Plasma Current Ramp-up by the Vertical Field and Heating Power in the CTF Device

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Abstract

The plasma current ramp-up by the vertical field and heating power in the component test facility (CTF) device (the major radius R_o=1.2 m, the minor radius a=0.8 m, the plasma elongation κ = 3, the aspect ratio A=1.5, and the toroidal field B_o=2.5 T) has been studied using 0-D equations. Firstly, using the simple and equivalent plasma circuit equation it is found that the external heating power of 37~40 MW and the fusion power of 300 MW could drive the plasma current to ~10 MA with the confinement factor γ_{HH}=2.2 over the IPB(y,2) scaling. The smaller heating power sometimes induces oscillations in the plasma parameters and terminates the plasma discharge. Secondly, using the plasma circuit equation with separate coil induction terms the plasma current evolution has been studied in detail. The PF1 (divertor) and PF2 (shaping) coils create the field null point in the plasma regime when I_{PF1}/I_{PF2}=(+20 kA)/(-0.8 kA) is satisfied. In the outward region of this null point, the normal vertical field for equilibrium is generated. The plasma current is ramped up to ~0.6 MA when I_{PF1}=20 kA/turn is maintained, and I_{PF2} is ramped from -0.8 kA/turn down to –40 kA/turn and I_{PF3} from 0 kA to –40 kA/turn. Here the upper PF1 coil has 4 turns, PF2 coil has 8 turns, and PF3 coil has 8 turns. After this initial phase the plasma current increases gradually up to 10 MA by the heating power and fusion power through the vertical field.