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V.M. Protsenko, associate professor, c.t.s.
B.P. Sereda, professor, d.t.s.
I.V. Kruglyak, associate professor, c.t.s.

RESEARCH OF MELTING OF ILMENITE CONCENTRATE IN ELECTRIC-ARC FURNACE OF DIRECT-CURRENT

Zaporozhe state engineering academy, Ukraine

Researches of smelting of titanic slags with the structure of anatase, containing a more than 76 % titania, from a ilmenite concentrate (47 % TiO_2) by renewal a coke in the experienced electric-arc furnace of direct-current at power 15…50 kW are realized. The results of melting showed possibility of receipt of the indicated slag, and also refining affecting slag of direct-current.

Keywords: ilmenite concentrate, titanic slag, anatase, electric-arc furnace, direct current

Possibility of involving of ores of new deposits at the production of pigmented titania by sulfuric acid method limited to rigorisms, produced to the feedstock on content in him harmful admixtures (*P*, *V*, *Mn*, *Cr*), and also on technologicalness of his processing. Such difficulties to a great extent are removed at the use of titanic slags instead of ilmenite concentrates.

At the receipt of pigmented titania from titanic slags simplification of flowsheet of production is possible, because the necessity of concentration of solutions and moving away of considerable part of iron are fall off; thus the decline of expense of sulphuric acid and reduction of quantity of wastes is arrived.

The purpose of the real work is research of process of receipt of titanic slags with content of TiO_2 more than 76 % from an ilmenite concentrate, containing ~ 47 % TiO_2 by the restoration melting in the electric-arc furnace of direct-current. Possibility of receipt of TiO_2 also with the structure of anatase was investigated for the improvement of treatability of slag in sulphuric acid at the production of pigmented TiO_2, and also refining operating on the slag of direct-current.

For melting of ilmenite concentrate used the electric-arc furnace of direct-current power 100 kW. In the steel casing furnace set graphite crucible of 200 mm high with an outward and internal diameter according to 150 and 120 mm. Space between casing of furnace and crucible cover magnesite powder. The crucible was placed on filing up from a graphite crumb, providing admission to him electric current. In the first experience used crucible with opening for tap, this was closed by a clay cork. Electrodes are graphitized. Voltage at melting was 30-50 V at strength of current 500-1000 A, i.e. power of furnace was within the limits of 15-50 kW depending on penetration of charge and state of fusion. Temperature in a furnace was taken by a tungsten-rhenium thermocouple; in fusion a temperature was apparently higher on 50-100 °C. Optical pyrometer did not give the good results of taking temperature from the small sizes of furnace. Before melting furnace warmed up during 20-30 min.

At the beginning of melting in a furnace downloaded an iron-ore with a coke in correlation, providing the receipt of iron fusion for prevention of burned completely

of bottom for graphite crucible. After building-up of iron there are carried out loading small portions of charge are mixtures of ilmenite concentrate with a coke. By change of position of overhead electrode in a furnace was providing stability of voltaic arc. The quantity of the loaded charge made 5-7 kg, which corresponded to filling of furnace on three fourths of her volume. In melting N 3 applied anodic polarization of lower electrode (bottom of furnace), in other melting - cathode polarization. Fusion after melting cooled in a furnace except for the melting N 1 in which tried to unseal tap and outpour fusion from a furnace. However, from problems with his weathering in this experience, at subsequent experiments fusion was cooled in a furnace. Cooling speed was 3-6 hail/min.

A titanic slag was slowly cooled for the receipt of titania with the structure of anatase, having same chemical composition, as well as retile, but better dissolved in sulphuric acid, that it is important at the production of pig mental titania. For realization of the regime of the slow cooling of slag furnace covered heat-resistant coverage.

