A closed divertor configuration for reduction of the heat load and efficient particle control for helical fusion reactors

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A new concept of a closed helical divertor for reduction of the heat load to the divertor plates and efficient particle control/pumping is proposed for helical fusion reactors. The closed divertor is optimized for controlling the peripheral plasma density and pumping neutral particles from the inboard side of torus. It is compatible with plasma heating systems and blanket structures installed in the outboard side in the fusion reactors. The closed divertor configuration utilizes three-dimensional complicated magnetic field line structures in the plasma periphery (ergodic layer and divertor legs) for reducing the heat load on the divertor plates and for preventing impurity penetration into the main plasma.

Figure 1 shows the closed divertor configuration which consists of the following five components: baffle plates, slanted divertor plates, back plates, a V-shaped dome and target plates. The baffle plates control the outflow of neutral particles and impurities released from the divertor plates (carbon) to the main plasma. The plasma wetted area on the divertor plates is enlarged by intersecting divertor legs obliquely, which confines neutral particles in the divertor region. It is also effective for guiding the neutral particles to the backside of the dome where large pump ducts are located along helical coils. The dome prevents the neutral particles from penetrating into the ergodic layer, which enhances the neutral pressure in the pump ducts. The back plates protect cooling components installed at the backside of the divertor plates from high energy protons. The target plates intersect two divertor legs in which magnetic field lines directly connect to the upper/lower side of the torus in order to change the position of the strike points into the inboard side. The target plates are also effective for confining the neutral particles in the inboard side by suppressing outflow of the neutral particles to the upper/lower side along the space between the helical coils.

Heat load profiles on the closed divertor components for a helical fusion reactor is estimated by using a three-dimensional neutral particle transport code (EIRENE) with a one-dimensional plasma fluid analysis of the divertor legs. The plasma parameter profile in the ergodic layer and the output current and the power are defined as the calculations by the EMC-EIRENE code for the Force Free Helical Reactor (FFHR) [1]. The feasibility of the closed divertor for efficient particle control for helical reactors is discussed in various plasma conditions.

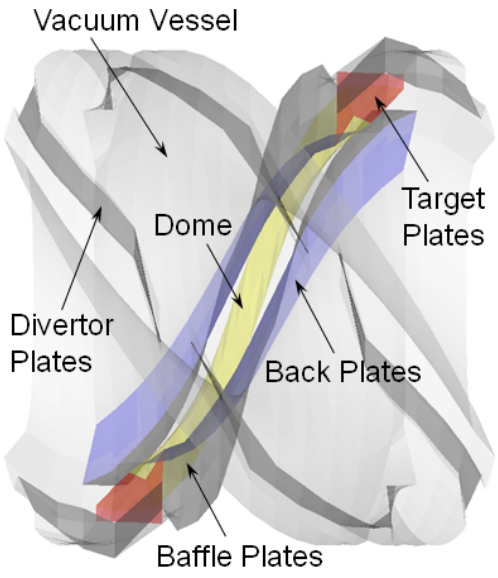

Fig. 1 Closed divertor configuration for helical fusion reactors.

[1] M. Kobayashi, N. Ohyabu, et al., Fusion Sci. Technol. **52** (2007) 566.