

The H-mode Power Threshold in Hydrogen, Deuterium and Helium Plasmas in DIII-D*

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Determining the H-mode power threshold and validating H-mode threshold scaling relations are very important issues for next step fusion devices, such as ITER. In particular, investigating key physics issues in hydrogen or helium plasmas is vitally important for the first operational phase of ITER, which is planned to be with hydrogen or helium plasmas, and in which access to H-mode is critical for testing relevant hardware and control systems prior to the activated deuterium phase. The H-mode power threshold has been determined for plasmas heated by neutral beam injection (NBI) and/or by electron cyclotron heating (ECH) and as a function of the applied torque. Results will be presented for hydrogen, deuterium and helium plasmas for plasma configurations in the favorable ion grad B drift direction. These experiments have shown that the power required to induce the transition from L-mode to H-mode (the L-H transition) is strongly dependent on the injected neutral beam torque. Overall, the H-mode threshold power in hydrogen is approximately a factor of 2 greater than in deuterium plasmas at comparable torque. Interestingly, the threshold power for hydrogen discharges with full counter current beam injection is found to be roughly the same as the threshold power for deuterium discharges with co-current beam injection.

The effects of varying the heating methods by using either NBI or ECH or a combination of both were also determined. For hydrogen and deuterium plasmas, the H-mode power threshold using ECH (or a combination of ECH+NBI) is 20–40% lower than that for discharges using NBI alone at zero applied torque (i.e., with balanced beam injection).

Changing the plasma geometry by decreasing the vertical distance between the X-point and the lower divertor surface from 26 cm to 10 cm led to a significant (~25–30%) reduction in the threshold power. The trend of increasing threshold power with increasing injected torque is still present. Analysis is underway to determine the cause of this reduction in threshold power, which may be related to the plasma flows at the plasma edge and the scrape-off layer.

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