EVALUATION OF PHYSICAL AND CHEMICAL PROPERTIES OF CHARGE MATERIALS FROM THE POINT OF POSSIBILITY OF RECEIVING THE ALLOY OF ALUMOSILICOMANGANESE

Ye. Mukhambetgaliyev, S. Baysanov, A. Baysanov, N. Yugay, D. Zhiembaeva, V. Tolokonnikova

Abishev Chemical-Metallurgical Institute, Karaganda, Kazakhstan, e-mail: mr._west@inbox.ru

ABSTRACT

The paper presents the results of petrographic and X-ray diffraction of charge materials to the further development of new technologies for receiving a new complex alloy-alumosilicomanganese. For melting alloy were involved substandard high-siliceous manganese of a field "Zapadny Kamys". As the reducing agent and the main source of silicon and aluminum were used high-Karaganda basin coals. As a result of large-scale laboratory heats qualitative and totally impervious to the disintegrating alloy was obtained.

KEYWORDS: *High-carbon, monoblend, X-ray analysis, petrographic analysis, alumosilicomanganese.*

The rapid development of the steel industry and increase the quality of steel requirements led to growing of complex manganese ferroalloys production.

Kazakhstan, with its large reserves of manganese resources, which are presented mainly in the form of oxidized ferromanganese-refractory species and manganese ores, cannot fully meet the rapidly growing demand for high-quality raw materials. Increased production of manganese alloys by the adoption of the technology connected with involvement in the smelting poorer manganese ore which require deep concentration, which will inevitably lead to increased losses of manganese and appreciation of the product. Therefore gains the special importance and an urgency improvement existing and development of new technologies of smelting of the manganese alloys providing decrease in losses of manganese that is possible on the basis of researches of physical and chemical properties of used raw materials.

One of ways causing interest in respect of decrease in losses of manganese is complex processing manganese of containing raw materials by without slag melting method with calculation of all ore oxides and reducer ashes complete recovery and receiving alloys of complex structure.

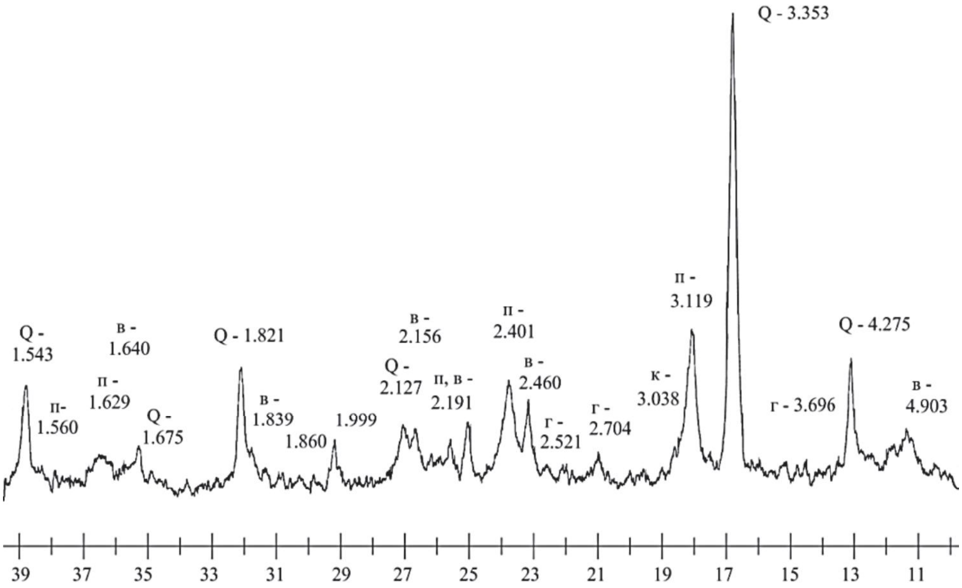
In this regard for receiving an objective picture of raw materials complex use it is necessary to conduct detailed studying of their material structure and technological properties.

Studying of mineral composition of ores for the solution of technological questions provides identification of all minerals of test (main, minor, core, etc.) with a quantitative assessment of their ratios and the characteristic of mutual accretions by a complex of methods: optical mineralogy, optical petrography, X-ray diffraction and chemical [1].

