COMPARISON OF WALL/DIVERTOR DEUTERIUM RETENTION AND PLASMA FUELING REQUIREMENTS ON THE DIII–D, TdeV, AND ASDEX-U TOKAMAKS*

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We present a comparison of the wall deuterium retention and plasma fueling requirements of three diverted tokamaks (DIII–D, TdeV, and ASDEX-U) with different fractions of graphite coverage of stainless steel or Inconel outer walls and different heating modes. Data from similar particle balance experiments on each tokamak demonstrate well-defined differences in equilibrium wall retention of deuterium gas, even though all three tokamaks have complete graphite coverage of divertor components and all three are routinely boronized. This paper presents new data from all three experiments and compares the evolution of several parameters, including: wall retention/divertor surface area; relative equilibrium wall retention (wall retention/total wall surface area, δ_{rel}); wall retention/plasma inventory; and fueling efficiency (plasma inventory/external gas required for fueling, $\eta_{gas} = N_{plasma} / N_{gas}^{startup}$).

On DIII–D (90% graphite coverage of entire wall, NBI-heated), it was demonstrated[1] that without inter-shot Helium Glow Discharge Cleaning (HeGDC), the wall loading during plasma discharges without cryopump exhaust far exceeded the exhaust between discharges, leading to a large increase in the wall deuterium retention (9x10^{22} atoms) and 3x increase in η_{gas} (8%–25%); these data suggested a very large wall capacity. After cryopump activation, the wall inventory was reduced back down to the reference inventory level. In contrast, the data from TdeV (20% graphite coverage of entire wall, Lower Hybrid RF heated) indicated that wall loading during plasma discharges was balanced by wall outgassing between discharges, even in the absence of HeGDC and divertor cryopump operation. Consequently, η_{gas} remained constant at a prescribed main plasma density level (although it did increase with density), suggesting a small wall capacity (~ 2–3x10^{21} atoms). Finally, data from ASDEX-U (40% graphite coverage of entire wall, NBI-heated) implied that the wall retention of deuterium increased during the course of a routine experimental day, thereby resulting in a gradual increase in η_{gas}. These data suggest a δ_{rel} for ASDEX-U between DIII–D and TdeV.

An explanation for these differences in the obtained wall loading is proposed with respect to the large variance in graphite coverage of the outer wall, and also the role of fast charge-exchange neutrals in wall pumping[2] which is enhanced by Neutral Beam Injection. Detailed comparisons of the aforementioned and other parameters indicative of wall conditions from the three tokamaks will be presented.

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*Work supported by U.S. Department of Energy under Contract Nos. DE-AC03-89ER51114 and DE-AC05-84OR21400.
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