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Integrated scenario analysis for HL-2M high-performance operation

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Abstract

HL-2M [1,2] is a new medium-sized tokamak under construction in Southwestern Institute of Physics (SWIP), dedicated to support the critical physics and engineering issues of ITER and CFETR. Analyzing the integrated plasma scenarios is essential for assessing the performance metrics and foreseeing physics as well as envisaged experiments of HL-2M. This paper comprehensively presented the kind of expected discharge regimes [3-9] (Conventional inductive (Baseline), Hybrid and Steady-state) of HL-2M based on the integrated suite of codes METIS. Simulation results show that the central electron temperature of the baseline regime can achieve more than 10keV by injecting 27MW of heating power with a plasma current of Ip=3MA and Greenwald fraction f_G=0.65, sustained for more than 10s, with thermal energy and β_N reaching 5MJ and 2.5, respectively (Figure 1). For sustaining the hybrid discharge, the stabilization method of q profile is studied. It is observed that the inductive current profile diffusion towards the magnetic axis can cause fluctuations of the q profile and enough non-inductive current fraction can efficiently weaken this. Meanwhile, controlling the plasma ramp-up rate as well as the additional heating rate is the other way to decrease the fluctuation of the q profile. The hybrid regime with fni=80%-90% can be realized in Ip=1-1.4MA with f_G around 0.5, and β_N is 2.5-2.9 with H_{98}(y,2)=1.1. Because of the effect of the on-axis NBCD, the hybrid steady state, in Ip=1.0 and 1.2, can be achieved more easily than the steady state regimes with reversed shear, corresponding to β_N=2.6 and 2.9. Such studies show that HL-2M is a flexible tokamak with a significant capacity of generating a broad variety of plasmas as a consequence of the different heating and current drive systems installed.

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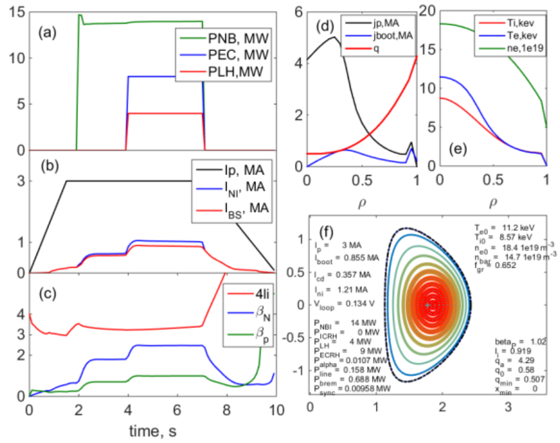

Figure 1 (a) waveform of auxiliary heating (PNB:NBI, PEC:ECRH, PLH:LH) implemented during the simulation; (b) waveform of the plasma current Ip, the bootstrap current I_{BS} and the non-inductive current I_{NI}; (c) time traces of β_N, β_p, li; (d) current profile and q profile at 6s; (e) electron temperature, ion temperature and density profile at 6 s; (f) equilibrium flux surface.

Note: Abstract should be in 1 page.