UDC 669.712.3+669.713.6

T.N. Nesterenko [(1)], associate professor, c.t.s.
V.P. Gritsaj [(1)], professor, c.t.s.
O.N. Nesterenko [(2)], engineer

# ABOUT IMPROVEMENT OF AN ELECTROTHERMIC PRODUCTION METHOD OF ALUMINIUM-SILICON ALLOYS

[(1)] Zaporozhe state engineering academy, Ukraine
[(2)] Zaporozhe Machine-Building Design Bureau «Ivchenko-Progress» State Enterprise named after Academician A.G. Ivchenko, Ukraine»

The main directions of development and improvement of an electrothermic production method of aluminum-silicon alloys such as raw material base spreading, optimization of a charge composition, a choice of rational constructive and technological parameters of furnace units are analyzed. Possibilities of increase of aluminium and silicon extraction from raw materials in aluminum-silicon alloys are shown.

Keywords: aluminum-silicon alloy, silicoaluminium, aluminosilicates, electrothermic method, aluminium and silicon extraction.

The use of cheap ore and secondary raw material (kaolin ores, cleaning rejects, ashes coal, slags of metallurgical production and that like) which in a sufficient for the industrial use quantity is on Ukraine allows to get the aluminium alloys with silicon by compatible renewal of metals from their oxides by an electro-thermal method and has certain advantages in comparison with the method of alloying of clean metals.

At the beginning of 80th XIX century it was succeeded technically to carry out the method of electro-thermal receipt of not aluminium, but its alloys [1]. At that time industrial production of poor aluminium alloys (17-20 % aluminium) by an electrothermal method could not compete with cheaper electro winning of aluminium.

In 1934 at the Dneprovsky aluminium plant (presently OAJ «Zaporozhe productive aluminium combine» is OAJ «ZApC») by direct renewal of kaolin with use a charcoal got silicoaluminium and by further dilution of its aluminium made commodity silumin. In 1939 at the plant it was first carried out smelting of rich on a content of aluminium (to 70 %) aluminium alloys, in an industrial scale on electric furnaces with power 10 MW. Thus it was attained high productive indexes after the output of alloy, by the expense of electric power and materials [2,3].

In work [4] it is set that during compatible renewal of aluminium oxides and silicon by carbon at first a carbon free reduced, and - silicon constrained in mullite. At temperatures over 1600 °C a carbon is almost fully bound in the carbide of silicon. In the interval of temperatures 1800-2000 °C reaction acquires development:

$$Al_2O_3 + SiC \Rightarrow Al_2O + SiO + CO \ , \qquad (1)$$

as a result there are losses of aluminium and silicon through a gas phase. To appearance of aluminum-silicon alloy the suboxide of aluminium, which enters into cooperating with the carbide of silicon, appears:

$$Al_2O + SiC \Rightarrow 2Al + Si + CO \ . \qquad (2)$$

Results of physical and chemical modeling of processes of renewal aluminosilicates and argil generalized in work [5]. It is set that at cooling of reactionary gases on the finishing stage of reacting of aluminosilicates in a gas phase credible is passing of metallothermic reactions:

- in the interval of temperatures 2300-1950 °C

$$2\,Al + SiO \Rightarrow Al_2O + Si\ , \qquad (3)$$

- in the interval of temperatures 2150-2100 °C

$$6Al + SiO + 3SiC \Rightarrow Al_2O + Al_4C_3 + 4Si\ . \qquad (4)$$

For prevention of melting of aluminosilicates to inflow it in the area of useful reactions from the insufficient rate of movement of charge and, as a result, to partial transformation of charge on slags in work [6] it is suggested lignin coal to add in the composition of argil-silica charges lignin coal in a quantity 10-27 %.

At replacement of part of kaolin in composition of charge on a cyanite or disthenefibrolate concentrate technology of drying is offered in two stages [7]. At first stage pellet charge with the initial humidity in an interval from 12 to 16 % heat with speed a 4…10 degree/min. to the temperature 60-80 °C. Farther she is irrigated by water or process a pair from the calculation of 1-3 % moistures from weight of material and adds to drying at temperatures 200-300 °C.

In work [8] it is suggested in the composition of charge to add metallized slags together with a lime and quartzite for decline of specific expense of electric power on the production of silicoaluminium on 12,8 % and expences of the briquetted charge - on 6,0 %, increase of exception of metal from carbides and oxides which are contained in slags on 52,2 %.

