NIOBIUM

by Louis Perron, (613) 992-4828

Summary

Canada's 1994 production of niobium concentrates was 3300 t of niobium pentoxide (Nb_2O_5), a decrease of 3.6% compared to 1993. Ferroniobium production from Niobec Inc.'s newly built plant was 96 t grading 65% niobium.

According to world statistics compiled by the Tantalum-Niobium International Study Center (T.I.C.), supplies of niobium concentrates in 1994 decreased by about 10% compared to 1993. However, consumption increased by about 12% to reach 15 825 t niobium content. The increase in consumption came mostly from an increase in demand for the manufacture of steel-grade ferroniobium as a result of increased industrial activity.

Prices for niobium concentrates and intermediate products in 1994 remained constant and are expected to stay at that level in the short term.

The market is expected to remain in balance in 1995. Consumption is expected to increase in the short term following increased demand from the steel industries of economies, such as Japan's, that are emerging from a long recession.

Uses

Niobium is used mainly in the steel industry, the superalloy industry and in industry segments using niobium oxides and other compounds such as for optical glass and enamels.

The steel industry consumes around 90% of all niobium used, mostly in the form of ferroniobium. In the steel industry, the T.I.C. estimates that high-strength low-alloy (HSLA) steels account for over 75% of niobium consumption, stainless and heat resisting steels for 15%, while the rest is for miscellaneous uses.

In the HSLA segment of the industry, niobium is used as a grain refiner and precipitation strengthener. Its use improves the yield strength and mechanical properties of the steel, which are important characteristics in applications such as large-diameter oil and gas pipelines, automotive components, structural components, rails, and drilling platforms.

In the manufacture of stainless steels, niobium is used to impart resistance to corrosion at elevated temperatures, a property of particular importance in applications such as exhaust systems for automobiles, petroleum-processing plants, heat exchangers for severe chemical environments, and acid pressure vessels.

The superalloy industry uses ferroniobium and high-purity niobium pentoxide, mainly for aircraft applications such as for turbines and engines. In these applications, niobium is used to improve the high temperature characteristics of cobalt- and nickel-based superalloys.

Niobium is also used for its property as a superconductor in the magnet industry, for optical applications in cameras and eyeglasses, for surgical implants, and for various other uses.

According to the T.I.C., niobium usage is expected to increase marginally following the growth of the steel industry. The end-use segment showing the best growth potential is the steadily expanding stainless steel industry, which is growing at a compound rate of over 4%/y. Other applications in the automotive industry, such as exhaust systems and other parts exposed to corrosion, offer new potential for niobium. In contrast, niobium's use in the form of alloys and compounds has suffered in recent years with the decline of the aircraft, aerospace, and nuclear energy industries. These industry segments should, however, contribute to the growth of niobium in the more distant future.

Canadian Developments

Canada, the world's second largest producer of niobium ores and concentrates, produced about 3300 t of contained Nb_2O_5 in 1994, a decrease of 3.6% from 1993. It also produced 96 t of ferroniobium grading 65% niobium at a newly built plant in Quebec.

In Canada, niobium is produced at the Niobec mine located near St-Honoré, Quebec. The mine, owned 50-50 by joint-venture partners Teck Corp. and Cambior inc., produces ores grading an average of 0.70% Nb_2O_5 which are beneficiated on site to obtain a final concentrate grading about 65% Nb_2O_5, or 43% niobium.

In October 1994, Niobec started producing ferroniobium at its new 3200-t/y capacity plant built at a cost of $7 million at the Niobec mine site. The plant uses an aluminothermic process to smelt niobium from pyrochlore. This signalled the pull-out of the company from the concentrates market since all of the mine's production will now be converted to ferroniobium instead of being shipped to converters in the United States, Europe and Japan.

The company's decision to enter the ferroniobium market, and to increase the value of the product marketed, came from the uncertainty caused by financial and environmental problems faced by the converters who were buying the concentrates from

Niobec. These converters are now left without concentrate supplies since Canada was the last significant world supplier. Brazil is also converting all of its production.

Other potential sources of niobium in Canada include the Thor Lake deposit near Yellowknife in the Northwest Territories, which has reserves of 70 Mt grading 0.57% Nb_2O_5, the Aley deposit located in British Columbia, the Oka mine in Quebec, and the Strange Lake deposit on the Labrador-Quebec border.

