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1-D Modeling of Massive Particle Injection (MPI) in Tokamaks[1]

W. WU, P.B. PARKS, General Atomics, V.A. IZZO, UCSD — A 1-D Fast Current Quench (FCQ) model is developed to study current evolution and runaway electron suppression under massive density increase. The model consists of coupled toroidal electric field and energy equations, and it is solved numerically for DIII-D and ITER operating conditions. Simulation results suggest that fast shutdown by D_2 liquid jet/pellet injection is in principle achievable for the desired plasma cooling time ($\sim$15 ms for DIII-D and $\sim$50 ms for ITER) under $\sim$150$\times$ or higher densification. The current density and pressure profile are practically unaltered during the initial phase of jet propagation when dilution cooling dominates. With subsequent radiation cooling, the densified discharge enters the strongly collisional regime where Pfirsch-Schluter thermal diffusion can inhibit current contraction on the magnetic axis. Often the 1/1 kink instability, addressed by Kadomtsev's magnetic reconnection model, can be prevented. Our results are compared with NIMROD simulations in which the plasma is suddenly densified by $\sim$100$\times$ and experiences instantaneous dilution cooling, allowing for use of actual (lower) Lundquist numbers.

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