CURRENT STATE AND PROSPECTS OF FERROALLOY INDUSTRY OF KAZAKHSTAN

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ABSTRACT

In the last decade the ferroalloys industry of Kazakhstan has sufficiently increased mining and processing of manganese and chrome ores consolidating its position in the sector of Mining and Metallurgy.

Explored resources of manganese ore allow to create the mining industry capable of providing the manganese producers of Kazakhstan and Russia with raw materials. Favorable situation in the market and high quality of Kazakhstan's ore increase importance and urgency of manganese mining branch development.

Total reserves of chrome ore in Kazakhstan amount to 420 million tons, aside from 200 million tons of low-quality ore and 16 million tons of serpentine-diluted ore. Chrome deposits suitable for mining are characterized by large scales, great dip and strike of ore bodies. Such deposits contain major part of chrome ore (about 92%) which is sufficient for mining for the next 50 years.

Kazakhstan also has big reserves of titanium ore. For example, Shokash Deposit is represented by ore sands containing 60 kg of ilmenite per cubic meter. Reserves of Shokash Deposit come to 10 million tons. Ore is processed into ilmenite concentrate and rutile-zircon-quartz by-product by means of gravity-magnetic separation.

Recently, Kazakhstan has began to develop a new industrial sector – production of metallurgical silicon. New ore-smelting furnace with transformer capacity of 9,6 MVA was put in operation in 2007. Annual capacity of the furnace is 5000 tons per year. Another silicon plant with expected annual output of 30 000 tons is being constructed in collaboration with German company "Thyssen Krupp".

Analysis of current state of Mining and Metallurgy sector indicates the tendency of increasing demand for Kazakhstan's ferroalloys. At present, production of manganese alloys in Kazakhstan amounts to 200 000 tons per year but further output expansion requires rational approach to resources management and higher production efficiency.

During the last decade the ferroalloy industry of Kazakhstan was gradually increasing mining and processing of manganese and chrome ores, consolidating its position in the sector of mining and metallurgy. Actual output of ferroalloys in 2008 totaled 1,407 million tons. Share of "TNK Kazchrome" (fig. 1) is 1,37 million tons including 0,99 million tons of high-carbon ferrochrome, 33 670 tons of ferrosilicon, 45 500 tons of medium-carbon ferrochrome, 32 900 tons of low-carbon ferrochrome, 115 000 tons of ferrochrome silicon and 147 000 tons of silicomanganese. 25 thousand tons of silicomanganese was produced by Temirtau Electrometallurgy Plant and 1,5 thousand tons of ferroaluminum silicon was produced by Ekibastuz Plant.

In 2007 production of silicomanganese was started in Taraz Metallurgical Plant in a sealed-top ore-smelting furnace with transformer power of 48 megavolt-ampere. The second furnace was put into operation in the end of the year. Smelting of silicomanganese was arranged in phosphorus furnaces without reconstruction. Annual capacity of each furnace is about 15 thousand tons. Further development of the plant includes startup of two more 25 MVA ore-smelting furnaces with total annual capacity of 50 000 tons of manganese alloys.

