The density dependence of H-mode access at high magnetic fields


— Experimental investigations on Alcator C-Mod explore the power requirements, and local edge threshold conditions, for H-mode transitions, while accessing reactor-relevant plasma densities and toroidal magnetic fields from 2.5T to 8T. As on many tokamaks, the power threshold for H-mode $P_{th}$ does not increase monotonically with density, but actually rises significantly below a particular value of $\bar{n}_e$ (the so-called ‘low-density limit’ for H-mode). Such behavior can not be reproduced by current scaling laws used to project the power threshold for H-mode on future devices, which tend to assume a power law form, e.g. $P_{th} \sim B_T^x n_e^y$. Considerably more complicated dependencies are suggested by experiments, which indicate that the low-density branch moves to higher values of density as $B_T$ is increased. We extend this examination to magnetic fields that meet and surpass the ITER design field, and interpret the results in the context of candidate models to explain the upturn in $P_{th}$ at low density.

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