IMPROVED ENERGY CONFINEMENT WITH NEON INJECTION IN THE DIII–D TOKAMAK*

G.M. Staebler, G.L. Jackson, R.J. Groebner, M.R. Wade,[a] R.E. Waltz, W.P. West, and D.G. Whyte[b]

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

Energy confinement improvement has been observed during neon impurity injection on several tokamaks in both limiter and divertor configurations. A number of DIII–D discharges have been produced which have high radiated power fractions due to neon injection but still have enhanced energy confinement over ITER-89P L–mode scaling. Even when the discharge has been driven out of H–mode by neon radiation, as evidenced by the loss of the edge density pedestal, the energy confinement remains 1.4–1.8 times the L–mode level. Both single- and double-null divertor topologies have been used. The proposition that E×B velocity shear could explain the core transport reduction in these discharges is tested. The radial electric field is computed from the charge exchange recombination (CER) diagnostic measurements on DIII–D. The E×B velocity shear rate is compared to the maximum growth rate for ion temperature gradient modes and trapped electron modes computed with a gyro-kinetic stability code. Theory predicts that the transport will improve when the E×B shear rate is greater than the maximum growth rate of the instability causing the turbulent transport. Comparing the power balance thermal diffusivities in the L–mode, ELMing H–mode and neon improved L–mode (IL–mode) phases of one particular discharge shows that both the electron and ion thermal transport is reduced, with the central electron temperature doubling during the IL–mode phase. The absolutely calibrated neon density profile is also obtained with the CER diagnostic so that the core neon concentration has been measured for the first time in an IL–mode. It is found that the neon concentration is almost constant across the plasma profile in the IL–mode. If the IL–mode makes a transition into ELM-free H–mode, the core the neon concentration drops and the neon profile becomes hollow, peaking near the edge. One discharge has been observed which had energy confinement 2.5 times ITER-89P L–mode during the ELM-free H–mode phase following an IL–mode. This discharge retained the improved core confinement of the IL–mode when it added the edge transport barrier of H–mode. This neon improved H–mode (IH–mode) is even more attractive than the IL–mode since it has a hollow neon profile and greater energy confinement for both the electrons and ions than an ordinary ELM-free H–mode. The improved energy confinement of IH–mode is lost once ELMs begin.

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[a]Oak Ridge National Laboratory, Oak Ridge, Tennessee.

[b]University of California, San Diego, California.