THE REGULARIZATION METHOD BY A.N. TIKHONOV AND THE RICHARDSON METHOD IN THE MATHEMATICAL MODELING OF SOME MAGNET SYSTEMS

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A nonlinear magnetostatic inverse problem is investigated for a case when it is needed to create a required magnetic field using conductors which coordinates vary on condition that current value is equal in all the conductors. It is known that the same problems fall under the category of noncorrect problems. Mathematical statement of this type of nonlinear magnetostatic inverse problems is given. The proposed numerical algorithm using the regularization method by A.N.Tikhonov permits to overcome comparatively easily the difficulties connected with badly conditioned equation systems to which usually the magnetostatic inverse problems reduce. This algorithm allows one to calculate the existing winding geometry of superconducting dipole ironless magnet which ensures a magnetic field homogeneity up to 10^{-5} within a rectangular aperture. Magnetic field distribution which is created by wires of an infinitely thin cross section being positioned near magnetic field surfaces and providing magnetic field index correction in the working region of accelerator is calculated by the mirror reflection method. Some expressions by which it is possible to calculate magnetic field gradient of arbitrary set of correcting wires are given. Current magnitude in correcting wires for 10 GeV JINR synchrophasotron magnetic field index correction under field level about 0.023 T are calculated and optimized by the regularization method. Design, optimization and construction of magnetic systems is a complex engineering and physical issue. Mathematical modelling of magnetostatic problems allows us to make easy and accelerate the process of research on physical properties of a specific magnetic system. In particular, the mathematical simulation provides a way for studying those segments of the magnet where it is quite difficult and even impossible for making measurements (for example, in the core or very thin constructions). Thus, it is the mathematical modelling that provides a way for finding an optimal configuration of the magnet in each particular case. It should be noted that in the course of modelling a specific magnetic system some problems related to the peculiarities of its design arise. This is connected particularly with the choice of an optimal calculated grid for the boundary problem of magnetostatics. It is the problem that arose for the authors of this work, because the magnetic system considered is of small size and has a very thin gap. As a result, various variants of the magnetic system with a round aperture have been investigated numerically, various configurations of the system have been proposed for realization. In the process of numerical modeling of a superconducting magnetic focusing system, additional control of the approximation accuracy according to Richardson of the condition $u(\infty)=0$ was performed on the basis of the above method using extrapolation with respect to the parameter R^{-1}.