For classification of initial ilmenite concentrate on factions executed a granulometry on apparatus of «*Ratap*» with the use of four sieves with the sizes of cells 1.0; 0.50; 0.25 and 0.106 mm. The output of faction made a 0.5-1.0 mm is 6.3 %, factions a 0.25-0.50 mm – 69.4 %, factions a 0.125-0.25 mm – 23.4 %, factions a less than 0.125 mm – 0.9 %.

For the separation of faction a less than 4.0 mm there carried out screening of tests of titanic slag. Then faction a more than 4.0 mm exposed to growing shallow in a roller mill to the sizes of particles a less than 4,0 mm and mixed up with the before separated faction less than 4.0 mm.

Magnetic separation of tests of slag was executed for the separation of metallic with the use of magnetic-field of 120 mTesla. The quantity of magnetic faction in a slag in different experiments changed from 28 to 78 %. Unmagnetic material crush to the size of particles less than 90 mcm in a ball mill with balls from the carbide of tungsten and roentgen-phase and chemical analysis subjected.

The chemical analysis of passing metal was carried out by dissolution by shaving in warmed-up solution 5.0 ml HNO_3, 1.5 ml *HCl* and 2.0 ml *HF*. Solution was diluted by 10 ml H_3BO_3 and 100 ml of the distilled water, after entered in ICP-analyser (ionization is in the inductively-constrained plasma) and analyzed in the presence of necessary elements. Contents of carbon and sulphur were determined on the device of «*LECO CS*-400».

In the different melting content of elements in a passing metal was scope, % the masses: 0.135-1.37 *Ti*; 3.45-5.54 *C*; 0.023-0.056 *S*; 0.10-1.84 *Si*.

At the analysis of titanic slag, ground up to the largeness < 90 mcm, took away a test mass 100 mgs and loaded in crucible from a fluoroplastic. A slag was lixiviated at interfusion in solution 5.0 ml HNO_3 during 45 minutes at a temperature 70 ° C. There are added 2.0 ml H_2SO_4, 5.0 ml *HF* and heated solution. Then 10 ml H_3BO_3 added, by the distilled water was take solution to the volume 100 ml and entered in ICP-analyser. The content of ions of Fe^{2+} is determined by the method of dynamic titration, as an oxidizing agent used a cerium.

Cathode polarization of lower electrode (bottom of furnace) renders the refining operating on a slag in connection with ionic electric conductivity of molten slag.

Magnetic separation shows high content of magnetic faction in a titanic slag, that confirms the unsatisfactory division of metal and slag. Plenty of shallow particles of metal is in a slag, looked also under a microscope, explained by high circulation of fusion in a furnace and subzero enthalpy of slag and, as a result, by high viscidity of slag and bad division of slag and metal. Growing of slag shallow to the sizes < 1.0 mm promotes the output of unmagnetic faction.

As results of chemical analysis show, the slags of all melting have enhanceable content of carbon, which testifies to the overpriced quantity of repairer in a charge. Roentgen-phase analysis shows that slags contain plenty of phases of the systems of *Fe-Ti-O* and *Fe-Ti-Mn-O,* and also ilmenite. This is confirming a fact, that not all ilmenite was restored in the process of melting. For his complete renewal it is recommended by conduct melting more than 20 minutes after the last loading of charge. Incomplete renewal of ilmenite concentrate results also in enhanceable content of carbon in a slag. Roentgen-phase analysis shows also, that in a slag there was TiO_2 as an anatase, that it is related to large duration of cooling in melting NN 3 and 5.

Conclusion. At a pilot plant there are realized researches on working off technology of melting of titanic slags in the electric-arc furnace of direct-current. Content of TiO_2 was attained in a slag > 76 %. It is executed the analysis of initial ilmenite concentrate, got slag and passing metal. Possibility of receipt is shown in the slag of TiO_2 of structure of anatase, having higher solubility in sulphuric acid, that increases the prospects of the use of titanic slags for the production of pig mental TiO_2. Cathode polarization of lower electrode (bottom of furnace) renders the refining operating on a slag. The got results ground for realization of more fundamental scientific researches in this direction.