The full quantitative phase (mineralogical) analysis in a combination to data of the chemical analysis of samples and minerals composing them allows carrying out calculation of useful components distribution balance among mineral phases that gives the chance to define a priori a number of parameters of projected technological processing of ore. In particular, the conclusions are based on calculation of balance about theoretically possible extraction of a useful component in a concentrate and about its inevitable losses in enrichment tails with vein minerals. Mineralogical researches, besides data on structure and textural-structural signs of ores, supply information on technological properties of ore-forming minerals depending on a form of separation of minerals, their composition, crystal structure, degree of its order, type and features of distribution of microimpurity in minerals [2, 3].

For mineralogical and petrographic researches were used representative samples of each of studied charge components. Preliminary preparation of each sample included operations of averaging, reduction and selection of representative samples on mineralogical, full chemical and X-ray phase analyses.

In representative sample of high-silicon manganese ore of Zapadny Kamys according to X-ray analysis which has been carried out on X-ray diffractometer DRON-2,0 (Fe Kα – radiation), were found the following minerals: pyrolusite (MnO_2), vernadite ($MnO_2 \cdot H_2O$), quartz, hematite (α – Fe_2O_3), calcite (figure 1).



п – pyrolusite, в – vernadite, Q – quartz, г – hematite, к – calcite

Figure 1: X-ray high-silicon manganese ore of a field Zapadny Kamys

During the experiments, the textural and structural characteristics of the mineralogical composition of metallic and non-metallic components were studied. Mineralogical and petrographic analysis was performed using a microscope «Neophot-21». In the analysis were used macro-and microscopic examination of high-silicon manganese ore samples.

As a result of the macroscopical analysis of studied high-silicon manganese ore it is established that sample is presented in the form of acute-angled fragments in the size from 2,0 to 4,0 cm. Structure of fragments the non-uniform: from massive to porous, easily soiled. At some samples there is not clear-layered texture.

Color of fragments debris from steel-gray to black, sometimes from red to brown. Shine from metallic to semimetallic. In some fragments are found the nodules (inclusions) filled with calcite and quartz. A microstructure is fine-grained, in separate sites it is hidden - crystal.

To conduct microscopic researches of representative samples were made polished thin sections. Thin sections were studied in reflected light.

By microscopic researches it is established that ore minerals are presented vernadite ($MnO_2 \cdot H_2O$), colloform pyrolusite (MnO_2) and hematite (α – Fe_2O_3).

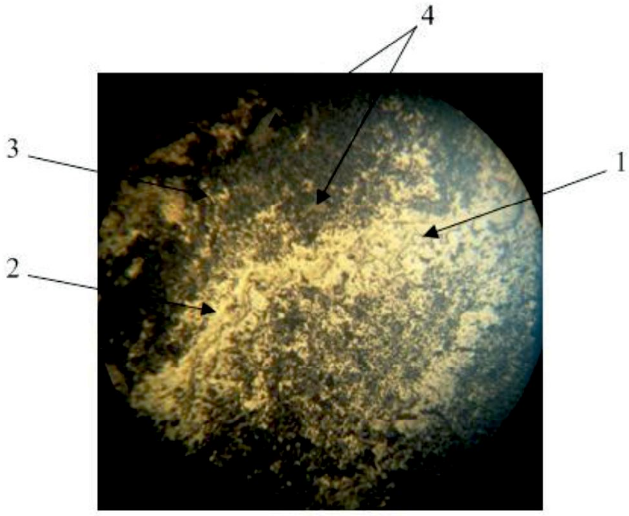
Vernadite ($MnO_2 \cdot H_2O$) is presented in the form of poorly crystallized mass of the spotty congestions filling intervals between grains of quartz.

Pyrolusite (MnO_2) in thin section is observed as cryptocrystalline formations, more often in accretion with vernadite, forming pseudomorphson it.

Hematite (α - Fe_2O_3) is presented in the form of hidden crystal grains (figure 2).