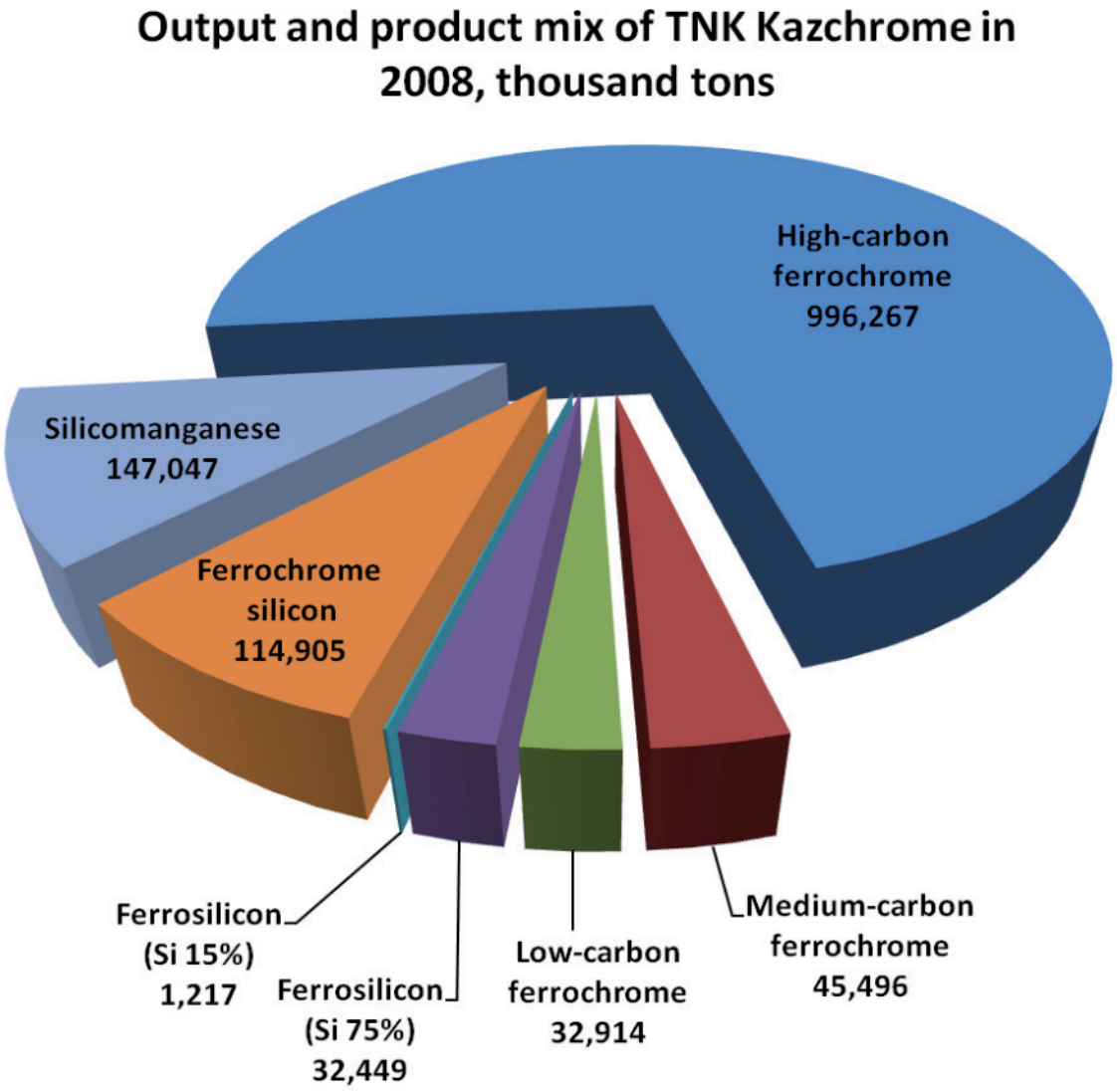

Figure 1: Output and product mix of TNK Kazchrome in 2008

According to geological reports, in Kazakhstan there are more than 100 deposits of manganese ore. 19 deposits listed in the State Register contain about 625 millions of oxidized ore. 60% of reserves contain 10 to 20% of manganese, 30% - 20 to 30% of manganese and 1/10 of reserves have manganese content above 30%. All ores contain low phosphorus – about 0,04% and sulphur – 0,2%.

Largest deposits – Karazhal and Ushkatyn III are represented mainly by oxidized ore. Ore bodies are located in the upper levels, which simplifies mining and processing. The share of oxidized ore is 70%.

Expansion of raw materials base is connected mainly with new deposits in Karaganda, Mangystau and Zhambyl regions with total expected reserves of 1 billion tons.

Kazakhstan's ores are characterized by presence of non-ferrous and rare metals. Table 1 represents chemical composition of Ushkatyn ore from Central Kazakhstan. As you can see, lead and zinc have high concentration. Research of non-ferrous metals behavior in manganese ore at high temperature has showed that 98% of lead and 94% of zinc would gasify during smelting[1]. To prevent this, complex ore processing techniques with low dust emission are required.

