Inductive flux usage and its optimization in tokamak operation

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Abstract. The energy flow from the poloidal field coils of a tokamak to the electromagnetic and kinetic stored energy of the plasma are considered in the context of optimizing the operation of ITER. The goal is to optimize the flux usage in order to allow the longest possible burn in ITER at the desired conditions to meet the physics objectives (500 MW fusion power with energy gain of 10). A mathematical formulation of the energy flow is derived and applied to experiments in the DIII-D tokamak that simulate the ITER design shape and relevant normalized current and pressure. The rate of rise of the plasma current was varied, and the fastest stable current rise is found to be the optimum for flux usage in DIII-D. A method to project the results to ITER is formulated. The constraints of the ITER poloidal field coil set yield an optimum at ramp rates slower than the maximum stable rate for plasmas similar to the DIII-D plasmas. Experiments in present-day tokamaks for further optimization of the current rise and validation of the projections are suggested.

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