RECONSTRUCTION OF THE RESISTANCE OF VACUUM CHAMBER T-15MD FROM MAGNETIC MEASUREMENTS BASED ON SOLUTION OF INVERSE PROBLEMS [[1]](#footnote-1)\*)

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At present, the Kurchatov Institute Research Center is preparing to launch the T-15MD. The vacuum chamber (VC) of the tokamak is thick with a low ohmic resistance; therefore, large eddy currents are induced in it. These currents influence the equilibrium of the plasma and, accordingly, the operation of the discharge control algorithms. Accounting for currents with maximum accuracy is an important task for successful experiments on the T-15MD.

When calculating discharge scenarios and in plasma discharge control systems, a two-dimensional model of the VC of the T-15MD tokamak is used. However, it can be different from a real 3D vacuum chamber. Therefore, the use of such a model can lead to errors in calculating the eddy currents in the VC of the tokamak. The problem is of improving and optimizing the two-dimensional model of the VC of the T-15MD tokamak.

The two-dimensional model of VC is as follows. The VC is divided into *N* toroidal turns, to determine the eddy currents, the Kirchhoff equations are written in them:

  (1)

where *Lij* are the mutual induction coefficients of the VC toroidal turns with each other, *Ij* is the current in the *j*-th turn, *Ri* is the resistance of the *i*-th turn, *Lim* is the mutual induction coefficient of the *i*-th toroidal turn and the poloidal coil with current, *Im* is the current in the poloidal coil.

Note that one of the most sensitive elements of the VC model is the resistance of individual toroidal turns into which it is divided in a two-dimensional model. To optimize the VC model, magnetic measurements are used in specially designed experiments, for the analysis of which the inverse problem is formulated.

Let us set a rising current with a fixed time derivative in one of the poloidal coil. Then, after a resistive time, the current in the *i*-th toroidal turn of the VC will reach a stationary value, i.e. the first term in equation (1) will vanish. In this case, from (1), one can find the current in each *i*-th toroidal turn:

  (2)

Knowing the currents in each VC toroidal turn, it is possible to calculate the magnetic field at the locations of the magnetic probes:

  (3)

Knowing the magnetic field  measured by the probes, we write the discrepancy functional:

  (4)

The minimum of functional (4) gives a solution of the problem, i.e. resistance of each toroidal turn of the VC of the T-15MD tokamak.

On the basis of the “quasi-real” experiment, the following studies were carried out: a) the optimal scenario of the experiment was determined, i.e. the rate of rise of the current in the poloidal coil; b) the dependence of the accuracy of reconstruction of the VC resistance on the error in measurements by magnetic probes was investigated; c) the dependence of the accuracy of reconstruction of the VC resistance depending on the number of used magnetic probes was investigated. Based on the results of “quasi-real” experiments, recommendations are given for carrying out a real experiment on the T-15MD tokamak.

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