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Investigation of Progression from Low to High Hydrogen Recycling during Long Duration Discharges on a Spherical Tokamak, QUEST

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Progression from low (LR) to high recycling (HR) was observed in full non-inductive long duration discharges up to 5 minutes on QUEST. Transitional repetitive behavior between LR and HR was induced by periodic gas puffing and the period to recover to LR, tau_rec, was gradually prolonged. The period, tau_rec normalized by gas rate has a linear relation to time-integrated H_alfa. As the prolongation of tau_rec was also induced by higher gas rate even in the start-up phase, the value of tau_rec is an index of the amount of recycled hydrogen. The experimental observation indicates hydrogen recycling rate is dominantly depending on hydrogen fluence to the wall. To understand the dependence, deuterium storing capability of the specimen exposed to QUEST plasmas during an experimental campaign was investigated by implantation of deuterium molecule ions of 1keV and subsequent thermal desorption spectrum (TDS) as a post-mortem analysis. The important desorption in the obtained TDSs appeared around 420 and 470K, and these peaks can be reconstructed by a model including diffusion, recombination, trapping, and plasma induced desorption. The model calculation was applied to the QUEST long duration discharges and shows that recycling ratio has a clear dependence on fluence and the fluence in the QUEST long duration discharges is sufficient to make a saturation in recycling ratio of unity. These results indicate that hydrogen recycling has the capability to provide a clear effect on plasma in long duration discharges and the progression is driven by enhanced hydrogen recycling with high fluence to the wall.

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