§ 27. Formation of the LID Configuration, and its Impact on Particle Control

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Formation of the LID configuration

In the LID configuration, a "divertor head" is installed into m/n=1/1 island, and the last closed flux surface (LCFS) is determined by inner separatrix of the island. On the other hand, in "limiter" configuration, divertor head installed without generation of the island, and the LCFS is determined by position of limiter (divertor head). Formation of the LID configuration was confirmed from T_e profile and particle flux to divertor measured by Thomson scattering and Langmuir probe arrays, respectively.

Figure 1(a) shows typical T_e profiles under the helical divertor (HD) and the LID configurations, respectively, with same input power. In this figure, m/n=1/1 island was also generated in the HD case. Therefore, shoulders were observed in T_e profile at the position of the island. In the LID configuration, inner and outer foot-points of T_e profile were moved inside. Changes of foot-points positions with divertor head position scan under the LID and limiter configurations are shown in figure 1(b). For both cases, foot-points move inside with approach of divertor head to outer separatrix of the island. In the case of limiter configuration, foot-points move inside gradually along the predicted positions of the LCFS (dashed lines) determined by position of divertor head. With the island, foot-points approach to inner separatrix of the island rapidly when divertor head reaches to outer separatrix of the island, and the positions of foot-points are fixed to vicinity of inner separatrix of the island until divertor head approaches to inner separatrix. It can be said that the LID configuration is formed from about 20mm to –160mm of divertor head position.

In the LID configuration, particle flux to helical divertor was not detected by Langmuir probe arrays embedded in 3 divertor tiles (torus inboard, outboard and bottom). That means almost all particle flux came to divertor head. It is very good situation for particle control using the LID configuration.

Impact of the LID configuration on particle control

Figure 2(a) shows time evolutions of line density in the HD and the LID configurations with same input power and wave form of gas-puffing. Maximum line density in the LID configuration was smaller, and density decay time after termination of gas-puffing is much shorter than those in the HD configuration, respectively. Reduction of density decay time is considered to indicate the reduction of recycling coefficient for the effective pumping at the divertor head.

Figure 2(b) shows the change of maximum line density and density decay time under the LID configuration with divertor head position scan. With deeper insertion of divertor head, both parameters reduced. Relative position of divertor head and pumping duct to outer separatrix is a key parameter for effective pumping. For reduction of escaping particles, pumping efficiency becomes maximum when outer separatrix comes between divertor head and pumping duct (see insertions in Figure 2(b)). This situation is same as that in the LID experiment in the CHS[1]

References

[1] Masuzaki, S., et al., Ann. Rev. NIFS, 1995-1996 (1996) 216.

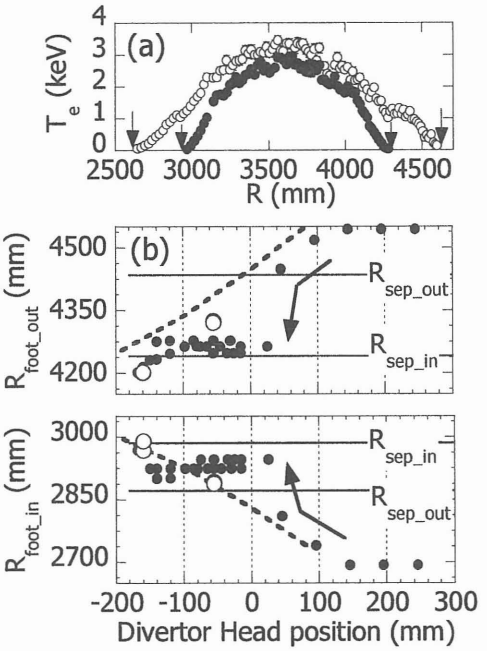

Fig. 1. (a) T_e profiles under the HD (open circles) and the LID (closed circles) configurations, respectively. Arrows indicate positions of foot-points of T_e profiles. (b) Outer and inner foot-points positions vs. divertor head position from outer separatrix of m/n=1/1 island (closed circle). Dashed lines indicate the LCFS position under limiter configuration (divertor head insertion without m/n=1/1 island) predicted from calculation, and open circles indicate the foot-points positions under limiter configuration. From about 20mm to –160mm of divertor head position, the LID configuration is formed.

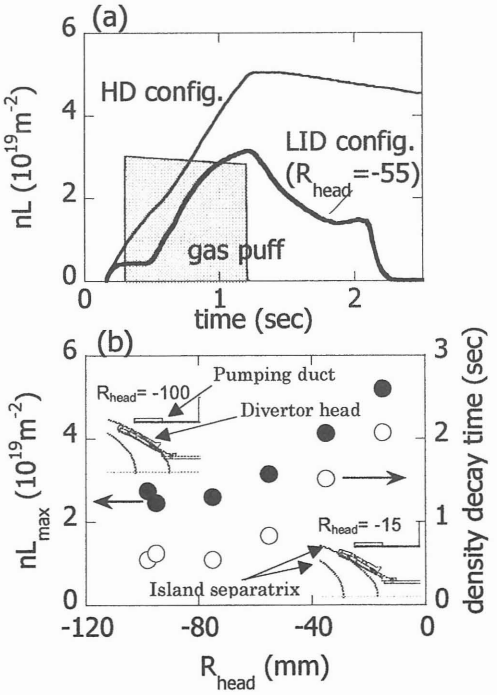

Fig. 2. (a) Time evolutions of line density for the HD and the LID configurations discharges with same input power and fueling. (b) Peak density and density decay time after termination of gas-puffing. Insertions show the upper part of divertor head, pumping duct and island separatrix. They indicate relative positions of divertor head to island separatrix.