Contribution ID: **698** Type: **Poster**

Predictions of the baseline operation scenario in Chinese fusion engineering test reactor

Friday, 21 October 2016 08:30 (4 hours)

The Chinese Fusion Engineering Test Reactor (CFETR) is under design. The machine aims to fill the gaps between ITER and DEMO. Recently, the physical design focuses on the so-called baseline scenario. It is a 10 MA steady state scenario to produce ˜200 MW fusion power. With the integrated modelling of the equilibrium calculation, pedestal structures prediction, 1.5D core transport simulation, 2D divertor and scrape-off layer transport simulation and MHD instabilities analysis, the plasma performance of baseline scenario is predicted. Equilibrium calculations show that both the ITER-like configurations and the snowflake configurations could be achieved. The EPED1 model is used to predict the pedestal structure, gives the pedestal height 40 kPa and width 0.03 psi. 1.5D simulations are performed with coupled ONETWO/TGYRO codes under the framework of OMFIT, show that with the 100 MW injected power, the temperature profiles could be sustained with Ti(0) ˜ 19 keV and the fusion power is 192 MW. At the same time, the plasma current is fully non-inductive, it is sustained by 4.65 MA bootstrap current and 5.39 MA driven current. The driven current is off-axis and the q profile is reversed. The heat flux on the divertor for the ITER-like configuration is simulated by the SOLPS (B2-EIRENE) code package. It shows that with the Ar or Ne impurity seeding (a rate of ˜10ˆ21 particles/s) from the top of the machine, the peak heat flux is effectively reduced below 10 MW/mˆ2, even at a relatively low edge density. MHD instabilities and its control methods are analyzed. The vertical instability could be controlled by the passive structure and the internal coils at the back of blanket. The global ideal MHD instability is stable since the baseline scenario is far below the ideal MHD limit. The neoclassical tearing modes (NTMs) could be controlled by 7 MW ECCD. The stability of toroidal Alfven eigenmodes (TAEs) is analyzed with the linear code NOVA-K, shows that it is stable for the reversed shear equilibrium. The integrated modelling gives a set of relatively self-consistent parameters, shows that the target plasma parameters of the baseline operation scenario could be achieved.

Paper Number

EX/P7-15

Country or International Organization

China

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Session Classification: Poster 7

Track Classification: EXC - Magnetic Confinement Experiments: Confinement