Compatibility of the Radiating Divertor With High Performance Plasmas in DIII-D*

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High performance "hybrid" plasmas [1], though similar in many ways to conventional ELMing H-mode plasmas, have been shown to have better stability and energy confinement. In this study, we show that hybrid plasmas can operate successfully under "puff and pump" radiating divertor scenarios. Argon was injected near the outer divertor target, while plasma flow into both inner and outer divertors was enhanced by deuterium gas puffing upstream of the divertor targets combined with particle pumping at the targets. For a fixed deuterium injection rate and three successively higher levels of argon concentration in the main plasma, the total radiated power fraction increased from 0.46 (at the trace argon level) to 0.62 (at an argon level <5%), while at the same time the energy confinement factor $H_{ITER89P}$ remained >2. Approximately 50% of the increment in the radiated power fraction originated in the main plasma, 40% in the divertor, and the remaining 10% elsewhere in the scrape-off layer plasma. At the maximum argon injection rate, argon emission was responsible for 25%-30% of the total radiated power from the main plasma and carbon for the remainder. Up to 30% of the radiated power in the divertor was from argon. The presence of argon in the divertor did not affect the carbon content of the main plasma.

The argon concentration was roughly 8 times higher near the outer divertor target than the inner target, leading to a much more dramatic reduction in the peak heat flux at the *outer* divertor target (factor of three) than at the *inner* target (≈20%). Such a large difference in the argon concentration may have been facilitated by the presence of a dome structure in the private flux region, which effectively blocked direct flight of neutral argon between inner and outer divertor targets. Both inner and outer divertor legs were attached at all times during argon injection. Exhaust enrichment η_{EXH} (defined as the ratio of impurity fraction in the pumping plenum to that in the plasma core) was ≈35, compared with 17 in previous experiments, and was insensitive to the argon injection rate. The MHD activity in the core of these hybrid plasmas was predominantly the m=3, n=2 neoclassical tearing mode; the particle transport resulting from this mode may have been responsible for maintaining a hollow emissivity profile inside the core plasma, even at the highest argon injection rate. Analysis of these data with the UEDGE, ONETWO, and MIST transport codes will be presented.

[1] T.C. Luce, *et al.,* Nucl. Fusion **43**, 321 (2003).

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