THE OPTIMIZATION OF THE TOROIDAL SOLENOID GEOMETRY OF THE TOKAMAK MEPHIST-0 [[1]](#footnote-1)\*)

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A helical configuration of a toroidal solenoid has been proposed for the tokamak “MEPHIST-0”. The configuration of the magnetic field created by such a solenoid has several features. The one of them is the possibility to reduce the scattered fields from the current leads. The next one is the simplification of the electrical circuit in comparison with the use of separate toroidal coils. The last one is the guarantee of the equal operation of each segment of the solenoid. For such toroidal solenoid, it is necessary to compensate the poloidal magnetic field inside the chamber, which is a result of tilting the coils.

The method of optimization which was used for the minimization of poloidal fields is the geometry modification of the solenoid coils, especially the distribution of the inclination angle of the solenoid coils along their length. In addition, the problem of the coils geometry design is also associated with decrease of the forces and overturning torque, acting on them.

The presented work is aimed for the optimization of the tokamak MEPHIST-0 toroidal solenoid geometry. The geometry has been modified step by step by an iterative method. At the zeroth step, the shape of the poloidal cross-section was calculated from basic principles based on the classical solution for the geometry of torqueless coils [1]. It was assumed that the solenoid was a superconducting toroidal surface, with a current flow in the poloidal direction. The task was to find the inclination angle distribution of the turns along their length. The toroidal part of the current, proportional to the slope of the coil was added to the current, flowing along the toroidal surface of the solenoid with a poloidal section corresponding to the condition of torquelessness. Then the distribution of the toroidal current over the poloidal toroidal surface was calculated to minimize the poloidal field [2]. At the first and subsequent steps, the shape of the poloidal cross-section was found based on the current distribution over the toroidal surface obtained at the previous optimization step. The current distribution along the length of the loop was found based on the refined shape of the poloidal section [3].

As a result, the geometry of the toroidal solenoid, based on the solutions obtained for an ideal toroidal surface, was designed taking into account the constraints set by the geometry of the “MEPHIST-0” discharge chamber. The effect of the solenoid geometry deviation from an ideally conducting toroidal surface on the magnitude and distribution of poloidal fields in the discharge region in the tokamak was estimated by modeling in the COMSOL software package. The expected values and spatial distributions of the ratios of the perpendicular and toroidal magnetic fields in the tokamak and the variation of the toroidal field were determined.

Refferences

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