CURRENT SITUATION AND MAIN TRENDS OF DEVELOPMENT OF RUSSIAN FERRO-ALLOY INDUSTRY

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ABSTRACT

The Ferro-alloy industry is an essential part of metal manufacture of highly developed industrial countries. The efficiency of ferro-alloys usage defines quality of metal production as treatment of molten metal with ferro-alloys is one of the main methods of improvement of characteristics and quality of steel, pig-iron and non-ferrous metals. Steelmaking is one of the leading ferro-alloy consumers so it defines trends of development of ferro-alloy industry. An estimation of steelmaking in Russia is given.
Ferro-alloy production leaders are usually located in countries which have sufficient mineral resources, power availability and highly developed industry. The biggest ferro-alloy producer countries in the world are China, South Africa, Ukraine, Russia, Kazakhstan, Brazil, India, Norway. They account for 84.4% of the world ferro-alloy industry.
There are 13 specialized ferro-alloy works and plants in Russia. Ferro-alloys are produced in 85 electric ferro-alloy furnaces with installed power capacity of transformers 1029 mega-voltampere and in blast furnaces. Industrial facilities can provide commercial ferro-alloy production of 2 million tons. In recent years in Russia an average annual increase of 6.2% in ferro-alloy production takes place.
Russian plants produce different competitive kinds and grades of ferroalloys. The yields of different ferro-alloys in the past several years are given.
Significant quantities of ferro-alloys are exported and imported from Russia. Data on import and export flows of ferro-alloys are given.
Amounts, quality and number of grades in Russian ferro-alloy industry fit the standards of highly developed industrial countries but the country lags behind in specific power consumption, extraction of elements, environmental appropriateness of technology and equipment of melting facilities.
Predicted data on production of chromium, manganese, silicon and vanadium ferro-alloys and possible means of improvement of engineering-and-economical performance are given.

1 STEEL AND FERRO-ALLOYS PRODUCTION AND TRENDS

Dynamic and structural changes in steelmaking influence the production and consumption of ferro-alloys. World and Russian steel production till 2007 is given in fig. 1 and 2.

The output in metallurgical industry substantially decreased since 2008 as a result of economic crisis. So, there was a reduction in steelmaking in the first six moths of 2009 to 70% and pig-iron to 72% compared with 2008 in Russia. Situation in ferro-alloy industry correspondingly worsened. Estimation of steelmaking outcome must include the analysis of steelmaking structure and its interconnection with consumption of basic ferro-alloys.

Production share of basic oxygen steel in the world averages 65%, electric steel 32%, and open-hearth steel 3%. In most of the countries (China, Germany, Japan) the basic oxygen process prevails, but in some countries (USA, India) prevails electric furnace steelmaking. Open-hearth steelmaking still remains in Russia and Ukraine. Continuous casting accounts for more than 90% in the world. It should be mentioned that in Russia there are some improvements in steelmaking. So, in 1990 the amount of basic oxygen and electric steel was 46,6% and in 2007 it became 83,2%. As for continuous casting, its share increased from 23% to 70,9%[1].

