RECENT ACTIVITIES OF NEGATIVE ION BASED NBI SYSTEM ON JT-60U

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Recently, the negative ion based NBI system has been intended to extend its pulse duration from 10 sec to 30 sec to study long pulse plasmas on JT-60U. There are two ion sources, which was originally designed to accelerate the negative ion current of 22 A up to 500 keV for 10 sec. One ion source was modified to reduce the heat load of the acceleration grids and used to demonstrate its capability for long pulse operation within the capacity of the power supply system. In the long pulse operation, it was found that the arc power of the source plasma gradually decreased due to reduction in the filament current at constant power supply voltage. This phenomenon was caused by the arc current flow in the filament itself, which depended on the filament temperature during operation. A feedback control technique has been employed and succeeded to keep the arc power constant by controlling the filament voltage. After achieving a constant arc power, it was clearly observed that the negative ion beam current increased with the temperature of the plasma grid of the ion source during long pulse operation. Up to now, pulse extension of 25 sec, ~1 MW with power reduction, and 17 sec, 1.6 MW at constant power has been achieved. Control of the arc discharge seems to play a key role to extend the life-time of the filaments. Indeed, the damage of the filaments was observed on the negative feeder side during the inspection of the ion source, where the temperature increased due to the same direction of the arc current flow as that of the filament current. To improve the performance in next experimental campaign, an installation of taper type filament is proposed, which is expected to reduce non-uniformity of the temperature by making the same current density of the filament feeders during arc discharge. Moreover, the feedback system of the arc power has been modified to use the arc voltage, which can quickly responses to the change of the fluctuation of the arc power in addition to the filament voltage feedback loop. On the other hand, high voltage holding at the accelerator is required to increase the injection power. In a high voltage holding test without beam extraction, it was found that the main species of the incremental outgassing during high voltage application was hydrocarbons and was the same as that of the breakdown case. Since the high voltage could be hold when the outgassing became small, the outgassing seems to be a key to limit the maximum voltage holding in the accelerator. These operational results and developments are presented.