PROGRESS IN DEVELOPMENT AND DESIGN OF THE NEUTRAL BEAM INJECTOR FOR JT- 60SA

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Neutral beam (NB) injection is one of the most promising candidates for the plasma heating in fusion experimental machines such as JT-60SA and ITER. For JT-60SA, D^0 beams of 30 MW in total are designed to be injected for 100 s in an initial experimental phase. To fulfill this requirement, existing twelve positive-ion-based NB (P-NB) injectors on JT-60U will be upgraded and reused to extend the injection pulse length from 10-30 s to 100 s. Mainly, the electric components such as water resistors in power supplies will be replaced with the higher-capacity ones, and the magnetic shielding system with passive shield and active coils also will be modified to reduce the stray field to an allowable level in the beam path. No modification of the beamline components such as ion sources and residual ion dumps is required except for injection ducts. The upgrade of the P-NB injectors allows to injecting 20 MW D^0 in total at 85 keV.

The remained power of 10 MW will be injected from a negative-ion-based NB (N-NB) injector to realize off-axis current drive. The N-NB injector on JT-60U, which was designed to inject 10 MW D^0 beams for 10 s via neutralization of the D^- ion beams produced from two large negative ion sources, will be upgraded for JT-60SA. Since the injection power is found to be limited by poor voltage holding capability of the negative ion sources in the past operation, the negative ion source has been energetically modified to improve voltage holding capability. Recently, the voltage holding capability has been improved to the power supply limitation of 500 kV by extending gap lengths between the acceleration grids. This improvement of voltage holding capability leads to a stable productions of the high-energy negative ion beam. Through 20 % of the ion extraction area, the highest beam energy of 510 keV at beam current of 1 A and highest beam-current of 2.8 A at beam energy of 490 keV have been achieved. Even in increasing the beam current by cesium seeding in the ion source, the beam is stably accelerated without degradation of voltage holding capability. From these results, high-energy beam production for JT-60SA is prospective. In addition to the development of the negative ion source, the design of the N-NB system for JT-60 SA is in progress. The level of the N-NB injector from the ground floor is designed to shift 60 cm downward to drive off axis plasma current in the high-β (β_N=3.0) plasma. Most of the power supplies will be upgraded by replacing electric parts except for the acceleration power supply. As for the acceleration power supply, parallel connection circuits in the inverter switching system is designed to be added. The upgrade of the inverter/converter in the acceleration power supplies starts in 2010.

In this paper, the progress in the development and the design of the NB system for JT-60 SA is described.