§11. Positional Stabilization of Torus Plasma with Simple Helical Coils

Tsuji-Iio, S., Hatakeyama, S., Miura, M., Yao, S.,
Tsutsui, H. (Tokyo Tech),
Ohno, N. (Nagoya Univ.),
Shibata, Y. (JAEA),
Kuwahara, D. (TAT),
Nakamura, K. (Kyushu Univ.),
Akiyama, T., Watanabe, K.Y.

The objective of this study is to stabilize vertical instabilities of elongated tokamak plasmas by the use of saddle coils which make helically perturbed fields. Although several studies have been made on the effects [1], they have been conducted in tokamaks with circular cross-sections. For the next step of this study, we have been constructing a small tokamak device (R = 0.33 m, a = 0.09 m, κ = 1.8, Bt = 0.3 T) which has a highly elongated cross-section to demonstrate the stabilizing effects. Among the progress of the construction, we report the following topics: strength tests of a trial toroidal field coil and discharge tests of flywheel power supply for poloidal field coils.

Firstly, we designed support structures for the toroidal field coils by stress analysis using the finite element method. After we confirmed soundness of the support structure numerically, we performed strength tests on a trial TF coil as shown in Fig. 1. The maximum electromagnetic force which was estimated to be a centering force of 550 kgf was simulated by the load of a heavy weight of 1000 kg in the tests. It was found from the strain measurements that the deformation of the support structure can be elastic even under overload up to twice of the estimated maximum centering force. After we got the result, we made all sixteen toroidal field coils and assembled them (Fig. 2).

We proposed a new simple flywheel generator system inspired by micro hydro power technology as the power supply for poloidal field coils (Fig. 3)[2]. This system uses a self-excited induction generator (SEIG) converted from a commercially available induction motor so that it can be cost effective. The SEIG can maintain nearly constant terminal voltage in combination with rectifier circuit much longer than commonly used capacitor banks. The post stage dc-chopper which was controlled by taking voltage fluctuations in SEIG into account converts the varying voltage to arbitrary voltage to control currents flowing in poloidal field coils. We conducted discharge test of the power supply with a sample coil comparable to poloidal field coils (Fig. 4). It was demonstrated that the proposed power supply can maintain command square-wave current flowing in the test coil for 1 s which is long enough to our small tokamak experiments.

1) Ikezi, H., Schwarzenegger, K. F.: Phys. Fluids 22 (1979) 2009.
2) Hatakeyama, S., et al.: 1PoCL-07, MT-23, 2013.

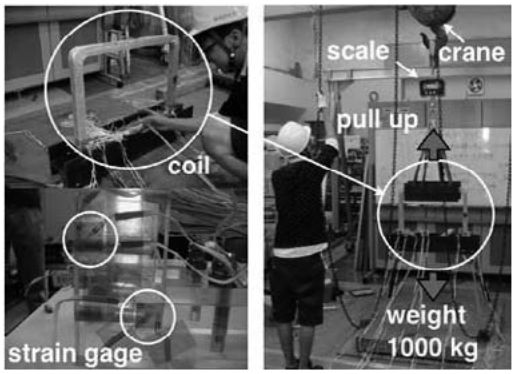

Fig. 1 Pictures of strength tests of a trial toroidal field coil.

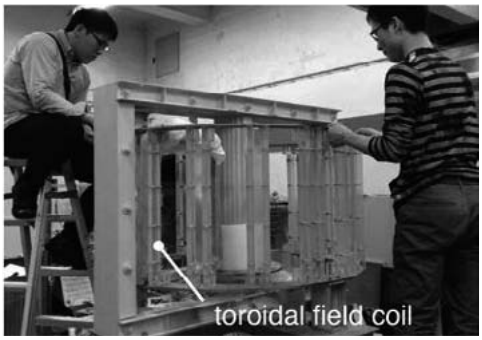

Fig. 2 Assembling of the toroidal field coils.

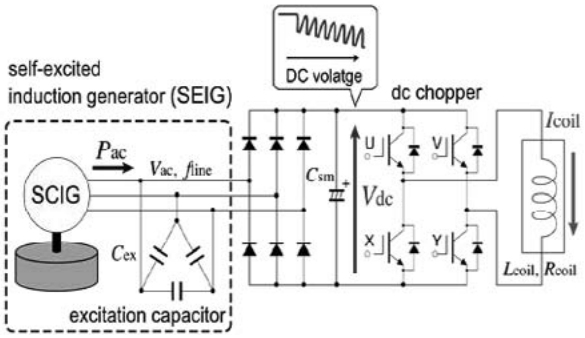

Fig. 3 Circuit configuration of the flywheel generator system.

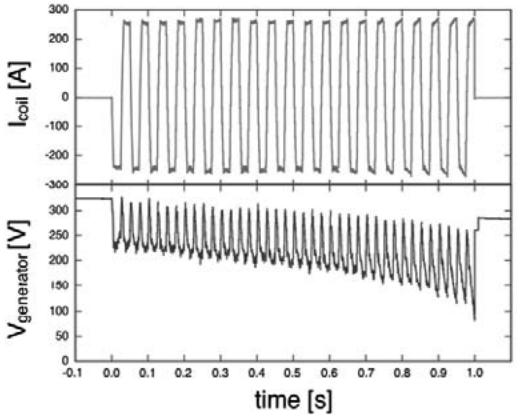

Fig. 4 Experimental waveforms of the sample coil current and the generator voltage.