Table 1: Chemical composition of Ushkatyn ore, %

Element	Size, mm		Raw ore
	0-8	8-50	
Lead	0,26	0,08	0,22
Zink	0,4	0,48	0,3
Copper	<0,005	<0,005	0,006
Titanium	0,18	0,22	0,18
Thallium	0,00039	0,00075	0,00029
Gallium	0,00019	0,00016	0,00018
Lithium	0,008	0,0062	0,0055
Germanium	0,00027	0,00021	0,00026
Strontium	0,16	0,16	0,088
Selenium	0,0095	0,0091	0,0019
Cobalt	0,0068	0,0069	0,005

Nearly all reserves of manganese (95%) are related to “actual”. Manganese ore mining in Kazakhstan is divided among six main producers: Zhairem GOK (Ushkatyn III and Zhomart deposits), TNK Kazchrome (Tur and Vostochny Kamys), Atasuruda (Zapadny Karazhal), Metallterminalservis (Shoyntas), Abaiken (Bogatch) and Gefest (Karaadyr).

Proven reserves already allow to produce enough manganese ore to satisfy the needs of ferroalloy industries of Kazakhstan and Russia. High quality of Kazakhstan’s ore combined with favorable market opportunities clearly indicates the necessity of manganese production development.

In order to supply raw materials for growing manganese alloys industry, it is necessary to concentrate researchers’ efforts on creating efficient methods of sub-grade iron-manganese ore processing. One of such methods is roasting-magnetic treatment of ore allowing to separate iron from manganese concentrate.

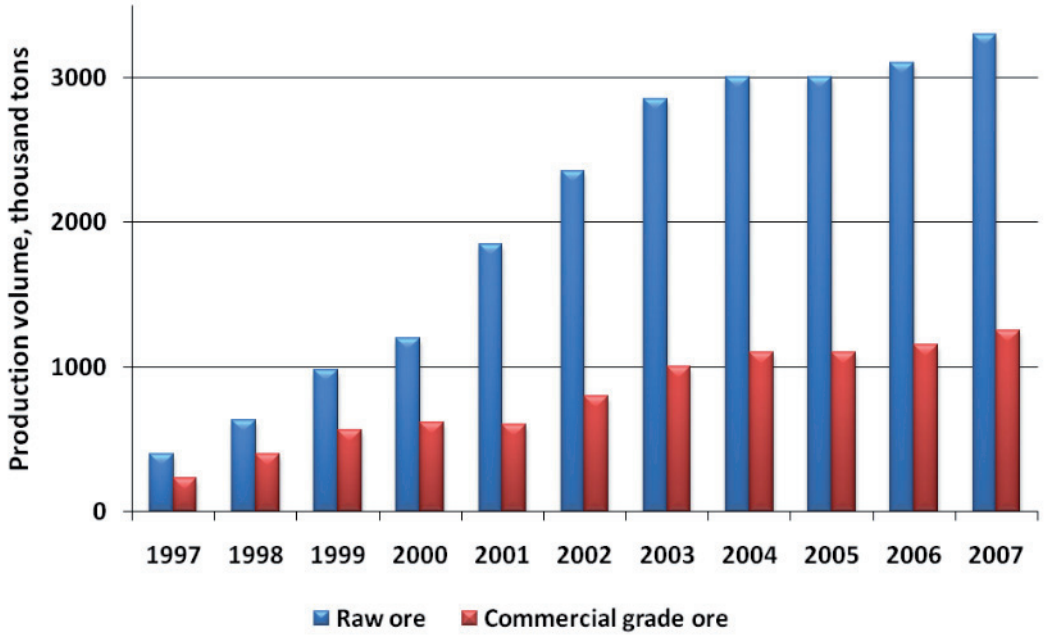

Figure 2: Manganese ore production in 1997-2007

Experiments on selective recovery of iron minerals to ferromagnetic state and further removal of iron by means of magnetic separation were made in our institute. Roasting-magnetic method of manganese and iron separation was successfully applied to iron-manganese ore of Zhomart deposit containing 26,21% Mn; 9,12% Fe; 26,08% SiO_2; 7,8% CaO; 0,02% S; 0,034% P. Such ore is not applicable to ferroalloys production due to high iron content and low Mn/Fe ratio. Reducing roasting was carried out in a shaft furnace with jet coal used as a reductant. As a result, two concentrates – magnetic and non-magnetic were obtained. Non-magnetic material contains 30,96% Mn; 1,19% Fe; 21,23% SiO_2 and 17,68% C. High carbon level was caused by unreacted reductant containing in the non-magnetic part. Magnetic material contains 15,7% Mn; 20% Fe; 24,4% SiO_2; 7,27% C. Thus, iron concentration after treatment was 7 times lower than at initial state. Manganese concentrate obtained in the experiment meets standard requirements for manganese alloys production.

