01aP60

原型炉ダイバータプラズマにおける放射冷却用希ガス不純物種の検討

Investigation on Noble Gas Species for Radiation Cooling of DEMO Divertor Plasmas

本間裕貴，星野一生，徳永晋介，朝倉伸幸，清水勝宏，坂本宜照，飛田健次，
原型炉設計合同特別チーム
Yuki HOMMA, Kazuo HOSHINO, Shinsuke TOKUNAGA, Nobuyuki ASAKURA,
Katsuhiro SHIMIZU, Yoshiteru SAKAMOTO, Kenji TOBITA
and Joint Special Design Team for Fusion DEMO

量研機構
QST

A Japanese DEMO reactor design is being developed by *the Joint Special Design Team for Fusion DEMO*. Handling huge exhaust heat is one of the major issues for divertor protection. A potentially effective solution approach is injection of noble gas impurity to dissipate large amount of plasma energy. Since each impurity species radiates at different electron temperature range, the distribution of radiation has to be carefully designed by balancing the divertor heat load and the core plasma performance. Our goal is to decide the noble gas species most appropriate for a steady state operation of DEMO plasma.

As a first step toward the goal, we have carried out SOL/divertor plasma simulation under actual DEMO tokamak geometry [1] with four different noble gas species: neon(Ne), argon(Ar), krypton(Kr), xenon(Xe). Integrated SOL/divertor simulation code SONIC [2] is used. Simulation conditions are summarized as follows: Plasma power (electron & deuterium ion D^+) 250MW, additional D gas puff $4.8\times10^{22}s^{-1}$ at the outer mid-plane to promote the detachment, 200MW of energy is radiated by impurity.

The results have been analyzed focusing on impurity density profile, radiation profile, divertor heat load as well as amount of injected impurity particle flux. For example, Fig. 1 shows the radiated power profile by Kr. Strong radiation is seen in front of the inner/outer divertor target and along the separatrix. In the SOL and edge region radiation intensity is much weaker, but the total radiated power becomes important when integrated over their large volume. Fig. 2 summarizes spatial distribution of radiated power by each impurity species. As the atomic number increases, the radiating area moves from the divertor regions to the upper SOL/edge region.

Characteristics of Ne, Ar, Kr, Xe injection are presented more in detail in the presentation. Advantages/disadvantages of each impurity species are summarized, and their appropriate choice for DEMO will be discussed.

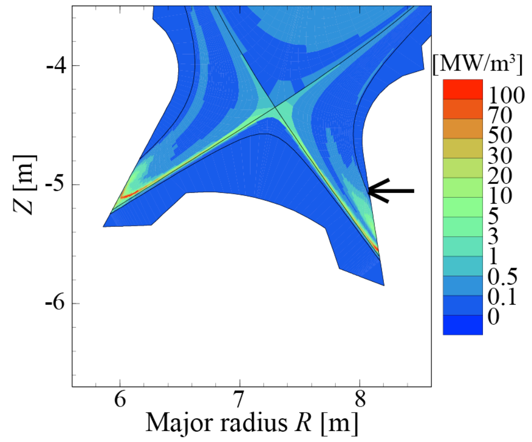

Figure 1: Radiated power profile by Kr, projected onto the poloidal cross section. The arrow indicates the position of impurity injection.

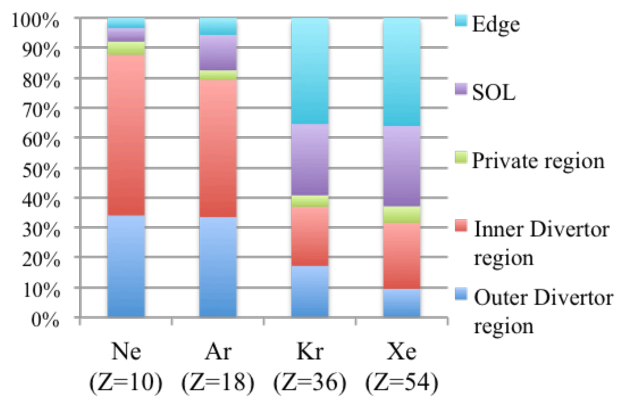

Figure 2: Radiated power by each impurity species is summarized as a function of plasma regions. Total radiated power is 200MW for all impurity cases.

[1] Y. Sakamoto *et al.*, in Proc. 25th IAEA Fusion Energy Conference, FIP/3-4Rb, St Petersburg, Russian Federation (2014).

[2] H. Kawashima, K. Shimizu, T. Takizuka, *et al.*, Development of Integrated SOL/Divertor Code and Simulation Study in JAEA, *Plasma and Fusion Research* **1** (2006) 031.