In 1993, Canada's reported consumption of ferroniobium, at 805 t niobium content, was 28% higher than in the previous year and one third the level of U.S. consumption (2477 t). This increase was brought about by increased steel production at companies across Canada. In 1994, imports, consisting mostly of ferroniobium, were valued at C$19.1 million, an increase of 7.8% over 1993, while exports consisted mostly of ores and concentrates from Niobec.

World Developments

According to statistics compiled by the T.I.C. for the first nine months of 1994, the world's niobium production for the year is estimated at 22 085 t Nb_2O_5 content, a decrease of 10% compared to 1993.

Based on statistics compiled by the T.I.C. for the first six months of 1994, niobium consumption for the whole year is estimated at around 15 825 t niobium content, an increase of about 12% compared to 1993. This market view is arrived at after statistics, showing a consumption of 17 240 t, are discounted to take into account a change in inventory policy at Companhia Brasileira de Metalurgia e Mineração SA (CBMM) in Brazil, the largest world producer of niobium. Practically all of the consumption increase mentioned above is attributed to a hike in demand for steel-grade ferroniobium.

Over 95% of the total world supply of niobium comes from pyrochlore ore produced at three mines. These are CBMM and Mineração Catalão de Goiás SA (Catalão) in Brazil, and Niobec Inc. in Canada.

Brazil

Brazil has 78% of the world's reserves of niobium and is the world's largest producer with 80% of total output. Niobium mining operations in Brazil are operated mostly by two companies. CBMM, which operates the Araxá mine in Minas Gerais State, has reserves estimated at 461.7 Mt grading 2.5% Nb_2O_5. The second producer, Catalão, operates a mine in Ouvidor, Goiás State.

In May 1994, in an effort to reduce ferroniobium production costs and have better control on its toxic emanations, CBMM switched its production process from the conventional thermite furnace to a smelting process using an electric furnace. By doing so the company will reduce its consumption of aluminum used as a reducing agent in the aluminothermic process, and will ensure the stabilization of the selling price for ferroniobium on a long-term basis.

Paranapanema SA Industria e Construção, the leading tin producer in Brazil, has plans to diversify its production by marketing other chemical elements found with tin at its Pitinga mine in the western Amazon. A niobium-tantalum recovery plant located near Sao Paulo, which was built in 1988 and shortly after put on hold, was operated by the company at a reduced capacity in 1994 using feedstock from the Pitinga mine. If operated at capacity, the plant could produce 360 to 720 t of contained Nb_2O_5 in 1995.

United States

During 1994, Shieldalloy Metallurgical Corp., a major U.S. producer of ferroniobium for steel-making and a subsidiary of Metallurg Inc., remained protected from its creditors under Chapter 11 of the U.S. Bankruptcy Code. The upturn in demand for ferroniobium during the year helped the company and, by the end of the year, it was on its way to resolving the situation with its creditors.

Japan

The Japan Metals & Chemicals Co. (JMC) announced that it will suspend ferroniobium production at its Oguni plant as soon as an import deal is struck with Mitsui & Co., Niobec Inc.'s sole agent in Japan. Until recently, JMC was importing niobium concentrates from Niobec, but with the latter now converting all of its concentrates on-site, few options are left open to JMC. The Oguni plant is Japan's last ferroniobium producer. Other smelters operated by Awamura Kinzozu, Taiyo Koko, NKK, and Nippon Denko stopped producing around 1991 due to stricter environmental controls.

Other Developments

Helsinki-based Kemira Agro Oy re-examined the pyrochlore-rich Sokli carbonatite occurrence in northern Finland and estimated reserves of niobium at 100 000 t metal content. Reports from the company state that ore grades are equivalent to grades at producing mines, and that technical and economic evaluations are ongoing.

