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

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Protecting the integrity of the divertor structure from excessive thermal power loading presents a serious issue for designers of future-generation, high-powered tokamaks. This problem may be mitigated if a significant fraction of the power transported across the separatrix can be dissipated before it reaches the divertor targets. One promising way to do this is by seeding impurities into the scrape-off layer (SOL) and/or divertor plasmas, and thereby enhancing radiation upstream of the targets. However, for this "radiating divertor" concept to be a practical solution, any collateral degradation in plasma performance that results from the presence of these impurities, e.g., dilution of the core plasma, must be minimized. This tradeoff between heat load reduction and plasma performance can be a particularly sensitive concern for future generation, DEMO-class tokamaks, where economic success is very dependent on maintaining high energy density operation in the core plasma, while at the same time protecting the divertor from damage.

We report on recent radiating divertor experiments with argon, where we systematically investigate these tradeoffs between high performance "hybrid" plasma operation and heat flux reduction. Based on the results of previous "puff and pump" radiating divertor [M.R. Wade, *et al.*, J. Nucl. Mater. **266-269** (1999) 44] and particle exhaust experiments [T.W. Petrie, *et al.,* J. Nucl. Mater. (to be published, 2005)], we investigate three factors that may affect the compatibility of "hybrid" plasma operation with radiating divertor conditions: (1) enhanced deuterium particle flow in the SOL by strong deuterium gas injection in order to keep impurity contamination of the core plasma to a minimum, (2) the effectiveness of the radiating divertor/hybrid plasma system with changes in the magnetic balance between divertors, and (3) whether or not it is necessary to pump <u>both</u> legs of the geometrically-"closed" divertor. These plasmas are ELMing H-mode at modest to low Greenwald fraction (i.e., $n_e/n_{GW} \approx 0.4$–0.6), $\beta_N > 2.8$, and $H_{89P} > 2$. These results are compared with studies of the radiating divertor in more "open" divertor configurations at higher n_e/n_{GW}.

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