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Current state of titanium-containing alloys production

Currently, the interest of metallurgists in titanium-containing alloys is growing. These alloys are successfully used in ferrous metallurgy for steel deoxidation, however, their widespread using is constrained by the complexity and high cost of raw materials for their production [1].

Titanium is a strong carbide stabilizer, which is used in austenitic stainless steel to prevent intergranular corrosion. In addition, it improves the hardening characteristics of steel [2-3]. Compared to pure titanium, titanium-containing ferroalloys (ferrotitanium, silicotitanium) have the advantage of better solubility (lower melting point and higher density) and lower cost. Titanium ferroalloys, depending on its composition, are produced in several ways. These methods are carbothermic reduction, aluminothermic reduction and the production of titanium scrap and iron in an induction furnace in a vacuum or argon atmosphere [4-5].

The raw materials for the production of titanium-containing ferroalloys are ilmenite, slag with a high titanium content, obtained from ilmenite and titanium scrap. Currently, the real objects of the mineral resource base of Kazakhstan are three alluvial titanium-zirconium deposits: Satpayev (East Kazakhstan area), Obukhovsk (North Kazakhstan region) and Shokash (Aktobe region). The explored deposits are developed at the initial stage of their processing - by obtaining concentrates, and their reserves are able to provide raw materials for processing enterprises for hundreds of years [6-8]. Ores are processed with the separation of ilmenite concentrates at the Ust-Kamenogorsk titanium-magnesium plant (JSC UK TMK) and the Aktobe ferroalloy plant (JSC Kazchrome) [9]. However, the extraction of raw materials and the production of titanium concentrates is carried out in small volumes.

The practice of applied technologies for processing and beneficiation of titanium ores does not satisfy the needs of the industry due to the high cost of the

final product. The demand of Kazakhstan ferroalloy plants for titanium-containing ferroalloys is mainly covered by imports from Russia, China and other countries. Against this background, the creation of a domestic production of such alloys for the deoxidation and alloying of steel and the separation of this production as a separate industry is an extremely important and urgent task, the solution of which will significantly raise the technical and economic level of domestic ferroalloy enterprises.

Despite the extensive research base, today in Kazakhstan there are no industrial enterprises for the production of titanium-containing ferroalloys. Therefore, domestic enterprises, in particular Arcelor Mittal Temirtau JSC, and for the lack of their own titanium-based ferroalloy in the republic, are forced to use imported titanium-containing types of ferroalloys when producing low- and medium-alloyed steel grades.

A number of methods are known for smelting ferrotitanium with aluminothermy [10-11], where, according to the production technology, expensive materials such as aluminum powder and FS75 ferrosilicon are used as a reducing agent. These technologies are currently operating at LLC UK Special Russian Alloys (Russia) and LLC Kluchevsky Ferroalloy Plant (Russia).

The practice of using the compositions of the charge materials used to produce ferrotitanium using known technologies indicates a number of disadvantages: the use of scarce raw materials during batching, which requires significant material and energy costs; the presence of harmful impurities in the components of the charge, which complicates the control of the safe conduct of the technological process of obtaining the guaranteed quality of a titanium-containing ferroalloy.

Thus, in the production of titanium-containing ferroalloys using known technologies, problems arise in the optimal choice of titanium-containing raw materials and other components of the charge for its smelting. As titanium-containing raw materials, ilmenite, rutile concentrates, ore composites, wastes, which, in addition to titanium oxide, contain harmful impurities (P, S, non-ferrous metals) are

mainly used, which complicates and increases the cost of the process for producing high-quality ferroalloy.

The reason mentioned above makes it necessary to carry out a complex of research work to improve and introduce technological processes for the production of new alternative titanium-containing complex ferroalloys in the Republic of Kazakhstan and the CIS countries. Therefore, the study of the technology for producing an effective titanium-containing alloy obtained from domestic substandard raw materials is an urgent task, the solution of which is of great practical importance.

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