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Simulation Analysis of Triangularity Effects for CFETR Plasmas

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The effect of triangularity for pedestal and core plasma is studied in 1.5D integrated modeling[1] for China Fusion Engineering Test Reactor (CFETR).A scanning of triangularity (roughly from 0.44~0.66) shows that the plasma performance will only increases a little for conventional H-mode with monotonically increasing safety factor profile and decreases for advanced H-mode with reversed magnetic shear(RS).The physics is explained detailed in this work. The pedestal height and width increases with triangularity according to the simulation with EPED-1 model[2]. However, the critical plasma equilibrium for CFETR locates at deep peeling boundary in j-α diagram,where j is the edge current and α is normalized pressure gradient, the effect of plasma shaping to expend peeling-ballooning boundary is weak in this regime, so that increment of the pedestal height and width is not large.For core plasma,turbulent transport dominates in both modes. higher triangularity yields stronger turbulent transport and then lower gradient of electron density, electron and ion temperature, according to the simulation with the turbulent transport model TGLF[3].Although the effect of triangularity to increase core transport is weakened in some radial region with confinement enhancement due to strong reversed shear or alpha stabilization, there is no such enhancement in the most radial region for both the conventional H-mode and radial region of advanced H-mode with positive shear.So although combining with consequent changed core profile induced by different pedestal boundary condition the total effect of triangularity for core transport is complex, the final outcome is clear that for CFETR the stiffness is weak and the core profile become flatter with higher triangularity. In summary,the increment from higher and wider pedestal will be counteracted by flatter core profile, so that higher triangularity have no remarkable improvement on fusion power and confinement for CFETR.

References

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