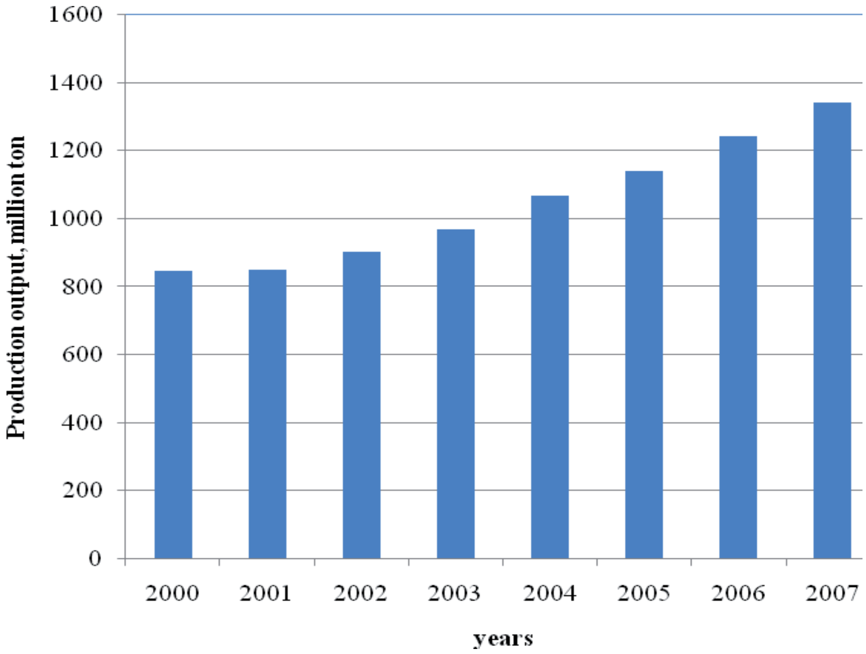


Figure 1: World steel production

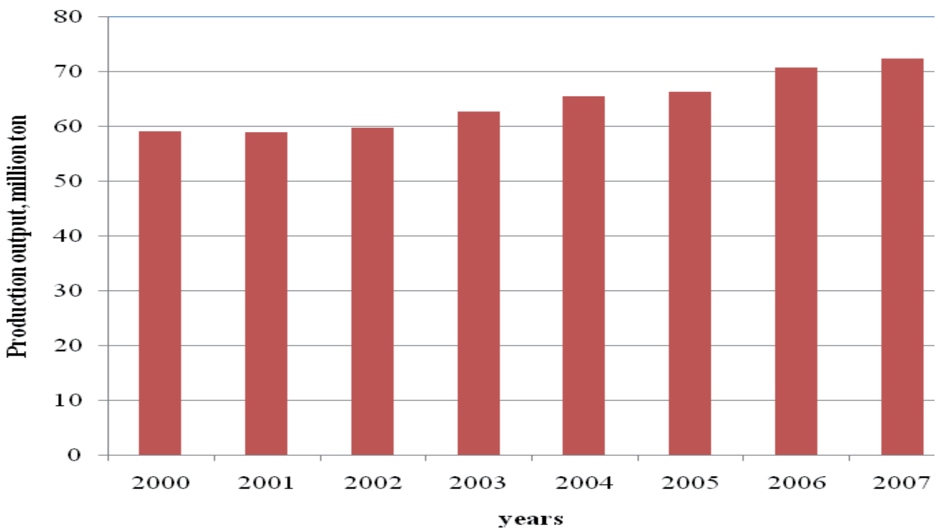


Figure 2: Steel production in Russia

Ferro-alloy production has an upward trend so, in 2008 the world production of ferro-alloys was 31,82 million ton, that is 65% increase to 2001 (see table 1). Amount of production during these years averaged 2,44% of steelmaking output.

Table 1: World ferro-alloy production, thousand ton (2001 – 2007) [2]

Alloy	2001	2002	2003	2004	2005	2006	2007
FeMn	4001	4001	4257	4838	4679	5000	5600
FeMnSi	3780	4300	4590	5820	6000	6900	7600
FeSi	4040	4230	4950	5660	5430	6080	6700
FeCr	4680	5050	6070	6590	6570	7350	8230
FeNi	954	1020	987	1050	1100	1230	1380
Total	17455	18601	20854	23958	23779	26560	29510

Ferro-alloy industry is resource-intensive and energy consuming, so it greatly depends on supply of electric power, ores and concentrates, natural gas and coal. Moreover, quality and assortment of ferro-alloys, are defined by needs and conditions of steelmaking industry. As a rule, leading ferro-alloy producers are the countries with sufficient mineral reserves, power availability and highly developed industry. The main ferro-alloy producers in the world are China, South Africa, Kazakhstan, Ukraine, Russia. They account for 76% of the world ferro-alloy industry in 2008 (see table 2).

Table 2: World ferro-alloy production in 2008 [1]

Country	Production, million ton
China	16,24
South-Africa	3,75
Kazakhstan	1,59
Ukraine	1,41
Russia	1,18
Other countries	7,65
Total	**31,82**

