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準軸対称ステラレータCFQSのコイル電源設計

Design of the Power Supply System for Magnetic Field Coils of Quasi-axisymmetric Stellarator CFQS

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The quasi-axisymmetric stellarator CFQS expected to have both advantages of a tokamak with superior plasma confinement property and a stellarator with good steady-state operation performance is being constructed as the joint project of National Institute for Fusion Science in Japan and Southwest Jiaotong University in China [1-3].

The CFQS coil consists of 16 modular coils (MCs) with 4 different types (MC1, MC2, MC3 and MC4), 4 poloidal field coils with 2 types (OV and IV), and 12 toroidal field coils (TFCs) with 3 types (TFC10, TFC32 and TFC70). Design of the power supply system for these coils is proceeding in two stages: 0.1 T continuous operation for examining characteristics of the generated magnetic surface and 1 T pulse operation for rated operation.

Fig. 1 represents the preliminary designed circuit diagram of the power supply system for 0.1 T. It mainly consists of voltage adjusters and 6 phase diode rectifiers for the MCs and DC power supplies with 6 phase thyristor-controlled units for the TFCs. The 0.1 T circuit will also be used to the plasma experiment by ECH and discharge cleaning.

In the case of 1 T operation, power supply system with 60 MW and 1s of output time is required. It is rarely allowed to provide such massive electrical power directly from power grid. Therefore, some kinds of energy storage systems should be adopted. There are mainly 4 options which may satisfy the 1 T operation. Candidates are 1) Capacitor bank, 2) DC motors, 3) Self-excited induction generator and 4) Induction motor (IM) and synchronous generator (SG). Although we still have not determine the storage type, IM and SG type may be the most dominant system for 1 T operation. It has been adopted for various fusion experimental devices. Furthermore, it can store large electrical energy and supply power with good controllability.

Fig. 2 shows the preliminary designed circuit diagram of power supply system for 1 T operation. The circuit is principally composed of IM, SG, the inverter for IM and SG revolution control, the excitation system for SG output voltage control and six phase thyristor-controlled units. To provide various magnetic field configurations, the system supplies the power to each coil type of group in parallel as shown in Fig. 2. More details of designs will be proceeded with a manufacturer.

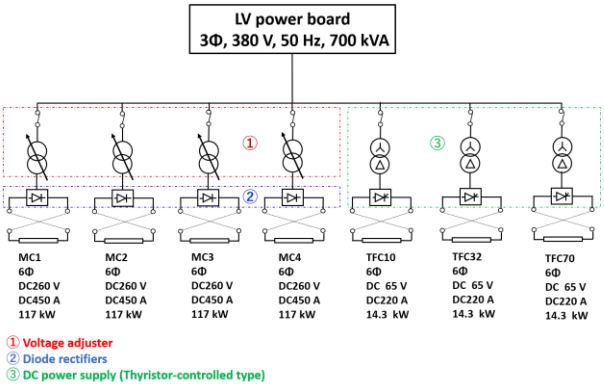

Fig. 1 Designed circuit diagram of the power supply system for 0.1 T operation.

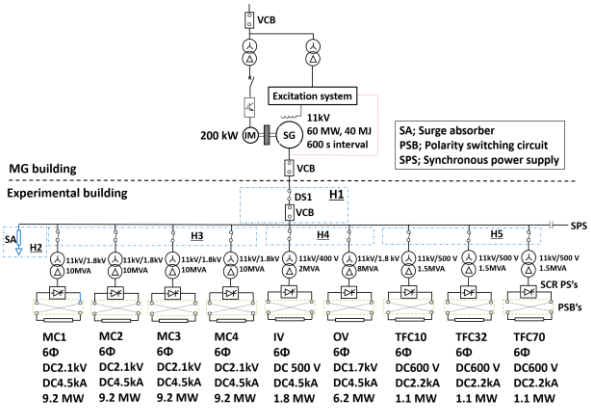

Fig. 2 Designed circuit diagram of the power supply system for 1 T rated operation.

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