RECONSTRUCTION OF THE CURRENT PROFILE IN TOKAMAK BASED ON MAGNETIC MEASUREMENTS taking into account ADDITIONAL INFORMATION [[1]](#footnote-1)\*)

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The paper considers the inverse problem of reconstructing the current profile in a tokamak using magnetic measurements and additional information obtained from various diagnostics. It is known that it is difficult to unambiguously determine the current profile in the central part of the filament based only on magnetic measurements. However, if additional information is involved, such as the distribution of electron temperature, density profile, pressure, then the reliability of determining the current profile from the inverse problem increases significantly.

The task is especially relevant in connection with the preparation of the physical launch of the T-15MD tokamak facility at the National Research Center "Kurchatov Institute". This installation provides an extensive system of electromagnetic diagnostics, which includes more than 500 sensors located in several cross sections [1-3]. This set includes one- and two-component sensors for measuring the magnetic field, magnetic flux, Rogowski coil for measuring plasma current and eddy currents on structural elements, diamagnetic signal sensors, etc. In addition, there is a non-magnetic diagnostics - combined CXRS and MSE diagnostics , which makes it possible to obtain temperature and density distributions with good spatial and temporal resolution. And although these distributions are themselves the result of solving the corresponding inverse problem, it becomes possible to use these data to solve the problem of reconstructing the current profile.

Thus, the pressure distribution can be used to formulate the statement and develop an algorithm for solving the inverse problem for the current profile. The numerical solution of the inverse problem is based on the integro-differential approach. The solution of the direct problem of MHD equilibrium is based on the differential method. The solution of the inverse problem is based on the Fredholm linear integral equation of the first kind. Since the problem is non-linear, an iterative process of successive approximations is applied. The integral equation is solved based on the Tikhonov regularization method.

A numerical study was made of the dependence of the current profile reconstruction accuracy on the number of magnetic sensors, the error of magnetic measurements, and the error in setting additional information (pressure profile). Based on the simulation results, recommendations were developed on the quality of initial data preparation and the necessary conditions for obtaining them in an experiment on the T-15MD facility.

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References

1. Melnikov A.V. et al. Physical program and diagnostics of the T-15 upgrade tokamak (brief overview). - Fusion Engineering and Design, 96-97 (2015), pp.306-310.
2. Zotov I.V., Belov A.G., Sychugov D.Yu., Lukash V.E., Khairutdinov R.R. Numerical modeling of the system of electromagnetic diagnostics of the T-15 tokamak // Problems of Atomic Science and Technology. Ser. Thermonuclear Fusion, 2015, vol. 38, issue 2, pp. 51-61.
3. Andreev V.F., Balashov A.Yu., Belov A.M. et al. Simulation of magnetic measurements on the T-15MD tokamak taking into account induced currents in a vacuum chamber // Problems of Atomic Science and Technology. Ser. Thermonuclear Fusion, 2021, vol. 44, issue 4, pp. 25-42.

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