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Design of 11 MA Snowflake divertor configurations of CFETR

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Chinese Fusion Engineering Test Reactor (CFETR) is under design, which will be operated in two phases [1]. In phase I, CFETR is envisioned to provide 200 MW fusion power Pf and its designed main parameters are R=6.6 m, a=1.8 m, BT=6-7 T, IP=10 MA. However, in phase II which aims to DEMO validation, the Pf is over 1 GW and the IP increases to 11 MA. Considering the large Pf, it will be a serious challenge to handle the high exhaust power in scrape-off layer (SOL) of a single null divertor (SND) configuration, which means some solutions should be taken to reduce the heat loads on divertor plates. One solution is employing the snowflake (SF) divertor configuration.
In this paper, the capacity of poloidal field (PF) coils in obtaining the SN and the SF configurations was evaluated. The PF coils must remain their current limits. Instead of doing time-depending discharge evolution, static equilibrium analysis method was done to calculate the equilibria and the corresponding currents in PF coils at some fiducial points in a discharge by using TEQ equilibrium solver. The volt-seconds consumption for the ramp-up stage was estimated and then we calculated the PF coil currents of the SND and the SF configurations during the flattop phase with a range of li for the 11 MA H-mode inductive scenario. The results indicate that there is at least 100 volt-seconds of flattop for the SD, and the SF configurations cannot be established at the start of the flattop (SOF) because the currents in some PF coils exceed their limits. By adjusting turns of the PF coils, all three kinds of SF configurations (SF plus, exact SF, SF minus) were realized at least after the SOF point. The properties of the SF were also analyzed. The connection length, flux expansion of the SF all significantly increased by at least 1.5 times over the SND.

Keywords: CFETR, PF coil, equilibrium, snowflake

References

[1] Yuanxi Wan et al 2016 26th IAEA FEC, Paper No. OV/3-4

Eligible for student paper award?

Yes

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