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Implications of JET-ILW L-H Transition Studies for ITER

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Unraveling the conditions that permit access to H-mode continues to be an unresolved physics issue for tokamaks, and accurate extrapolations are important for planning ITER operations and DEMO design constraints. Experiments have been performed in JET, with the ITER-like W/Be wall, to increase the confidence of predictions for the L-H transition power threshold in ITER. These studies have broadly confirmed established dependencies of P_{LH}, reduced uncertainties in extrapolations, and highlighted the largest remaining sources of uncertainty. We have also obtained unexpected results with direct relevance for lowering P_{LH} during the non-active phase of ITER operation. A database has been compiled of JET-ILW P_{LH} measurements spanning a range of plasma magnetic geometries, density and toroidal magnetic field values, hydrogen isotopes, ion species mixtures, effects from impurity seeding, and differences in heating and momentum sources. Regression analysis of the database shows in comparison to past scaling studies and to JET-C results, P_{LH} is lower for matched density and magnetic field; however, the exponents for density and magnetic field are larger, resulting in possibly reduced threshold at low magnetic field operation in ITER, but increased values at full field operation. The single largest uncertainty in extrapolating to ITER is the effect of the divertor configuration, a factor of two difference in JET alone. The minimum of the density dependence of P_{LH} also moves to about a 30% higher value in H than D. The dependence of P_{LH} was also studied in mixed species plasmas. It was found that most of the variation in H-D mixtures was at less than 20% or more than 80% H concentration, with little variation in between. Helium-4 fuelling into H plasmas was also performed, resulting in a ~25% reduction of the threshold with up to about 10% He concentration. This reduction in L-H threshold in H-He mixtures may have application for the non-active phase of ITER operations. Detailed hydrogen and helium concentration analysis, transport simulations, and ICRH power deposition calculations have been performed to constrain interpretation of the mixed ion species effects. We will summarize results across all JET-ILW P_{LH} data and the implications of the conclusions for ITER.

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