2 FERRO-ALLOY PRODUCTION IN RUSSIA

2.1 Ferro-alloy production structure

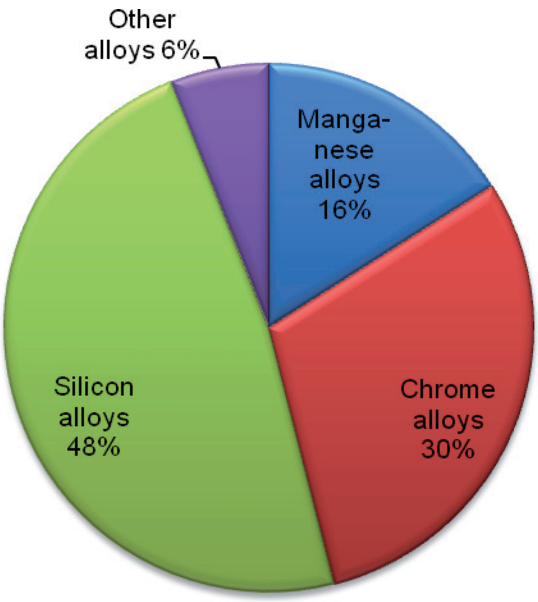
A wide range of grades and kinds of competitive ferro-alloys are produced in Russia. The share of silicon alloys in Russia amounts to 48%, chrome alloys 30% and manganese alloys 16% of total ferro-alloy amount (fig. 3), whereas the production structure in the world is different: manganese alloys 41%, chrome alloys 26%, silicon alloys 24% and other alloys 9% of production volume (fig. 4).

Ferro-alloy demand of Russian industry can be supplied by national producers, with the exception of some special and manganese ferro-alloys, that usually are imported. Such serious limits in production of some groups of alloys are related to Russian sources of raw materials. There are abundant deposits of minerals only for production of silicon, calcium, vanadium and boron. This is the reason why Russia has to import ferro-alloys and at the same time exports comparably great amounts. Data on dynamics of import and export of ferro-alloys in 2002 – 2006 are given in table 3.

Table 3: Import and export of ferro-alloys in Russia (million ton / million US dollars) [2]

Article	2002	2003	2004	2005	2006
Import	0,37/130,5	0,52/202,8	0,60/369,3	0,51/312,0	0,50/300,0
Export	0,38/234,8	0,52/331,1	0,66/755,0	0,81/1312,4	0,50/1100,0

There is no reliable data on export and import of ferro-alloys in Russia for 2007 – 2008.



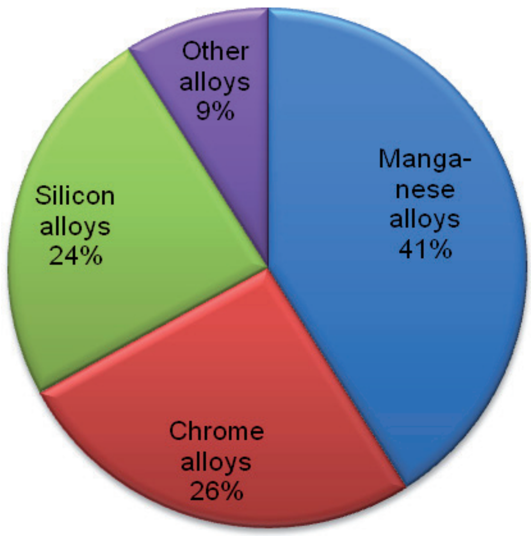


Figure 3: Ferro-alloy production structure in Russia

Figure 4: World ferro-alloy production structure

2.2 Ferro-alloy production prospects

Significant improvements happened in Russian ferro-alloy industry during the last 30 years such as increase of unit capacity of melting facilities and successful smelting of large-tonnage ferro-alloys (FeSi, FeCr, FeSiCr) in closed-top submerged arc furnace. Automated control systems for ferro-alloy technology are introduced. The emphasis is placed on issues of environmental protection, ecology and waste processing and recycling.

Production volume, quality and assortment of ferro-alloy Russian producers are comparable with highly developed industrial countries. However, such characteristics as specific energy consumption, extraction ratio of elements, environmental pollution and equipment of melting units are behind the times. Low quality of raw materials is not the only reason for the gap. There is need to improve technology of raw materials pretreatment, drying, sintering and preheating of charge before smelting, and also heat recovery of waste gas. The design of domestic furnaces has also remained behind the times.

Ferrosilicon production in Russia increased in recent years from 652 thousand ton in 2000 to 741.9 thousand ton in 2005 (by 13,8% to 2000). This is explained by growth of export and domestic consumption, related to the increase in steelmaking. The annual gain was 2.76%. Production of low-percentage ferrosilicon (with 18 – 25% Si) hasn't been resumed. Ferro-silicon industry in Russia is completely supplied with domestic raw materials and energy resources.

Production of ferrochromium sufficiently increased in recent years from 274 thousand ton in 2000 to 578 thousand ton in 2005, i.e. doubled in 5 years. Ferrochromium is produced in Russia mainly from imported ores (from Kazakhstan, Turkey and others), that caused some difficulties in certain periods of time for Russian producers of ferro-alloys.

