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Simulation of turbulent plasma heat flux to the DEMO first wall

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First wall (FW) of the DEMO reactor should protect the breeding blanket and mechanical construction elements of the burning plasma exposure. The plasma impacts the wall surface by heating and by energetic particles. The heat load on FW during steady state burning mainly consists of the following factors: (i) the plasma photonic radiation, (ii) the plasma heat flux along the magnetic field lines, (iii) charge-exchange neutrals, (iv) alpha particles produced by fusion reaction and partially leaked into the scrape-off layer (SOL).
Assessment of the FW heat load is one of the key design issues determining the DEMO reactor, because the heat flux there is a challenge for the FW armor material both due to high operation temperature and considerable erosion rate by sputtering. Cooling system of the first wall in DEMO should provide stable operation in the wide range of surface heat fluxes: from 0.3 MW/m2 up to 3-5 MW/m2.
In this paper a model for the FW heat load caused by the plasma turbulent heat flux associated with plasma blobs is developed. Plasma blobs, or plasma blob filaments, are localized regions of isolated enhanced plasma density and temperature of a few cm cross-field sizes, spanned along magnetic field in SOL from wall to wall. The blobs propagate in radial direction from separatrix to the wall with rather large velocity, depositing heat flux by electron thermoconductivity and by ion convection parallel to the magnetic field at the intersections with the wall. A model of the blobs moving with constant radial velocity and depositing heat flux to the wall due to these processes has been developed and implemented into the TOKES code, developed over the past decade at FZK-KIT for integrated 2D simulations of transient events in tokamaks.
First simulations of the intermittent turbulent plasma wall heat load due to the blobs for the DEMO-I tokamak reactor design have been performed. Poloidal profile for the heat flux to the toroidally symmetric first wall has been calculated.

Eligible for student paper award?

No

Author: Dr PESTCHANYI, Sergey (KIT)

Presenter: Dr PESTCHANYI, Sergey (KIT)

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