§24. Neutral Particle Transport in CHS Edge Region

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Improvement of plasma confinement such as H-mode is one of urgent issues in the fusion research. Edge transport barrier(ETB) discovered recently in the compact helical system(CHS) [1] is characterized by clear drop of Hα emissions. As Hα emission intensity is often used as the measure of recycling particle flux, particle confinement is thought to be improved. Quantitatively, however, this conclusion must be checked carefully, since Hα emission has deep relationship with the profile of atomic/molecular hydrogen, which is very complicated in helical systems like CHS.

In order to study the neutral particle behavior in CHS, we have used Monte Carlo simulation code DEGAS. In Fig. 1, calculation geometry at $\phi = 0$ cross section is shown [2], where the CHS plasma in the standard magnetic configuration has contact with the inside wall like as the material limiter and the neutral recycling becomes dominant. When we move along toroidal direction, the gap between plasma and wall becomes large and partial magnetic limiter configuration is established at $\phi = \pi/8$. In this report, we expand the simulation model to three-dimension to include the toroidal behavior of neutral particle [3]. We made two model geometry and compare their results more clearly. One is referred as "CHS" , which include toroidal periodicity of $m = 8$. Another is "torus ", which is axial symmetric around the major axis and has cross sections like Fig. 1 for all toroidal angle ϕ.

In the Fig. 2, poloidal profile of atomic hydrogen is shown. Neutral density is localized to torus inside (poloidal angle is 0 or 360[deg.]) and poloidal transport is almost prohibited. Hydrogen molecules are produced at the recycling area on the wall(indicated with arrows in the Fig. 1 and 2) Hydrogen atoms are also produce near the recycling area by interactions between molecules and plasma particles. As the mean free path of these neutral particles is a few cm or less, they have little chance to reach the right-side vacuum region in Fig. 1 along the poloidal (also radial) direction. If the poloidal extention of effective recycling region is large, however, this chance becomes large and neutral density in the vacuum region increases. So the precise modeling of the recycling region is important.[2]

As for toroidal transport, there exist a gap between Last Closed Flux Surface (LCFS) and chamber wall. So neutral particle can easily move several cm in toroidal direction. Fig. 3 shows toroidal profile of atomic hydrogen for two model geometry. In "CHS" model, the gap between LCFS and wall becomes wider and then narrower periodically. But the gap is kept to be narrow in "torus" model. So the atomic density in "torus" (thin lines in Fig. 2 and 3) becomes smaller far away from recycling areas. The difference of two models is clearer for molecular density profile.

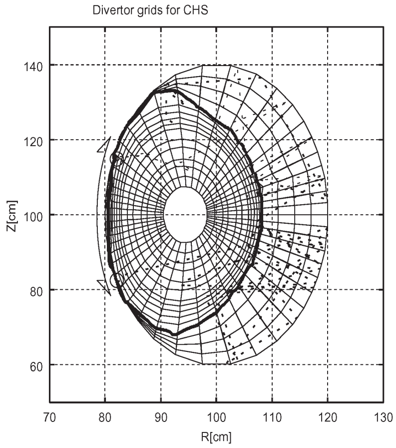

Fig. 1: Calculation geometry for the DEGAS simulation. trajectories of some test particles are also indicated with dashed lines.

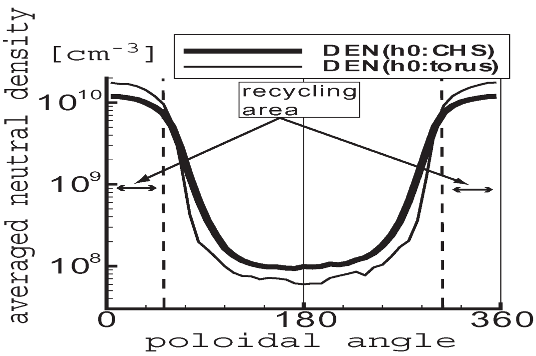

Fig. 2: Poloidal profile of atomic hydrogen radially-averaged density at $\phi = 0$ cross section.

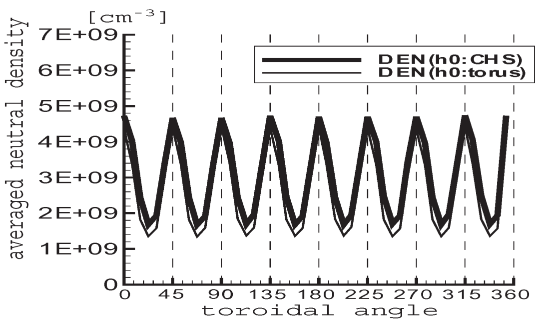

Fig. 3: Toroidal profile of atomic hydrogen surface-averaged density.

References

1) S. Okamura et al., J. Plasma Fusion Res., **79**,(2003)977.

2) H.Matsuura et al.: to be publish in J.Plasma Fusion Res. SERIES, **7**.

3) S.Iguchi et al., Joint Conf. PSS-2005/SPP-22 P2-093, (Nagoya, 2005).