Renewal and melting of silicon- and aluminiumcontaining materials in work [18] it is suggested to carry out in different, connected chambers of plasma furnaces with coke nozzle. Previous renewal of powdery charge (quartz, electro-corundum, coke) to more subzero oxides and hydroxycarbides aluminium and silicon, and then melting provides the extraction of aluminium to 81-88 % and silicon to 92-96 %.

In work [19] it is suggested from a cyanite concentrate to get aluminium-silicon alloys by the division of melting and restoration operations and use of plasma technique for rapid renewal. Energy on melting of charge is created, with use to the charge aluminum-silicon alloy and burning it by oxygen. A charge which contains oxides is given during incineration of aluminum-silicon alloy, and renewal of oxides to the metal carries out after completion to the operation of charge melting.

*Conclusions.* For providing of competitiveness of electro-thermal method of receipt of aluminum-silicon alloys comparatively with traditional synthetic technology not enough to have stable technology. It follows to continue research of source of raw materials, carry out the search of new raw material materials, and also apply in industry there are already research developments.

## LIST OF LITERATURE

1. Беляев, А. И. К истории электротермического способа получения алюминия и его сплавов [Текст] /

А. И. Беляев // Известия Вузов. Цветная металлургия. – 1967. – № 1. – С. 152-156.
2. Рагулина, Р. И. Электротермия кремния и силумина [Текст] / Р. И. Рагулина, Б. И. Емлин. – М. : Металлургия, 1972. – 240 с. – Библиогр. : с. 236-237.
3. Салтыков, А. М. Становление и развитие электротермического способа производства алюминиево-кремниевых сплавов [Текст] / А. М. Салтыков, А. Ю. Баймаков // Цветные металлы. – 2003. – № 7. – С. 101-104.
4. Кожевников, Г. Н. О совместном восстановлении окислов кремния и алюминия углеродом [Текст] / Г. Н. Кожевников, А. Г. Водопьянов, А. С. Микулинский // Цветные метал-лы. – 1970. – № 10. – С. 40-42.
5. Катков, О. М. О некоторых особенностях карботермического восстановления оксидных минералов алюминия и кремния в дуговой электропечи [Текст] / О. М. Катков // Известия Вузов. Цветная металлургия. – 1998. – № 4. – С. 15-20.
6. А. с. 569631 СССР, МКИ2 С 22 В 21/02. Шихта для получения алюминиево-кремниевых сплавов [Текст] / Ю. И. Брусаков, С. А. Ржавин, В. П. Киселев и др. (СССР). – 2126364/02 ; заявл. 10.03.75 ; опубл. 25.08.77, Бюл. № 31. – 2 с.
7. А. с. 857283 СССР, МКИ3 С 22 В 1/14, С 22 В 4/06. Способ подготовки шихты для производства алюминиево-кремниевых сплавов [Текст] / И. А. Бережной, Б. О. Вайсман, В. П. Киселев и др. (СССР). – 2839464/22-02 ; заявл. 16.11.79 ; опубл. 23.08.81, Бюл. № 31. – 2 с.
8. А. с. 931776 СССР, МКИ3 С 22 В 21/02. Способ получения алюминиево-кремниевых сплавов [Текст] / Д. В. Ильинков, С. А. Артеменко, Ю. И. Брусаков и др. (СССР). – 3232467/22-02 ; заявл. 08.09.80 ; опубл. 30.05.82, Бюл. № 20. – 3 с.
9. А. с. 1772186 СССР, МКИ5 С 22 В 4/06, С 22 С 21/02. Способ получения кремнеалюминиевых сплавов [Текст] / Р. Д. Лабадзе, Г. Н. Звиададзе (СССР). – 4881019/02 ; заявл. 11.11.90 ; опубл. 30.10.92, Бюл. № 40. – 3 с.
10. Способ производства алюминиево-кремниевого сплава [Текст] : пат. 2148670 Рос. Федерация : МПК7 С 22 С 1/10, С 22 С 21/02 / Коршунов Е. А., Третьяков В. С. ; заявитель и патентообладатель Коршунов Е. А. – № 99106598/02 ; заявл. 24.03.1999 ; опубл. 10.05.2000.