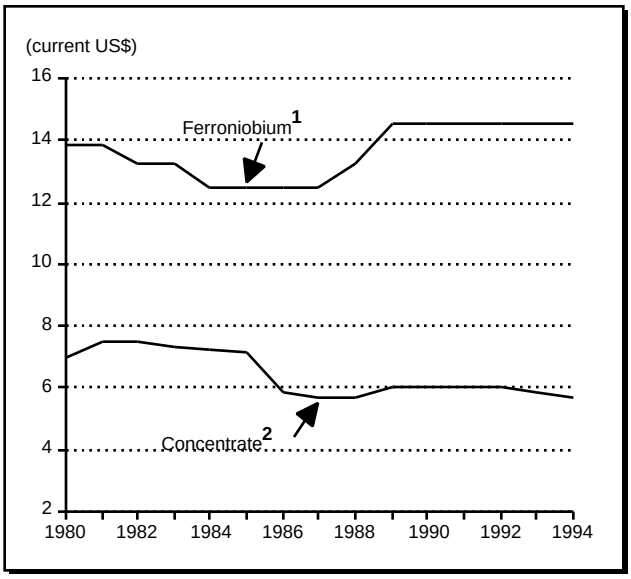
Also, Almazy Rossii-Sakha, Russia's Yakutia-based diamond mining joint stock company, signed an agreement with the Yenisei mining and chemicals plant to produce about 65 t of niobium. Under the agreement, Almazy would ship 1000 t/y of niobium concentrate to the plant from its Tomtor rare earth deposit in Northern Yakutia until its own plant is operational, expected by 1997.

Prices

In constant dollar terms, the price for niobium concentrates has been decreasing since 1977. This is due in part to the large supplies of concentrates readily available on the market from Brazil and Canada.

Published prices for pyrochlore concentrates produced in Brazil and Canada have not been available since 1981 and 1989 respectively, since most of the production is being sold through long-term contracts. The *Metal Bulletin* published spot price, which has remained stable since May 1993, quotes a range of US$5.29-$5.73/kg of contained Nb_2O_5 for concentrates grading a combined 65% Nb_2O_5 + Ta_2O_5, at a ratio of 10:1. Similarly, the *Metals Week* quoted spot price for standard-grade ferroniobium has remained constant at US$14.50/kg of contained niobium, f.o.b. port, since July 1989.

Figure 1
Niobium Price Variations in the Past Fifteen Years, 1980-94



Sources: *Metal Bulletin; Metals Week.*

[1] Average year-end price per kilogram contained Nb, for standard-grade ferroniobium, f.o.b. port.

[2] Year average price per kilogram contained Nb_2O_5, c.i.f. Europe; for concentrates, 65% Nb_2O_5 + Ta_2O_5, 10:1.

Outlook

In 1995, Niobec Inc. is expected to produce 2200 t of ferroniobium. The company also plans to invest $6 million to deepen the mine shaft to access additional ore reserves. The mine has sufficient reserves for 15 years of operation.

On the world supply side, there will be excess ore production capacity for decades to come. Brazil, with its abundant proven reserves, will continue to be the dominant supplier for the foreseeable future. However, should the world balance change, a number of deposits in Canada, Gabon, Zaire, Greenland and elsewhere could be brought into production rapidly.

Supply is more than adequate to meet any potential demand and, as a result, prices for niobium concentrates and intermediate products are expected to remain stable at their present low level in the near future.

In the short and medium terms, consumption of niobium is expected to increase further following greater industrial activity in the recovering world economies. Growth should centre around the steadily expanding stainless steel industry, increased sales in the automotive industry, and the recovering aircraft industry. In contrast, the continued reduction in military spending is expected to lead to reduced demand from the aerospace sector.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2615.90.00.10	Niobium ores and concentrates	Free	Free	Free	Free
7202.99.90.90	Ferroniobium	9.5%	6.5%	Free	Free
8112.91.10.40	Niobium (columbium), unwrought metal, not alloyed; powders, not alloyed	3.7%	Free	Free	Free
8112.91.20.14	Niobium (columbium), unwrought metal, alloyed; waste and scrap; powders, alloyed	8.8%	6.5%	Free	Free
8112.99.90.40	Niobium (columbium), other	8.8%	6.5%	Free	Free

Sources: Customs Tariff, effective January 1995, Revenue Canada; Harmonized Tariff Schedule of the United States, 1995.