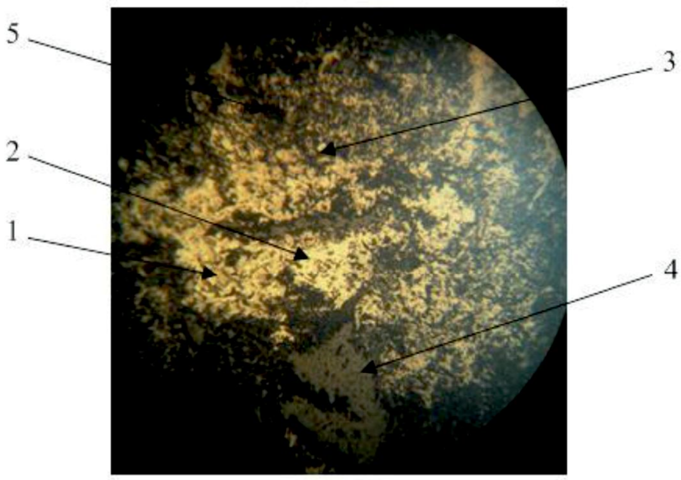
Non-metallic minerals are mainly represented by quartz (α - SiO_2) and a small amount of calcite ($CaCO_3$).

Quartz is observed both in the form of separate xenomorphic grains, and in the form of the cryptocrystalline silicon dioxide, extended between ore units (figure 3).



1 - vernadite 2 - pyrolusite, 3 - hematite, 4 - quartz, x100

Figure 2: Microstructure of ferromanganese ore



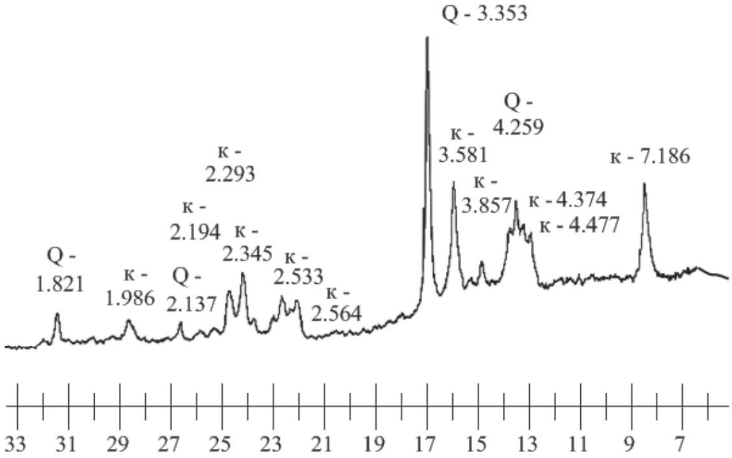
1 – vernadite, 2 - pyrolusite, 3 - hematite,4 - siliceous material, 5 - pores, x100

Figure 3: Detail of the microstructure of ferromanganese ore

Also representative samples of highly cindery coal of Borly field were subjected to more detailed mineralogical and petrographic research. According to X-ray analysis in representative sample of high-ash coal of Borly field were found the following minerals: kaolinite ($Al_2Si_2O_5(OH)_4$) and quartz (α – SiO_2) (figure 4).

High-carbon coal of field of "Borly" belongs to humic coals, stone (K_{en}), (gumolity–group of the fossil coals formed as a result of transformation of the remains of the highest plants in wetland conditions). Color from gray to the black. Glitter from matt to mirror.

The petrographic structure of high-cindery varieties of coals and carbonaceous rocks is presented in table 1, where the raised contents inertinite is noted that along with the low maintenance of low-melting (caking) components when smelting an alumosilicomanganese practically will exclude agglomeration of this type of carbonaceous raw materials.



к - kaolinite, Q – quartz

Figure 4: X-ray Borly high-ash coal-field

The studied raw materials were used at carrying out large laboratory researches on smelting of a complex alloy of an alumosilicomanganese in the RKO-200 kV·A furnace.

For experienced heats was used manganese ore of a field Zapadny Kamys, high-cindery coal of a field of Borly and quartzite of a field Tekturmas which chemical composition is given in table 2. Technical structure of coal: ash – 48-55%, volatile components – 16-18%, moisture – 1-3%.

