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PROSPECTS FOR THE APPLICATION OF A BRONZE HEAT-SINK STRUCTURE MADE BY VACUUM MELTING FOR THE FIRST WALL OF THE ITER THERMONUCLEAR REACTOR *)

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The plasma-facing units (PFU) of the First Wall (FW) and the Divertor Dome for the International Thermonuclear Experimental Reactor (ITER) are equipped with a cooling system implemented in the form of a hypervapotron-type cooling channel structure. The PFU design includes a protective tungsten armour, a bronze (CuCrZr) heat sink with the cooling channel - hypervapotron, and a steel support structure serving as a base.

The purpose of this work is to study the possibility of replacing the traditional hypervapotron with steel thin-walled tubes around which the vacuum melting of bronze is performed. It is assumed that such changes will be aimed at improving the functional characteristics and reliability of the design.

The advantages of the new design as compared to the hypervapotron include a significant reduction in the amount of machining, a reduction in metal consumption, increased reliability and tightness of the design as a result of the implementation of the principle of coolant double containment. The proposed changes do not require modifications to the interfaces with the blanket, plasma, or adjacent panels, which maintains compatibility with existing systems and simplifies the implementation of changes to the existing design.

To confirm the durability of the heat sink under high heat fluxes (HHF), a mock-up was designed and tested with different thicknesses of the steel walls of the cooling channel. The vacuum melting of bronze was performed in a resistance furnace.

The mock-up was subjected to thermal tests in the range of heat loads up to 4.7 MW/m² and withstood 2000 thermocycles.

The temperature measurements during the tests coincided with the results of the thermal calculation of the mock-up. The metallographic analysis of several sections of the cut mock-up after the tests did not reveal any cracks or discontinuities, including those of a fatigue nature. It was also noted that the contact between the steel tubes and the melted bronze did not result in significant thinning of the walls of the latter.

The test results have confirmed the prospects for the application of the vacuum melting of bronze on steel walls of the cooling channel for high-energy-loaded components.

*) abstracts of this report in Russian