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Thermodynamic simulation of the Al-V-Ti-C master alloy aluminothermicsmelting

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Abstract

The Al-V-Ti-C master alloy brand AVTU is used in the deformable titanium alloys production. The main component – vanadium – stabilizes β-phase of titanium, whereas aluminum and carbon are α-stabilizers. Carbon at concentrations up to 0.12-0.14% significantly strengthens titanium alloys, improving their operational characteristics to the level of materials intended for use at high temperatures and in corrosive mediums. There are some disadvantages of using an elemental carbon (graphite) for master alloy smelting, which lead to a decrease in product quality: the inhomogeneous distribution in the mixture, gaseous products formation which increase the porosity of ingots and others. To introduce the carbon into the alloy smelting mixture in the form of aluminum, calcium or titanium carbides was suggested in the paper. The estimation of possibility of graphite replacement with an equivalent amount of Al_4C_3, CaC_2, TiC was carried out by the thermodynamic modeling method using an HSC Chemistry 6.1software (Outotec). The effect of the "carbonizers" type (C, Al_4C_3, CaC_2, TiC) on the phase formation during the master alloys melting as well as a carbon distribution in carbide phases were studied by the example of the mixture composition which is regulated by smelting technology of the AVTU alloy. Temperature dependences of the equilibrium compositions of the reaction products of the mixture components with Al_4C_3, CaC_2, TiC were obtained for the 100-2500^o Crange as well as material and heat balances (provided that heat loss is equal to "zero") were estimated to predict the process parameters of the AVTU master alloys melting with the use of elemental carbon (graphite) and carbides of aluminum, calcium, titanium as "carbonizers". It has been shown, that considered carbide compounds can be part of the mixture instead of graphite without prejudice to the heat mode of the aluminothermics melting. Moreover, calcium carbide is able not only to play a full-fledged part as a "carbonizer" of a metallic phase, but also to replace the equivalent part of aluminum and to increase thermic properties of the AVTU master alloys melting mixture. In the case of titanium carbide, the partial substitution of graphite will be the optimal solution. In terms of thermodynamics, the replacement of elemental carbon with carbides of aluminum, calcium or titanium will not affect on the carbon distribution in phase components of the master alloy and on the grade of metal extraction into the Al-V-Ti-C alloy.

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