03aE35P

RELAX装置のリミター配位における磁束分布と渦電流の逆解析

Shape reconstructions of magnetic flux and eddy current in a limiter configuration of the RELAX device

板垣正文[1], 三瓶明希夫[2], 政宗貞男[2], 渡邊清政[3]
Masafumi Itagaki[1)], Akio Sanpei[2)], Sadao Masamune[2)], Kiyomasa Watanabe[3)]
[1]北大工, [2]京都工芸繊維大, [3]核融合研
[1]Hokkaido Univ., [2]Kyoto Institute of Technology, [3]NIFS

Introduction: As strong eddy currents exist on the shell of the reversed field pinch device, RELAX, the Cauchy condition surface (CCS) method [1] based on magnetic sensor signals needs to be modified to reconstruct accurately the magnetic flux profile in the device.

Method: The new term

$$\mu_0 \int_{\Gamma_{\rm Shell}} j_S(\mathbf{r}_l)\psi^*(\mathbf{r}_l \to \mathbf{r}_i)d\Gamma(\mathbf{r}_l)$$

is added to each boundary integral equation (BIE) in the CCS method formulation. Here $\psi^*(\mathbf{r}_l \to \mathbf{r}_i)$ is an influence function, while $j_S(\mathbf{r}_s)$ denotes the linear density [MA/m] distribution of the eddy current on the shell, which is integrated in the poloidal direction along the shell. The set of BIEs is discretized and converted to a matrix equation where unknowns are the Cauchy conditions and the eddy current density values at the nodes that are set on the shell. To suppress unacceptable large numerical oscillation of the eddy current, the modified truncated singular value decomposition (MTSVD) technique by Hansen et al. [2] is adopted for solving the matrix equation.

Results: The new CCS method is applied to a problem that models a limiter configuration of the RELAX device. One assumes 40 flux loops and 40 tangential probes inside the shell. The CCS is placed in a domain that can be supposed to be inside the plasma. When the number of current nodes on the shell is smaller than 40, the reconstructed solutions disagree with the reference solution that is obtained using the RELAX-Fit code [3].

Figures 1 and 2 show the reconstructed profiles of flux and eddy current respectively, when one takes 6 nodes on the CCS and 60 current nodes on the shell.

Conclusion: This new method enables one to identify accurately not only the magnetic flux profile but the eddy current distribution. The number of eddy current nodes should be large enough to ensure that the number of unknowns (the node-wise current values + the Cauchy conditions) is close to the number of equations (for the sensor signals + nodal points on the CCS). The MTSVD technique is an effective way to suppress the numerical oscillation of the eddy current.

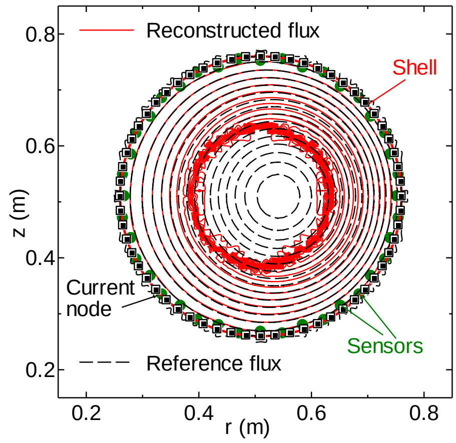

Fig.1 Reconstructed magnetic flux profile

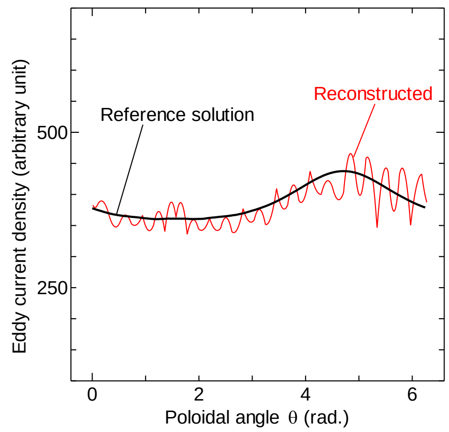

Fig.2 Reconstructed eddy current density profile

References:

[1] K. Kurihara, *Fusion Eng. Des.* **51-52**, 1049 (2000).
[2] P.C. Hansen, T. Sekii, H. Shibahashi, *SIAM J. Sci. Stat. Comput.*, **13**, 1142 (1992).
[3] A. Sanpei et al., *J. Phys. Soc. Jpn*, **78**, 13501(2009).