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Fishtail Divertor: A New Divertor Concept on EAST For Active Control of Heat Load on Divertor Plate

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A new divertor concept, the Fishtail divertor (FTD), is proposed and investigated on EAST, which can quickly move the strike point along the radial and poloidal direction like the swing of fishtail by additional alternating magnetic field. The maximum moving distance of the strike point is controlled by the alternating field amplitude. The wetted area of the heat flux is widened, so that the averaged heat load is reduced.
Being different from the position swing of plasma on JET and for quasi-steady-state operation on EAST, the additional alternating magnetic field is to be generated by the AC current in the coil located behind the divertor target near the strike point. The maximum moving distance of the strike point is proportional to the coil current but inversely proportional to the plasma current. When EAST tokamak is operated at a plasma current 500 kA, 5 kA AC current in the coil is found to be required for a maximum moving distance of 10 cm on the divertor target.
The numerical simulations show that the surface temperature of the divertor target plate is reduced significantly when the strike point swings. Without moving the strike point on EAST, the maximum surface temperatures of the carbon target plate are 1057 ℃ and 1872 ℃, respectively, for a heat flux 10 MW/mˆ2 with a width of 1 cm and 2 cm. With a 10 Hz swing, the maximum surface temperatures are reduced to 525 ℃ and 532 ℃, respectively.
Based on the results from numerical simulations and preliminary engineering design, it is found that FTD has the following advantages compared with other divertor concepts:
1.The precise radial profile of the heat flux becomes unimportant
2.Uniform distribution of the heat flux on the divertor target plate
3.Reliable controls the heat load region on the divertor target plate
4.Little effect on the plasma shape and X point location;
5.Feasibility from the engineering and technology point of view
6. Fast swing is possible and can be utilized for ELM mitigation
Further analysis on the application of FTD or its combination with other concepts for a fusion reactor has also been carried out. A long divertor leg configuration together with a special divertor chamber is found to be attractive for reactors, since in this case the FTD coils can be located away from the core plasma to avoid neutron radiation.

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