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Power and Particle Exhaust for the Infinity Two Fusion Pilot Plant

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Successful operation of fusion power plant (FPP) depends on a particle and power exhaust strategy which simultaneously facilitates good core performance. "Infinity Two"is Type One Energy's proposed design for a practical FPP with a robust baseline physics solution and a conservative design margin [1]. It is four-field period, aspect ratio A = 10, quasiisodynamic stellarator with improved confinement, elevated plasma density and high magnetic fields (B = 9 T). Two divertor designs are analyzed for Infinity Two - classical divertor and a novel large Island backside divertor (LIBD) concept which promises improved neutral pumping [2].

For the analysis performed, a suite of codes have been used; DIV3D [3] which is a diffusive field line tracing code, 3D plasma boundary code EMC3-EIRENE [4] with FLARE [5] code used to provide the input magnetic meshes, and EMC3-Lite [6] code which is the simplified version of EMC3-EIRENE that restricts the heat transport equation to only parallel electron conduction and perpendicular heat diffusion.

Results from both the divertor designs show a way to mitigate the large heat loads expected in FPP by operating with divertor detachment wherein a large fraction of power entering the scrape-off layer is radiated away. The classical divertor design possesses the flexibility in that the position of the plates can be adjusted in accordance with connection length and other parameter dependency on the target heat flux width to obtain the desired heat-flux profile. However, the open divertor geometry design leads to a poor neutral pumping efficiency. Alternatively, the LIBD results show a good particle-exhaust efficiency as the divertor design closes off pathways for neutralized plasma particles to escape back into the plasma and forces them into the divertor pumping gap. A sensitivity study for field error and beta effects has been carried out and possible ways to mitigate it has been explored.

References

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