NEUTRAL PARTICLE PATHWAYS IN DIII–D*

R.J. Colchin,[1] S.L. Allen,[2] T.N. Carlstrom,[3] M.E. Fenstermacher,[2] C.M. Greenfield,[3]
R. Maingi,[1] L.W. Owen,[1] R.C. Isler,[1] and M.R. Wade[1]

[1]Oak Ridge National Laboratory, Oak Ridge, TN 37831-8072
[2]Lawrence Livermore National Laboratory, Livermore, CA 94551-9900
[3]General Atomics, P.O. Box 85608 San Diego, CA 92186-5608

Neutral particles are introduced into DIII–D discharges via gas puffing, pellets, neutral beams, and desorption from the walls. These particles enter the discharge, are ionized in the core or SOL, and ultimately flow to the vessel boundaries by radial and parallel transport processes. The particle flows in DIII–D are predominantly to the divertor regions via deuterium ions. In the divertor regions the deuterium ions are neutralized by charge exchange with neutral particles, by three-body recombination, or by contact with solid surfaces. Particle sinks consist of one or two cryo-pumps in the divertor plena, three turbopumps, and wall absorption.

During the 1997 operating campaign, a more restrictive "closed" pumping geometry was introduced in the upper divertor region of DIII–D. Pressure measurements in the midplane and the divertor plena indicate a significant compression of the neutrals in the divertor. The measured ratio of pressures between the midplane and the upper divertor plenum is in the range 30–150 even with active pumping of the upper divertor. With the pumps turned off, the maximum upper and lower divertor pressure buildups are comparable, under similar discharge conditions even though the divertor geometries differ.

The net flow of neutrals from (or to) the walls is inferred by a global particle balance. The gas puff fueling rate, the neutral beam fueling rate, the rate of fueling (or loss) of particles due to changes in plasma density, and the pumping speed of the cryo-pump(s) are measured. The net difference in these particle sources and sinks indicates whether the wall is acting either as a source or sink for neutrals. It is found that divertor pumping serves to condition the walls over a series of several discharges. Active pumping is observed to convert the walls from a net source to a net sink.

Neutral particle flows are also modeled using the b2.5 plasma transport code in conjunction with the DEGAS neutral transport code. The modeling is constrained by fitting diagnostic data obtained from CER spectroscopy, IRTV, Thomson scattering, bolometry, divertor Langmuir probes, and neutral light emission. Simultaneous measurement of D_α and D_β provides benchmarking of both electron impact excitation of neutrals, as well as electron-ion recombination. Calculated divertor/midplane pressure ratios are in reasonable agreement with the measurements for both upper and lower single-null discharges. Results show a sharp peak with a surprisingly high concentration of neutrals (10^{10} to 10^{11} neutrals/cm^3) just inside the separatrix near the X–point.

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