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GAMMA 10 E-Div. プラズマにおける中性粒子効果のシミュレーション解析
Simulation Analysis on Effects of Neutral Particles for E-Div. Plasma in GAMMA 10

武田寿人[1]、中嶋洋輔[1]、古田哲朗[2]、畑山明聖[2]、細井克洋[1]、市村和也[1]、木暮諭[1]、高橋樹仁[1]、岩元美樹[1]、細田甚成[1]、清水啓太[1]、蒋佳希[1]、長屋孝信[1]、大木健輔[1]、坂本瑞樹[1]、市村真[1]
TAKEDA Hisato[1], NAKASHIMA Yousuke[1], FURUTA Tetsuro[2], HATAYAMA Akiyoshi[2], HOSOI Katsuhiro[1], et. al.

[1]筑波大プラズマ、[2]慶応大理工
[1]PRC, Univ. Tsukuba, [2]Science and Technology, Univ. Keio

Divertor is one of important devices in the toroidal nuclear fusion devices such as tokamak and helical reactors. The heat load of about 10 MW/m^2 in the steady state is applied to the divertor plate. In addition, it reaches 0.5 ~ 1.0 GW/m^2 when ELM occurs. In this condition, melting and sputtering on the divertor plate made of tungsten are produced. Therefore, it is important to continue the plasma detachment state steadily near the divertor plate. For enhancing radiation loss of plasma energy near the plate, injection of impurity gas such as Ar, Ne, N_2 also is considered.

In order to study divertor plasma, linear devices are widely utilized. By using the GAMMA 10 tandem mirror machine in the Plasma Research Center at University of Tsukuba, divertor simulation calculation for peripheral plasma have been started [1]. Therefore, we undertake a numerical simulation study using two-dimension fluid code. This fluid code contains of five equations which are used in the B2 code without the effects of drifts and current [2]. By solving these equations, spatial profiles of plasma density, ion velocity, ion temperature and electron temperature are calculated.

In the recent study, the background plasma is simulated in case of not only considering interaction between recycling neutral particles and charged particles but also injection of additional neutral hydrogen gas and injection of neutral argon gas in the background plasma. In the results, when neutral hydrogen gas is injected in the plasma, background plasma density builds up and the peak of background plasma density transfers from the entrance toward the target plate (Fig.1). On the other hand, in the case of neutral argon gas injection, electron temperature is obviously reduced in the calculation area. However, the motion of neutral particle is not calculated in the fluid code. The distribution of neutral particles is defined by simple model based on various assumptions. Especially, it is important to analysis not only plasma parameter but also neutral particles because the interaction between plasma and neutral particles is very important in the divertor region. It has started to calculate the distribution of neutral density by using the Monte Carlo simulation code which traces the transport of neutral particles (DEGAS) [3]. In addition, by using this distribution of neutral density in background plasma fluid code, more accurate numerical simulation results of effects of neutral particles injection is expected.

In this presentation, we will report detailed simulation results of the behavior of background plasma using the distribution of neutral particles calculated DEGAS code. Also, the effects of impurity gas injection will be discussed.

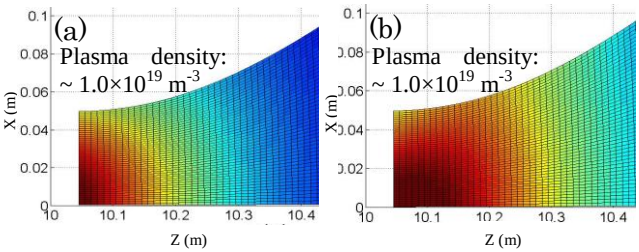

Fig.1 Distribution of plasma density
(a) without injected neutral particles
(b) with high neutral density: 4.0×10^{18} m^{-3}.

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