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Development of HL-2M power supply system

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Southwestern Institute of Physics (SWIP) is establishing a new tokamak (HL-2M) which needs about doubled power capacity and energy than its existing tokamak (HL-2A). The HL-2M power supply system shall meet these requirements, make full use of existing power supply equipment and provide the operation compatibility for both HL-2A and HL-2M.

Besides three existing flywheel six-phase motor generators (MG), two 90 MVA and a 125 MVA, with horizontal configuration, another 300 MVA MG with vertical shaft, which is the first vertical type pulsed MG in China, is designed and manufactured. The weight of the new MG is about 800 t and the rotor is about 400 t. Its released energy in one shot can be 1350 MJ which is the sum of three existing horizontal MGs.

A new toroidal field (TF) filed power supply is developed to provide 1660V/140kA for HL-2M. Eight paralleled diode rectifiers can be divided by two parts and connected in series to provided compatibility of 45kA with higher voltage for HL-2A TF coil. The output of rectifiers is controlled by adjusting the excitation of motor generator. Four sets of three-winding transformer with extended delta $\pm 15^\circ$ are adopted to provide better impedance symmetry than delta/star configuration.

Central solenoid (CS) power supply is the most challenging one in HL-2M. It is a four-quadrant thyristor converter ($\pm 750\text{V}/\pm 220\text{ kA}$) with circulating current mode. Special design is considered both on the transformer and converter configuration. A bi-direction bypass unit which is consist of 120 thyristors is developed to protect the system in case of faults. There are 16 poloidal power supplies (PF) in HL-2M, which contribute not only equilibrium but also volt-second. Therefore most of them are four-quadrant thyristor converters.

Besides the main circuit, there are also improvements on the control system, PLC and data acquisition. For example, the converter is fired by a integrated real time control system with reflective memory communication with central control. A synchronization signal processor based on digital filter is developed, to obtain clean and accurate reference from the varying frequency and distorted output voltage of motor generator.

Eligible for student paper award?

No

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