Kazakhstan reserves of chrome ore amount to 420 million tons, aside from 200 million tons of low-quality ore and 16 million tons of serpentine-diluted ore[2]. Chrome deposits suitable for mining are characterized by large scales, great dip and strike of ore bodies. Such deposits contain major part of chrome ore (about 92%) which is sufficient for mining for next 50 years.

Reserves of chrome ore related to “Donskoy” Ore Processing Enterprise are described in the Table 2.

Table 2: Reserves of commercial chrome ore

Mining method	Reserves, million tons	Cr_2O_3 content, %
Open-cut mining	24,8	41,1
Underground mining	292,4	50,7
Total	317,2	avg. 45,9

Increasing production of high-quality steel, in particular alloyed steel, stimulates growth of chrome alloys production. Development of corrosion-resistant steel production in electric furnaces and steel-making converters, for example, promotes great demand for high-carbon ferrochrome. Such situation makes it necessary for Aksu Ferroalloys Plant to develop production of ferrochrome in high-power furnaces (33 and 63 megawatt). Production of ferrochrome in 63 MWt furnace is unique for ferroalloy industry. Thorough research was required to combine geometrical and electrical parameters of the furnace with physical-chemical conditions of chrome reduction in high-power unit.

Kazakhstan is also known for its titanium ore deposits. Composition of ilmenite concentrates from local deposits is represented in the table 3.

Table 3: Chemical composition of ilmenite concentrates, %

Deposit	TiO_2	Fe_{total}	Cr_2O_3	MnO	MgO	Al_2O_3	SiO_2	V_2O_5	Nb_2O_5
Satpaev	48,0	45,4	0,14	2,5	0,26	0,68	1,86	0,46	0,05
Shokash	53,7	33,9	1,65	0,95	0,8	1,89	3,46	0,1	0,08
Obukhov	52,0	33,1	4,46	2,65	0,5	3,34	2,68	0,35	0,18

Reserves of Shokash Deposit are represented by ore sands containing 60 kg of ilmenite per cubic meter. Total reserves of Shokash Deposit amount to 10 million tons. At present, Shokash ore is being processed by means of gravity-magnetic concentration which allows to separate ilmenite concentrate from rutile-zircon-quartz mixture. The mixture is further separated into rutile and zircon concentrates at concentration mill of Aktobe Ferroalloys Plant.

Organization of pyrometallurgical processing of titaniferous magnetite may solve such urgent problem as shortage of raw materials for titanium and titanium dioxide production.

Efficient use of titanium-iron concentrates is one of important tasks of titanium industry of Kazakhstan. For example, Kazakhstan's producer of spongy titanium – Ust-Kamenogorsk Titanium Plant has to import rich titanium slag (RTS) from abroad because, despite the great reserves of titanium ore, RTS is not produced in Kazakhstan.

For a long time the Chemical-Metallurgical Institute has been working on the problem of ferrotitanium production (20-70% Ti) in electric furnaces. The technology is based on combined smelting of RTS or ilmenite concentrate with complex reductant and lime. Ferrosilicoaluminum with various content of aluminum and silicon is used as a reducing agent.

The production of crystalline silicon represents the new trend in the metallurgy of Kazakhstan. In 2007 the ore-smelting furnace with transformer capacity of 9,6 MVA was built in Almaty region of Kazakhstan. Annual output of the furnace is 5000 tons of silicon. Another silicon plant was built in Karaganda in cooperation with German company "Thyssen Krupp". The plant includes two furnaces with transformers capacity of 25 MVA each. Total output of the new plant is about 30 thousand tons of silicon per year.

For further development of ferroalloys production with rational use of mineral resources it is necessary to intensify the work in the following directions:

- construction of concentrating plants with complete cycle of ore processing and classification of materials according to size and chemical composition. Processing scheme must include agglomeration of ore fines that constitute up to 50% of ore;
- elaboration and commercialization of iron-manganese ore processing methods;
- protection and recovery of environment by means of utilization of metallurgical wastes;
- expansion and intensification of research work aimed at complex processing of minerals;
- diversification of ferroalloys assortment, production of manganese and chrome alloys with wide range of silicon and carbon concentration;
- construction and application of high-power furnaces with higher output and transformer capacity.

REFERENCES

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