DECOUPLING THE EFFECTS OF PLASMA CURRENT, DENSITY, AND TEMPERATURE ON DIII–D H–MODE ENERGY CONFINEMENT*

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Experiments that decoupled H–mode plasma current and plasma density have been performed for the first time on the DIII–D tokamak by application of divertor cryopumping. Deuterium ELMing H–mode discharges were operated in the single null configuration with 6 MW of neutral beam injection. These steady-state discharges were operated at 1.5 and 0.75 MA with density ranges of (4.0–8.3) x 10^{19} and (2.7–4.0) x 10^{19} m^{-3}, respectively. Therefore, for the first time in a steady state DIII–D H–mode, a factor of 2 range in I_p (n_e) has been obtained at fixed n_e (I_p). A power law dependence of ELMing thermal confinement was assumed, with the result that for a given magnetic field and fixed power dependence, τ_{th} = 0.18 $I_p^{0.91\pm0.08}\,n_e^{0.18\pm0.09}\,P_L^{-0.5}$. If a linear dependence of τ_{th} on internal inductance is assumed the density dependence disappears.

In these discharges it is clear that as the density was increased the plasma temperature responded by decreasing. suggesting that the density and temperature were inversely coupled. To eliminate this coupling a second set of discharges were operated at 1.0 MA where the temperature was kept constant by increasing the neutral beam power at higher density. The temperature profiles were matched in H–mode discharges with a density of 2.9 x 10^{19} m^{-3} and 3.5 MW of neutral beam heating and n_e of 5.4 x 10^{19} m^{-3} and P_{NBI} of 8.5 MW. The global analysis finds that the thermal energy confinement times are consistent with the above equation. The local power balance analysis employing the 11/2–D ONETWO transport code found that both the electron and ion diffusivities remain unchanged within the calculated uncertainties in the range $0.2 \le \rho \le 0.6$. With a 50% increase in electron and ion temperature at constant density the core diffusivities increase with the electron diffusivity increasing with T^2 and the ion diffusivity increasing with T. Analysis of energy transport properties in the region $0.6 \le \rho \le 0.8$ has been complicated by the uncertainty of the neutral density profile in that region of the plasma with an active cryopump. Present work is concentrating on understanding the energy transport in the outer part of the discharge. Both the global analysis and local transport analysis of these experiments will be presented.

Session Topic: Active Control of H–Mode

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