Some small deposits of chromites have commercial significance in Russia, such as poor chromites of Saranovskoe, Alapaevskoe and other deposits in Urals and a number of deposits in Komi region. These deposits have common disadvantages of low content of chromite (30 – 40% Cr_2O_3) and comparatively high iron content (up to 20% of FeO). Ores from Saranovskoe mining deposit are used in JSC "Serov ferro-alloy plant".

High-carbon ferromanganese in Russia is smelted from imported manganese ores in blast furnaces of JSC "Kosaya Gora Iron Works" and JSC "Satka iron-smelting works". Volume of output increased from 88 thousand ton in 2000 to 109.5 thousand ton in 2005 (by 24.4% to 2000).

Silicomanganese is produced (mainly from Kazakhstan manganese ore) at JSC "Chelyabinsk electrometallurgical plant". Nevertheless the demand in basic manganese ferro-alloys (high-carbon ferromanganese and silicomanganese) in Russia is still supplied by import. As for medium- and low-carbon ferromanganese and manganese metal, all these alloys are imported mainly from Ukraine. Annual need for manganese alloys in Russian Federation is about 600 thousand ton.

Carbonate based low manganese ores (19.8% Mn) with high content of phosphorus (0.2 – 0.3% and higher) prevail in structure of confirmed manganese mineral resources of Russia (90.2%). Oxide ores with 23 – 26% Mn form only 6% of resources. Top-priority goal to solve the problem of manganese in Russia is organization of commercial production and enrichment of poor domestic ores. It requires substantial investments so, it is important to keep and enhance relations within the bounds of CIS with traditional suppliers of manganese ores – Ukraine, Kazakhstan and other countries such as Brazil, Australia, South Africa, Gabon that supply high-quality rich manganese ores. It is necessary not only to extend production volume of high-carbon ferromanganese and silicomanganese and involve domestic manganese ores into technological process. Moreover, there is a need to organize production of purified manganese ferro-alloys in Russia, most of all medium-carbon ferromanganese.

Involving of poor manganese ores and chromites can satisfy the needs of both Russian and world ferro-alloy producers[3].

It is a well known fact that rich ores (chromites, iron, manganese and other) allow to cut energy and coke consumption and increase unit efficiency at their metallurgical treatment in comparison with poor ores.

While the production price of ferro-alloys depends on raw materials costs, the price of ores and concentrates can form up to 97% (for expensive alloys) of production price and depends on alloy type, e.g. the cost of chromites form 30 – 40% of high-carbon ferrochromium production costs. So, the use of comparably low-priced poor ores with their high processing costs can be more effective than use of expensive rich ores.

Enrichment of poor ores can't be the way of effective improvement of concentrate quality (reaching of high content of main element and low content of detrimental impurities) in all of the cases, as it leads to rise in price of production and requires sintering of materials. One of the rational ways of poor ores use, besides enrichment, is production of certain non-standard alloys fit for steel treatment or further refining.

There are several ways to improve performance characteristics of ferro-alloy plants to be used:
- rational raw materials pretreatment before smelting (sizing, sintering of fines, charge preheating to 650 — 850°C);
- assortment change of ferro-alloys, development and enhancement of production of ferro-alloys for microalloying and modification of steel, allowing to improve steel quality, decrease specific consumption and production of standard ferro-alloys;
- reprocessing of own and other industries wastes, use of off-grade materials, that cuts raw materials expenses and decreases pollution at and around the plants;
- equipping of submerged electric arc furnaces with automated control systems that allow to cut energy consumption by 8 – 10% and improve conditions of work;
- improvement of quality of ferro-alloys by reduction of detrimental impurities (phosphorus, sulfur and other content), nonmetallic inclusions and gases;
- more effective heat recovery of waste gas of electric arc furnaces;
- improvement of existing and development of new effective technologies of ferro-alloy production with higher performance characteristics, improved conditions of work and environmentally friendly solutions;
- development and mastering of optimal furnace design, including DC units for ferro-alloy production.

3 CONCLUSIONS

Production volume of ferro-alloys depends on development of steel industry. Ferro-alloy production structure in Russia differs from elsewhere in the world and is determined by peculiarities of national mineral resources. Industry development trends include utilization of poor domestic ores, rich imported ores, improvement of equipment, units and technologies. General ways of performance characteristics improvement of Russian ferro-alloy industry are given.

4 REFERENCES

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