INJECTION SYSTEM FOR HEATING PLASMA TOKAMAK T15-MD [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2021.48.1.037

Barkalov K.E., Anashkin I.O., Barkalov E.E., Gribov A.A., Korolev V.F., Nikulin V.A., Panasenkov A.A., Petrov V.S.

NRC "Kurchatov Institute", Moscow, Russia, Barkalov\_KE@nrcki.ru

The report presents the system of injection heating (SIH) plasma of the tokamak T15-MD being created, designed to inject beams of hydrogen atoms with energies up to 75 keV at a maximum total power of at least 6 MW. At the first stage, the pulse duration should be up to 30 s, at the second, the pulse lengthening is supposed to 400 s (stationary mode). The SIH includes three neutral atom injectors, each of which is equipped with two ion sources, components inside the vacuum chamber, such as a gas neutralizer, a magnet for deflecting residual ions, an ion receiver, a sliding atom receiver for beam diagnostics, a cryocondensation pump, and connecting the injector with the tokamak chamber by an atomic pipeline with an internal cooled liner. The operation of the injector is provided by low-voltage and high-voltage power supply systems with protection of ion sources from breakdowns, power supply of auxiliary equipment, a working gas inlet system, devices for water-cooling of ion sources and components of the beam path, and a control system. Taking into account the transition to a practically stationary mode, all components of the path, systems and devices are being modernized to meet new requirements. The ion source (IS) STIS-1S [1] consists of a copper gas discharge chamber (GDC), which provides a uniform current density of hydrogen ions on the emission surface with an area of 12x35 cm2 at a level of 0.3 A/cm2 [2], and an insulator unit with a multi-slot three-electrode cooled ion-optical system, which must be upgraded to operate with voltages up to 75 kV at ion currents up to 50 A. The screening of the section of the ion beam path from the GDC to the exit from the neutralizer from the scattered magnetic fields of the tokamak, which can reach a value of 150 G. The efficiency of neutralizing an ion beam from an IS containing molecular ions in addition to protons is about 50%, therefore, after neutralization and dissociation of molecular ions, the beam contains atomic and residual ion components with energies E, E/2, and E/3. The requirements for the stabilization of high-voltage voltages at two sources of the injector and the magnitude of the ion-deflecting magnetic field to ensure complete interception of all ion components at the receiver are considered. Calculations were made of the efficiency of beam transport to the entrance to the tokamak chamber and the loads on the components of the tract, both from the main beam and from ions formed along the tract during the re-ionization of atoms in the background gas, and from atoms resulting from the recharging of residual ions during their deflection magnet. The most loaded are V-shaped receivers of atoms and residual ions, which should receive beams with a power of up to 2.5 MW in a stationary mode at a maximum power density of up to 15 MW/m2 on the panel. The conditions for cooling all components are considered.

References

1. A.G. Barsukov, A.I. Krylov, A.Y. Markelov, A.A. Panasenkov, V.A. Smirnov, G.N. Tilinin *«Development and experimental study of the quasistationary ion source STIS-1»*, XL International (Zvenigorod) Conf. on Plasma Physics and Controlled Fusion, 2013.
2. Barkalov K.E., Barkalov E.E., Panasenkov A.A. *«*[*Measurment of plasma parameters in GDC STIS-1S.*](http://www.fpl.gpi.ru/Zvenigorod/XLVI/Lt/en/GO-Barkalov_e.docx)*»*, XLVI International (Zvenigorod) Conf. on Plasma Physics and Controlled Fusion, 2019., Book of abstracts, p.193.
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVIII/Mu/ru/AW-Barkalov.docx) [↑](#footnote-ref-1)