ENERGY AND PARTICLE TRANSPORT IN THE RADIATIVE DIVERTOR PLASMAS OF DIII–D*

A.W. Leonard, S.L. Allen,[a] N.H. Brooks, T.E. Evans, M.E. Fenstermacher,[a] D.N. Hill,[a] R.C. Isler,[a] C.J. Lasnier,[a] M.A. Mahdavi, R. Maingi,[b] R.A. Moyer,[c] T.W. Petrie, G.D. Porter,[a] M.J. Schaffer, M.R. Wade,[d] J.G. Watkins,[e] W.P. West, D.G. Whyte,[c] R.D. Wood[a]

General Atomics, P.O. Box 85608, San Diego, CA 92138-9784

We present our recent 2D measurements of divertor plasmas which highlight the important divertor physical processes of convective energy transport, atomic radiation, and loss of pressure balance and particle flux due to charge-exchange and recombination. Our comprehensive divertor diagnostic set enables us to measure the 2D profiles of plasma temperature and density, the energy balance and transport from the divertor target heat flux, and 2D radiative emissivity profile as well as the radiative contributions from different atomic species. Additional gas puffing of deuterium produces intense radiation distributed through most of the divertor which dissipates three-quarters of the energy flowing into the outboard divertor below the X-point. The electron temperature drops to 1–3 eV throughout the divertor such that classical electron thermal conduction can no longer support the observed energy flux through the divertor. However, plasma convection at the ion sound speed, $v \le c_s$, supplied by upstream ionization can account for the observed divertor energy flux. The intense radiation is supplied by carbon upstream near the X-point with hydrogenic radiation filling in down the divertor leg, peaking at the plate. Neutral interactions are also important in reducing plasma pressure and ion flux through charge-exchange and recombination. At the low temperatures, $T_e \le 1$ eV, and high densities $n_e \ge 3 \times 10^{20}\ m^{-3}$ measured near the target three-body recombination significantly exceeds the ionization rate and aids in reducing the flux of ions to the target. Recombination further reduces target heat flux by removing the plasma ionization potential above the target plate. Spectroscopic measurements of plasma flow and recombination will also be presented. Modeling of these plasmas with the 2D fluid code UEDGE has produced good agreement with the diagnostic observations.

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[a]Lawrence Livermore National Laboratory, Livermore, California.
[b]Oak Ridge Associated Universities, Oak Ridge, Tennessee.
[c]University of California, San Diego, California.
[d]Oak Ridge National Laboratory, Oak Ridge, Tennessee.
[e]Sandia National Laboratories, Livermore, California.