SOLPS-ITER study of the relative roles of fueling and plasma transport on setting the density pedestal in high pedestal opacity H-modes on Alcator C-Mod

R. Reksoatmodjo[1], S. Mordijck[1], J. W. Hughes[2], J. D. Lore[3], X. Bonnin[4]

[1]College of William and Mary, 200 Stadium Dr, Williamsburg, VA 23185, United States of America
[2]MIT Plasma Science and Fusion Center, 167 Albany St, Cambridge, MA 02139, United States of America
[3]Oak Ridge National Laboratory, 1 Bethel Valley Rd, Oak Ridge, TN 37830, United States of America
[4]ITER Organization, Route de Vinon-sur-Verdon, CS 90 046, 13067 St Paul-lez-Durance Cedex, France

rmreksoatmodjo@email.wm.edu

SOLPS-ITER modeling of EDA H-mode experiments on Alcator C-Mod show that electron density pedestal structure is largely unaffected by increased edge fueling when approaching ITER-like opaqueness conditions[1]. Simulation results also suggest that main chamber fueling dominates over fueling through the X-point in these discharges, an important consideration for future fusion-relevant devices that will operate in similar high density, high neutral opacity regimes. In order to assess the relative role of fueling versus transport at the plasma edge, an experimental basis for these simulations was formed from a series of similar high density ($n_{e,PED}$ ~ $2*10^{20}$ m^{-3}) EDA H-mode discharges which exhibited both high neutral pedestal opacity and lower neutral pedestal opacity. Gas puffs of varying magnitude were applied to these high-density discharges, both at high and low opacity, to further probe the response of the pedestal to increased edge fueling. Initial simulated electron density and temperature profiles were matched to upstream experimental data by varying radial transport coefficients in SOLPS-ITER, revealing midplane neutral densities an order of magnitude lower in the high opacity discharge (~10^{15} m^{-3}) vs the lower opacity discharge (~10^{16} m^{-3}). However, the addition of gas puffs in these simulations were observed to cause temperatures to decrease as observed in experiment, but also cause the electron density pedestal to increase by up to a factor of 2, an effect unobserved in experiment. To achieve greater fidelity with experiment, and to further probe the behaviour of neutrals in this environment, several changes are thus made to the SOLPS model. Self-consistent changes in transport, as well as non-diffusive transport effects, are implemented to emulate the observed stiffness of the density pedestal. A simple ballooning transport model is introduced to better approximate expected poloidal asymmetries in plasma transport[2] around the main chamber, resulting in neutral densities redistributing poloidally around the vessel. Particle drifts are also turned on in the SOLPS model, to investigate the effect of drifts on neutral densities in the main chamber and divertor region. Ultimately, analysis of the radial neutral e-folding length around the plasma, and close examination of the pressure and flow of neutrals in the divertor, is performed, revealing that in these high opacity conditions, neutrals tend to become trapped in the PFR, confirming our assertion that edge fueling mainly occurs through the upstream midplane.

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[1] R. Reksoatmodjo *et al* 2021 *Nucl. Mater. Energy* **27**
[2] B. LaBombard *et al* 2004 *Nucl. Fusion* **44** 1047