Metals had not exceeded 10% of the total delivery volume. Stratcor had possessed 50% of the stock of CS Metals before, but in 2002, the stock was sold, and, according to some informational sources, the last owner intends selling the enterprise once more, and until then, operation of production capacities will remain stopped. As one of traders say, on the overall background of deliveries on American market, that event will have just a local importance, because supply of ferrovanadium on the market of the USA has been and remain insufficient.

Suppliers of *ferrovandium* for the USA in 2000-2004 were the following countries: Czechia – 25%, SAR – 20%, Canada – 17%, CPR – 14%, other countries – 24%, of *vanadium pentoxide*: SAR – 95%, Mexico – 2%, other countries – 3%.

Preliminary estimated, the consumption of this metal in the country increased by about 13% in 2004 as compared with 2003 (see Table 5). 5). 34, 30 and 29% of the total consumption vanadium in the USA are used for production of high-strength low-alloyed steel, high-alloyed steel and carbon steel. Production of steel had been expected to rise by 2-3% in 2004 as compared with 2003, but it practically rose by 5.1%.

**Table 5. Characteristics of Vanadium Market in the USA
(tons, converted to content of the metal)**

	2000	2001	2002	2003	2004
<i>Import for consumption</i>					
Ores, slag, ashes, wastes	1890	1670	990	1630	1830
Vanadium pentoxide, anhydrous	902	600	406	474	1230
Oxides, hydroxides etc.	14	1080	42	39	193
Aluminium-vanadium ligature	16	10	98	232	33
Ferrovandium	2510	2550	2520	1360	3260
<i>Export of the products</i>					
Vanadium pentoxide, anhydrous	653	71	91	185	376
Oxides, hydroxides etc.	100	63	203	284	709
Aluminium-vanadium ligature	677	363	529	671	807
Ferrovandium	172	70	142	397	214
<i>Consumption (according to data from companies)</i>	3520	3210	3080	296	3350
Store at consumers (at the end of the year)	303	251	221	220	219
Average price (\$ per American pound)	1.82	1.37	1.34	2.21	5.28

Source: Information bulletin of the Ministry for Economic Development of RF

Number of companies manufacturing vanadium products in Western Europe has sharply decreased due to lack of own raw material (extracting vanadium-containing magnetite was stopped in Finland and Norway at the beginning of the 80s), as well as due to some economic and ecological reasons.

Xtrata Vanadium, a Swiss company, is the only world manufacturer of vanadium extracting and processing vanadium raw materials over two continents. The share of the company in 2003 was a quarter of world production of vanadium pentoxide (V_2O_5), which was manufactured at the two plants of the company, namely **Vantech** (stopped at present) and **Rhovan** in South Africa, and **Windimurra** plant (stopped at present) in Western Australia. Xtrata Company takes the second place in the world as to production of vanadium, following **Highveld Steel and Vanadium**, British & American company.

Xtrata acquired Vantech and Rhovan enterprises from Glencore Company in 1999. Glencore remains the only agency dealing in trade of all vanadium products manufactured by Xtrata.

Vantech plant produces three kt of V_2O_5 per year. Vantech exploited a deposit of vanadium with the highest content of V_2O_5 , i. e. 2.3%.

Windimurra plant (Western Australia) was put into operation at the end of 1999, its production capacity being 780 tons of V_2O_5 per year, and the costs for maintaining the enterprise were much more than those of two enterprises in South Africa. The deposit is the only one in the world containing weathered rock of vanadium- and titanium-containing magnetite. Although chemical properties of the ore of the deposit are similar to those extracted in South Africa, Russia and China, the physical properties are very different due to weathering the rock. The deposit possesses reserves enough for 20 years of operation with expansion potential up to 100 years.

Highveld Steel and **Xtrata** companies produce together over 50% of the total world volume of V_2O_5 , the rest being produced in China and Russia.

Production of ferrovandium is much wider. There are about 15 manufacturers of the product, mainly in economically developed countries of Northern Hemisphere.

