Dynamic helium wall retention in long pulse discharge in LHD

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Global helium particle balance in long-pulse discharges is analyzed in the Large Helical Device (LHD). The global particle balance analysis is applied to long pulse discharges (n_e ~1.2×10^{19} m^{-3}, Ti,e ~2 keV) over 40 min. by ICRH and ECH (1.2 MW), indicating that the helium wall retention is dynamically changed.

The retention of helium in the plasma facing components (PFCs) is one of the crucial points to be investigated for fusion devices, particularly for steady-state long-pulse discharges. LHD has a peculiar plasma facing components, which are composed of the first wall with stainless steel and the divertor with carbon. The co-deposition layer with a mixture of carbon and stainless steel, which is different from a base material, is found to be formed [1]. The post-mortem analysis shows the deposition layer might take an important role of wall inventory of helium. In this study, we report the experimental results, which exhibit a different behavior of helium retention in long pulse discharges of LHD plasmas. The helium wall inventory is mainly separated into three phases. In the first phase, defined from 0 to ~300 sec., quite high wall inventory occurs. After the first phase, the wall inventory shows modest declination. Namely, in the time range between ~300 and ~1,500 sec., the wall retained the particles in the first phase rather releases some particles. However, the high wall inventory appears again in the third phase from ~1,500 sec. to the end of the discharge. In the discharge, the wall inventory including the dynamic retention is 85±30 Pa m^3 (60±20 % of injected amount). We will discuss the physics of the dynamic helium retention based on a simple assumption that there are two kinds of helium reservoir; “divertor plate with carbon” and “first wall with stainless”.

References

[1] M. Tokitani et al., J. Nucl. Mater. 438 (2013) S818–S821.