DEVELOPMENT OF A DC 1MV POWER SUPPLY TECHNOLOGY FOR NB INJECTORS

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Important issues of NBI power supplies are a high-speed switching of high voltage, suppression of surge energy into a beam source at breakdown, and transmission of dc ultra-high voltage to the beam source. A GTO(gate turn off thyristor) inverter type power supply where the high speed switching is performed at the low voltage ac side has been designed for the ITER NB. In recent years, instead of the GTO, high power IGBT (insulated gate bipolar transistor) and IEGT (injection enhanced gate transistor) have been developed. Thus the design of the inverter for NB system is to be modified simpler and compact using such elements to cut off the dc high voltage shorter than 200 μs. Based on experiences of the JT-60 N-NBI, allowable surge energy input to the ion source at breakdown has been estimated for the ITER power supply as 3 kA and 10 J, respectively. Core snubbers made of Fe-based nanocrystalline soft magnetic materials and surge suppression L-R circuits are adopted in the ITER NB to limit the input surge lower than the allowable value.

Transmission of the dc high voltage with intermediate voltages is required for the NBI power supply. A bushing is a key component in the transmission line. For the ITER NB system, a disk shape multi-conductor bushing whose dimensions are 1.8 m in diameter, and 140 mm in thickness at the edge has been designed and fabricated as a part of ITER R&D. The bushing was tested in a transmission line test chamber whose dimensions are 1.6 m in diameter and 6 m in length. The design value of electric field strength was chosen to be 5 kV/mm at the conductor surface based on the existing low voltage bushing. Electric field at the bottom of the transmission line outer chamber was considered to be lower than 1.8 kV/mm to suppress metal particle levitation, which could reduce voltage holding of the surface of the insulator. A high voltage of 1,175 kV was successfully sustained for 300 s. This voltage corresponds to the testing voltage of the ITER NB power supply.

In the present paper, these key technologies for NB power supplies are reported.

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