The Behavior of Injected Impurities Under Radiating Divertor Conditions With Puff-and-Pump Type Particle Control*

T.W. Petrie[1], G.D. Porter[2], N.H. Brooks[1], M.E. Fenstermacher[2], J.R. Ferron[1], M. Groth[2], A.W. Hyatt[1], R.J. La Haye[1], C.J. Lasnier[2], T.C. Luce[1], A.W. Leonard[1], P.A. Politzer[1], M.E. Rensink[2], M.J. Schaffer[1], M.R. Wade[1], and J.G. Watkins[3]

[1]*General Atomics, PO Box 85608, San Diego, California 92186-5608, USA*
[2]*Lawrence Livermore National Laboratory, Livermore, California, USA*
[3]*Sandia National Laboratories, Albuquerque, New Mexico, USA*

The effectiveness of active seeding of the divertor with impurities to maximize radiated power in the divertor depends sensitively on both the divertor magnetic geometry and the ion $B \times \nabla B$ drift direction. In these scenarios, argon is injected into the private flux region and deuterium gas upstream of the divertor targets; both are exhausted upon recycling at the divertor targets by in-vessel cryopumps. Modeling of unbalanced double-null (UDN), H-mode plasmas with the UEDGE fluid transport code is qualitatively consistent with our experimental result that the argon accumulates to higher concentrations in the plasma core when the ion $B \times \nabla B$ drift direction is toward the divertor, which indicates that the particle drifts in the scrape-off layer and divertor strongly affect this accumulation. In balanced double-null (BDN) cases, argon always shows a larger accumulation in the divertor out of which the ion $B \times \nabla B$ drift is directed, regardless of the divertor into which the argon is injected. Experiments have also shown that the degree to which the deuterium gas-puffing rate inhibits the escape of the seed impurity from the divertor(s) depends critically on the direction of the ion $B \times \nabla B$ drift and on whether the plasma is UDN or BDN. For example, raising the deuterium gas puff rate is most effective in screening impurities from the core plasma for UDNs when the ion $B \times \nabla B$ drift is directed away from the X-point, and least effective for BDNs when the ion $B \times \nabla B$ drift is directed toward the divertor into which impurities are injected. The transition from BDN to UDN behaviour of the seed impurity occurs at $dRsep = +0.4$ cm, when the ion $B \times \nabla B$ drift points away from the dominant divertor. The lowest argon density build-up in the main plasma of any of the configurations studied during puff-and-pump was achieved in UDN plasmas with the ion $B \times \nabla B$ drift direction away from the divertor. Preliminary results from experiments combining ELM-suppression induced by resonant magnetic perturbations with impurity seeding will be discussed.

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