The largest manufacturers of vanadium and derivatives are also the following countries: **Shieldalloy Metallurgical Corp** (USA), **Vametco Minerals Corp**, (a part of Strategic Minerals Corp. (Stratcor) (USA), **Nippon Denko** (Japan), **Mitsui Co. Ltd.** (Japan), **Vanady-Tula**, **Chusovskoy Metallurgicheskoy Kombinat**, **Precious Metals Australia** (PMA).

The largest manufacturer in Germany is **Gesellschaft für Elektrometallurgie GmbH** Company. Other large-scale manufacturers in Europe are the following companies: **Treibacher Chemische Werke A.G.** in Austria and **S.A. d'application de Chim Industrielle (Sadaci S. A.)** company in Belgium.

Vanadium products are also manufactured in small amounts in Czechia, Brazil and India.

Production volume had exceeded consumption on the world market until 2004.

Prices for ferrovanadium (80% V) and vanadium pentoxide, on the average, were \$10 and \$6 per kg, respectively. Sometimes, jump of prices took place due to temporary cutting production of vanadium.

In 2004, vanadium sharply rose in price. In the first quarter the prices rose up to \$12-13 per kg of V_2O_5 and \$28 per kg of *ferrovanadium*, which fact can be explained by the following reasons: - general rise of demand for vanadium in the world because of increasing steel production, - considerable increase of consumption of vanadium in China and cutting its export from that country, - stopping operation of two enterprises of *Xtrata* company, namely *Winidimurra* (Australia) and *Vantech* (SAR), which led to decreasing production of vanadium pentoxide by the company in 2003 to 29 million pounds (13 kt), while in 2002, the company produced 41.3 million pounds (18.8 kt) of the product, - decreasing the volume of vanadium products at “Vanady-Tula” enterprise.

In 2005, *the prices for ferrovanadium* rose from the level of \$48-52 per kg at the beginning of March 2005 to \$78-81 per kg, and prices for V_2O_5 rose nearly two-fold as compared with the previous year, i. e. \$16-18 per ton. In the middle of April, the prices for ferrovanadium reached their peak value of \$123-128 per kg. Industrial information sources explained such a considerable rise in prices for vanadium, first, by cutting deliveries of the material for the market and by stable growing of demand for vanadium from the part of steel manufacturers and aircraft and space industry. In Europe, the prices for ferrovanadium were kept on the level of \$125 per kg in the spring of 2005, and those for ferrovanadium with 50% content, on the level of \$110 per kg.

On the USA market, in April of 2005, a fact was reported of passing by the prices for ferrovanadium a mark of \$50 per pound. Purchasing was reported of the material at a price of \$50 per pound by a metallurgical works for using the ferrovanadium in the second quarter, and by another consumer at a price of \$52 per pound at delivery in the volume of truck. Traders noted that they do not meet a very strong resistance from the part of consumers, mainly, because the latter do not generally have a large choice and many offers. Traders and manufacturers acknowledge that they have raised the prices up to the upper limit of the range of \$50-60 per pound, influenced by active sales of ferrovanadium.

In April, metallurgical works bought material for April, May and June. However, in May the prices began lowering due to decrease of demand for those ferroalloys from the part of European manufacturers of stainless steel, which, in their turn, also decreased the production.

In May, European prices for ferrovanadium lowered to \$116-120 per delivered kg, and the traders, which had bought the material in condition of rising prices, tried to quickly liquidate their stores and to get profit without any loss. As traders say, “...when prices were rising, which process was very active, the traders literally snatched such a lot of material, as they only could get. These reserves were mainly distributed over customers and consumers, but the traders are keeping some reserves of material, mainly of South-African origin, which was bought in the period of \$70-

80-90-per-kg prices, and now, time and prices are very profitable for realization of this material. But, if that will do, nearly all material will keep belonging to manufacturers once again”.

In the middle of June, the prices for ferrovanadium of the basic content of 70-80% lowered from \$100-107 per kg to \$98-104 per kg, and for 50% ferrovanadium, the range of prices was \$93-95 per kg. In the middle of July, European prices for ferrovanadium were \$68-71 per kg.

As some traders say, such increase in prices for that material was excessive, and for “noble” allows, in general, too, and lowering of prices was too much belated.