TABLE 1. CANADA, NIOBIUM (COLUMBIUM) IMPORTS, 1992-94

Item No.		1992		1993		1994p	
		(kilograms)	($000)	(kilograms)	($000)	(kilograms)	($000)
Imports							
2615.90.00.10	Niobium ores and concentrates						
	Germany	–	–	–	–	11	...
	United States	33	1	–	–	–	–
	Total	33	1	–	–	11	...
7202.93	Ferroniobium						
	Brazil	429 532	4 035	872 344	9 543	1 442 313	16 709
	United States	691 015	7 238	697 394	7 743	151 233	1 643
	Other countries	17	...	–	–	142	2
	Total	1 120 564	11 274	1 569 738	17 287	1 593 688	18 354
8112.91.10.40	Niobium (columbium), unwrought metal, not alloyed; powders, not alloyed						
	Estonia	–	–	–	–	8 200	325
	United States	309	21	610	45	483	36
	Other countries	–	–	–	–	413	30
	Total	309	21	610	45	9 096	392
8112.91.20.14	Niobium (columbium), unwrought metal, alloyed; waste and scrap; powders, alloyed						
	United States	2 979	106	2 427	169	2 371	165
	Brazil	3 000	69	–	–	1 557	108
	Total	5 979	176	2 427	169	3 928	274
8112.99.90.40	Niobium (columbium), other						
	United States	2 662	196	3 022	220	1 063	78
	United Kingdom	–	–	4	...	–	–
	Total	2 662	196	3 026	220	1 063	78

Source: Statistics Canada.
– Nil; ... Amount too small to be expressed; p Preliminary.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, NIOBIUM (COLUMBIUM) PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975 AND 1980-94

	Production[1]	Imports		Exports[2]	Consumption[3]
		Primary Forms and Fabricated Metals			
	Nb_2O_5 content	Niobium	Niobium Alloys	Niobium Ores and Concentrates to United States	Ferroniobium and Ferrotantalum-niobium (Nb and Ta-Nb content)
		(kilograms)			
1970	2 129 271	..	..	576 227	132 449
1975	1 661 567	..	..	9 682	215 910
1980	2 462 798	877	156	655 721	486 251
1981	2 740 736	913	303	419 865	455 500
1982	3 086 000	805	59	291 193	356 000
1983	1 744 722	967	396	543 599	359 000
1984	2 766 805	1 045	236	1 132 892	482 000
1985	3 182 900	889	499	1 279 764	447 000
1986	3 346 100	706	963	1 292 623	438 000
1987	2 769 800	3 922	6 302	2 035 510	574 000
1988	3 367 200	See Table 1	See Table 1	1 662 000	657 000[r]
1989	3 502 800	See Table 1	See Table 1	2 213 000	670 000
1990	3 394 000	See Table 1	See Table 1	2 222 000	703 000
1991	3 365 800	See Table 1	See Table 1	2 241 000	726 080[r]
1992	3 283 600	See Table 1	See Table 1	2 214 000	629 789
1993	3 423 800	See Table 1	See Table 1	2 217 000	805 000
1994[p]	3 300 000	See Table 1	See Table 1	..	..

Sources: Natural Resources Canada; Statistics Canada; U.S. Department of Commerce.
.. Not available; [p] Preliminary; [r] Revised.
[1] From 1970 through 1984, the data represent producers' shipments of niobium ores and concentrates and primary products, Nb_2O_5 content. From 1985 onward, the data represent company published information. [2] From U.S. Department of Commerce, Imports of Merchandise for Consumption, Report FT 135 for 1970-87. From U.S. Department of Commerce, Minerals Yearbook, Columbium and Tantalum, for 1988-93. Quantities in gross weight of material. [3] Available data as reported by consumers.

TABLE 3. T.I.C.[1] NIOBIUM STATISTICS, 1991-94

	1991	1992	1993	1994[e]
	(000 kg contained Nb_2O_5)			
PRIMARY PRODUCTION				
In niobium concentrates: pyrochlore, columbite	22 268	20 003	15 796	21 959
Occurring with tantalum (e.g., in tin slags, tantalite)	437	251	132	124
Total	22 705	20 254	15 928	22 083
Equivalent Nb	15 878	14 157	11 134	15 436
PROCESSORS' SHIPMENTS	**(000 kg contained Nb)**			
Compounds and alloy additives: chemical and unwrought forms such as $NbCl_5$, Nb_2O_5, NiNb FeNb (excluding HSLA grades), etc.	1 436	1 349	1 115	1 249
Metal and alloys: mill products, powder, ingot and scrap	277	186	186	255
HSLA-grade ferroniobium	13 520	13 325	12 202	14 727
Total	15 233	14 860	13 503	16 231

[e] Estimated from nine-month data.
[1] Tantalum-Niobium International Study Center, members' estimate.