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Integrated modelling of core and divertor plasmas for DEMO-FNS hybrid facility

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The steady state regime for tokamak based neutron source DEMO-FNS with parameters R/a=3.2 m/1m, B=5T, Ip=4-5 MA, PNBI=30MW and PECR=6MW is studied using a consistent modeling of the central and divertor plasma. In our formulation, the divertor plasma state is determined by the values of heat flux PSOL and the pressure of the neutrals in the divertor pn. As boundary conditions for the central plasma we use values of density and temperatures of ions and electrons on the separatrix and the neutral flux through the separatrix toward to the central plasma column. In divertor region all values calculated by the program SOLPS4.3 for a set of operating points (~30 in our case) with different values of PSOL and pn, and then the calculation results are approximated by analytical formulas. Heat transport in the central plasma is calculated using the ASTRA code and sets the scaling for the confinement time of energy IPB(y,2) with variation of H-factor. The simplified physical model for the description of the pedestal in H-mode inside the separatrix is used, based on the scalings for width and pressure at the pedestal. The density of the plasma (electrons or ions of deuterium and tritium) is modelled taking into account sources of neutrals coming from divertor region, as well as the injection of fast atoms and/or pellet injection. The neon injection is modeled to reduce the heat loads to divertor plates, that would able to radiate up to 60% of input power. The Helium plasma dilution is taken into account to estimate the maximum permissible helium confinement values.
The simulation determines the window of plasma parameters DEMO-TIN, in which the heat load on divertor plates remain at an acceptable level, and the divertor plasma does not go into “detachment” mode. The dependence of these conditions on the radiation power, the impurity level, fraction of alpha-particles is investigated.

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