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Evaluation of tungsten transport and concentration control in ITER scenarios

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In order to evaluate if W accumulation is expected in ITER plasma conditions and whether the available heating systems can provide the degree of control required for stable H-mode operation we have applied integrated plasma models (ASTRA and JINTRAC) to a wide range of plasma conditions in ITER including confinement transients (i.e. L-H and H-L transitions). The studies find that, in agreement with present experiments, W transport is anomalous for most of the ITER plasma cross section except in the very central region (typically r/a ≤ 0.3). In the central plasma region W transport is neoclassical and for most stationary plasma conditions temperature screening is dominant over the inwards force originating from the density gradient. Main ion density gradients in the central plasma region are always found to be very moderate due to the low core fuelling rate provided by the ITER 1MeV NBI system. This prevents strong W accumulation to occur in ITER stationary H-modes, which is a result robust to assumptions on the level of particle and energy transport in the central region of the plasma. Modelling also shows that the application of central ECRH or ICRH heating at a level of 20 MW is sufficient to change the density and temperature gradients in the central region so as to modify the central W density profile and avoid strong peaking. While the situation regarding core W control in stationary H-mode phases looks rather positive, core W control is found to be more complex, in the termination phases of ITER H-modes. For optimum plasma radial position control, the plasma energy should decrease with timescales of 5-10 s in the termination phase of high Q H-modes in ITER. The decrease of the plasma energy in such timescale can be achieved by a slow ramp-down of the auxiliary heating power, which together with alpha heating, extends the H-mode phase and the timescale of plasma energy decay over 5 s. Modelling of W transport for Q = 10 H-mode terminations shows that strong W accumulation (with timescales of ˜ 5 s) can occur when the auxiliary heating power is gradually decreased. Further H-mode termination studies will be carried out to optimize the ramp-down of auxiliary heating power (as well as the type of heating scheme applied in this phase) and pellet fuelling so that the requirements regarding radial position and W control can be fulfilled simultaneously.

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