The RAFMS RUSFER-EK-181 as Structural Material for the Test Module DEMO


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In the framework of the RF R&D activity for fusion power energy mastering and manufacturing of the test ceramic module DEMO, reduced activation ferritic-martensitic steel (RAFMS) based on Fe-12Cr-2W-V-Ta-B system (RUSFER-EK-181) is obtained. Industrial ingots of RUSFER-EK-181 steel and its modifications, articles of which (plates, rods, tube stocks, others) posses the necessary complex of physical, mechanical (short-term and longterm) and technological (welding) characteristics in a wide temperature range, have been manufactured. The factor determining high heat resistance of the steel is its structural-phase state and precipitation hardening regulated by the chemical composition and the developed regimes of thermo-mechanical treatments of the steel. Structural-phase state of the steel provides the required level of the operating characteristic of goods under the established regimes of radiation and temperature loads. Good results of heat resistance tests of the steel under the stress 80 MPa at 650 °C during 25000 hours have been obtained. The technologies of welding of the articles have been developed, examples of argon-arc welding joints and their structural states are given.

The results on the effect of different regimes of heat treatment on the radiation properties of RUSFER-EK-181 at low irradiation temperature (fast reactor BOR-60) have been obtained. The gradient structural-phase state changing along the length of the steel article has been suggested. High level of heat resistance in the high temperature application zone of the articles is developed with use of the traditional heat treatment for ferritmartensitic steels (normalization and tempering). New combined heat treatment including additional heat cycling of the steel near its critical point is applied for the low temperature part of the article. The structure obtained by the combined heat treatment of the steel provides higher level of its resistance to the low temperature initial and irradiation embrittlement. Using of the combined heat treatment of the article decreases hardening and increases ductility of the steel in the initial state and after low temperature irradiation, increases the value of the impact toughness and decreases the value of the shift of the ductile-to-brittle transition temperature.

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