Optimization of Tritium Fueling Scenario in DT Fusion Reactors

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To sustain deuterium (D) - tritium (T) burning plasmas efficiently in magnetic confinement fusion reactors, the amount and the ratio of D and T to be supplied into the reactor as fuels should be controlled accurately. In addition, the tritium consumption should not be too large because of its radioactivity and scarcity, so that it is important to optimize the reactor operation scenario which can satisfy both the good reactor performance and the tritium resource preservation.

In order to analyze the relationship among D/T fuel ratio, tritium consumption, and reactor output power numerically, we apply the TOTAL (toroidal transport analysis linkage) simulation code [1] for the modelling of fuel supply in the D-T burning plasmas. The 2-dimentional or 3-dimentional equilibrium calculation using APOLLO or VMEC code to calculate tokamak or helical magnetic configuration and 1-dimentional transport simulation model to calculate the radial profile of plasma parameters are combined in the TOTAL code. Several models of fuel supply, such as pellet injection, neutral beam injection or gas puffing, can be included in the code.

Recently, in the case of ITER-like tokamak reactor with the reversed magnetic shear and the internal transport barrier, the simulation with scanning the D/T ratio in a fuel pellet revealed that the operational region of temperature and density varies with the D/T ratio. In the case that deuterium-rich pellet was employed, the amount of tritium to be injected to the reactor as the fuel was saved approximately 30 % compared with the case that D and T ratio is same within the density operation limit [2].

Based on these results, we propose tritium fuel reduction scenario in the fusion reactor operation including the start-up phase of the reactor. The control method of fusion power by adjusting D/T fuel ratio will be also discussed.

[1] K. Yamazaki and T. Amano, Nuclear Fusion **32** (1992) 633.

[2] T. Oishi *et al.*, J. Plasma and Fusion Res. SERIES **8** (2009) 1044.