Table 2: Chemical composition of manganese ore, high-ash coal ash and quartzite

Material	Content, %						
	Mn_{total}	SiO_2	Al_2O_3	CaO	MgO	Fe_{total}	P_{total}
Manganese ore	26,72	35,80	2,08	0,93	0,72	2,77	0,02
Coal ash	–	58 - 62	32 - 35	1,50 - 3,30	0,30-0,60	0,20-0,60	0,01-0,02
Quartzite	–	97,05	0,76	0,77	0,02	0,49	0,01

At a stage of metallurgical testing of alumosilicomanganese smelting technology five campaigns with various on chemical and technical composition charge materials and their ratios were carried out. And in each campaign were tested on 3-4 options of charge structure [4-6].

Feature of the technology is the exception of application of coke. As a reducer and the main source of silicon and aluminum were used high-cindery and low phosphorous coals of a field of Borly. For all series of heats the mixture made of calculation of a complete recovery of all ore oxides and coal ashes by its solid carbon. In all series of experiences process conducted continuously at the closed throat. A charge layer around an electrode supported in the form of a cone.

Table 1: The petrographic composition of Borly coal-field

Name of sample	The overall composition of coal, %							The composition of coal with minerals,%					Composition of pure coal,%								only	The amount of components in a clean coking coal,%	Amount emaciated components in pure coal,%	Index of reflection of vitrinite
													Inertinit											
		minerals																						
	clean coal	clay minerals	Iron sulfides	carbonates	silica	other	only	vitrinite	inertinit	leyptinit	minerals	only	vitrinite	semifyuzinit	makrinit	fyuzinit	sklerotinit	inertodetrinit	mikrinit	leyptinit				
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**
Raw coal	39	56	traces	-	5	-	100	6	31	2	61	100	15	35	6	24	-	13	2	5	100	20	80	0,95

The analysis of test results showed possibility of receiving a complex alloy of an alumosilicomanganese containing, wt.%: 45-50 silicon, aluminum 15-25, 12-30 manganese, iron 6-10; carbon 0.3-0.4; phosphorus 0,02-0,03.

The received new complex alloy because of the low content of phosphorus and high (>12 %) aluminum was not scattered. Results of experimental batches of an alumosilicomanganese are presented in fable 3.

Alumosilicomanganese smelting alloy is characterized by a complex use of all the main elements of the ore, high rate of transition elements in an alloy causing the low rate of charge materials per ton of an alloy.

Table 3: Chemical composition of the alloy alumosilicomanganese

Alloy	Content of elements,%						Extraction of elements,%		
	Si	Al	Mn	Fe	Ca	P	Si	Al	Mn
1	46,15	16,45	20,04	6,50	0,60	0,03	80,95	75,94	92,28
2	45,54	20,11	17,30	8,70	0,70	0,02	83,98	81,70	90,87
3	48,58	25,41	12,13	10,10	0,05	0,02	85,35	82,75	91,29

The developed technology of alloy smelting complex of an alumosilicomanganese from high-siliceous manganese ores has the following advantages:

1) for production of a complex alloy of an alumosilicomanganese used to highly unfortified poor manganese ore;

2) used as a reducing dumping of high-rank coals (without coke technology);

3) complex used poor manganese ore - waste rock and ore coal ash used as raw materials for the alloy of silicon and aluminum;

4) In the production of an alumosilicomanganese alloy to the target product about 85–92 % of manganese against 70–75 % are taken by modern production of manganese ferroalloys. The low content of phosphorus completely excludes possibility of an alloy spillage, additional expenses disappear by pelletizing of a powdered alloy.

5) Use of low-grade ores, coal and simplicity of the technology provide a low cost alloy and almost unlimited source of raw materials for their production.

Thus conducted mineralogical and petrographic studies of charge materials showed on the feasibility of using them in the smelting complex alloy, which is proved by tests conducted smelting technology of an alumosilicomanganese with establishing the fundamental possibility of obtaining a new type of complex alloy chemical composition contain high aluminum and low phosphorus from the available raw materials relating to industrial waste.

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