CALCULATION OF POWER LOADS FROM THE BEAM ON COMPONENTS INJECTOR PATH AND ON WALL CHAMBER T-15MD TOKAMAK [[1]](#footnote-1)\*)

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Currently, work is underway to modernize the neutral beam injection system of the T-15MD tokamak. As a source of additional plasma heating in the tokamak, it is planned to use three injectors of energetic hydrogen atoms, each with a power of 2 MW [1]. The injection heating system (IHS) of the T-15MD installation is a deep modernization of the IHS of the "old" T-15 tokamak, many elements of which functionally do not meet modern requirements, one of which is a significant increase in the pulse duration to tens and then hundreds of seconds. Upon transition to a practically stationary mode of operation, the power loads on the components of the injector beam line begin to play a significant role. If, when operating in the short pulse mode (at the level of 1 second), it was possible to simplify the cooling of the components, taking into account their heat capacity and the possibility of cooling in the pauses between pulses, now the modernized design of the components should provide them with adequate stationary cooling.

This paper presents the results of calculations for the transport of ion and atomic beams using the PDP and BTR codes [2, 3], on the basis of which the parameters of the beam entering the tokamak plasma and the power loads on the beam line components both from direct beam interception and from energetic re-ions formed along the entire path due to the re-ionization of the neutral beam part due to collisions of fast atoms with background gas molecules. These re-ions are deflected by the stray magnetic field of the tokamak mainly onto the walls of the atomic duct connecting the injector to the tokamak, and, as calculations show, they can, depending on the profiles of the magnetic field and the background gas, give local loads with a high power density. Similarly, some of the residual ions emerging from the neutralizer, deflected by the magnetic field of the electromagnet, as they move towards the receiver, are recharged on the background gas with the formation of energetic atoms. Based on the calculated data, the places were determined of cooled protective elements installation in the injector vessel and in the atomic duct and the load profiles on them.

The neutral beam introduced into the tokamak is not completely captured in the plasma, part of it passes "through" to the chamber wall. The fraction of transmitted power, which depends on the plasma density, beam energy, beam size and profile at the entrance, has been calculated. Since the power of the input beam from one injector can be up to 2 MW, for the uncooled chamber wall, restrictions on the input power are determined depending on the plasma parameters.

References

1. Barkalov K.E., Anashkin I.O., Barkalov E.E., Gribov A.A., Korolev V.F., Nikulin V.A., Panasenkov A.A., Petrov V.S. (National Research Center «Kurchatov Institute» Moscow, Russia), «Injection system for heating plasma tokamak T-15MD», XLVIII Zvenigorod international conference on plasma physics and controlled fusion, 15-19 March 2021, Books of abstract, p. 69.
2. S.S. Ananyev, E.D. Dlougach, B.V. Kuteev, A.A. Panasenkov. «Modelling and optimization of neutral beam injectors for fusion neutron source DEMO-FNS», Problems of atomic science and technology, ser. Thermonuclear fusion, vol. 41, i. 3, pp. 57-59.
3. Dlougach, E.D. BTR code for NBI design and study. VANT Fusion Ser. 2021, 44, 68–79.

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Mu/ru/BB-Barkalov.docx) [↑](#footnote-ref-1)