

Simple Core-SOL-Divertor Model To Investigate Plasma Operational Space

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To understand operational SOL-Divertor conditions is the critical issue to realize a fusion power plant. Those conditions should be investigated consistently with core plasma conditions. Recently, the core plasma performance required to generate net electric power is roughly revealed [1]. According to that study, we have to increase the ratio of greenwald density limit (fn_{GW}) together with normalized beta value (β_N), and fn_{GW} required to generate net electric power depends on the core plasma temperature. The core plasma temperature will be restricted by the divertor operation of detached plasma. Consequently, the relationship between the core plasma temperature and the divertor operation condition has a great impact on fn_{GW} required for a fusion power plant. To understand such relationship between core and SOL-divertor plasma, we integrated 0D core plasma model and two-point model into a simple Core-SOL-Divertor (C-S-D) model.

The 0D core plasma model is based on ITER physics design guideline [3] and the LH transition condition is installed by the same fashion as in ref. [4]. The two-point model[5,6] is basically applied to SOL-divertor analysis. The SOL density, which is usually a given parameter, has to be calculated including the core plasma conditions such as particle and heat flux across the separatrix. In the present study, we solve the particle balance with a simple neutral transport model[2,6].

We compare this C-S-D model with B2-EIRENE analysis results for the attached divertor of JT-60U[9], and the following good agreement is obtained; $T_{sol} = 51.4 \text{ eV}$ ($T_{sol}^{B2} \approx 50 \text{ eV}$), $T_{div} = 10.1 \text{ eV}$ ($T_{div}^{B2} \approx 12.0 \text{ eV}$), $n_{sol} = 0.9 \times 10^9 \text{ m}^{-3}$ ($n_{sol}^{B2} \approx 1.0 \times 10^9 \text{ m}^{-3}$), $n_{div} = 2.3 \times 10^9 \text{ m}^{-3}$ ($n_{div}^{B2} \approx 3.0 \times 10^9 \text{ m}^{-3}$), where those inside brackets are B2-EIRENE results. With this C-S-D model, we also reproduce the transition phenomenon from Low to High recycling state as reported in ref.[7,8]. We apply this C-S-D model to the HT-7U(EAST) operational space. In the first phase of HT-7U, the plasma current will be driven with LH current driving method, where low density is preferable. In contrast, High recycling state of divertor is required to decrease heat load on the divertor plate. We carry out the preliminary analysis for the operation space for both core and divertor plasma. We also apply this model to ITER LH transition phase and find the possibility of the divertor density oscillation during the LH transition, which may makes it difficult to control divertor plasma[2]. The modelling of the detached plasma condition remains to be done. This work is partly supported by JSPS-CAS Core-University Program on Plasma and Nuclear Fusion.

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