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Influence of the Divertor Plate Material on the Plasma Performance in DEMO

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One of the most challenging issues of fusion research is the development of DEMO scenario which satisfy simultaneously the requirement of sufficiently high power amplification with the needs for sustainable power exhaust. Independently of the plasma facing materials in DEMO impurity seeding seems to be an unavoidable element of operation to protect the divertor from excessive heat loads.
The presented approach is based on integrated numerical modelling of DEMO discharges using the COREDIV code, which self-consistently solves 1D radial transport equations of plasma and impurities in the core region and 2D multi-fluid transport in the SOL. The model is self-consistent with respect to both the effects of impurities on the alpha-power level and the interaction between seeded and intrinsic impurities. This interaction leads to a significant change in the intrinsic impurity fluxes and energy power balance, and it is found to be essential for a correct evaluation of the average power to the target plates. The code has been successfully benchmarked with a number of JET ILW and ASDEX-U discharges.
Calculations are performed for DEMO inductive scenario, characterised by rather conventional physics and technology assumptions.Preliminary results show significant difference in the reactor performance for different plate materials. It has been found, that the fusion performance in the terms of fusion factor Q is quite similar for W and Mo plates, whereas it is slightly reduced for Ni target. It is mostly related to the stronger dilution effect in the case of Ni impurity. Second important finding is that for Ni divertor, even without seeding, the divertor heat load is at the acceptable level. In the case of W and Mo seeding is always required to reduce power load to the target plates. With tungsten divertor, most of the radiation comes from the core, whereas in the case of Mo and in particular for Ni target significant fraction of the power is radiated in the edge region. Therefore, for Mo and Ni targets the power crossing the separatrix is well above the PLH threshold. It should be noted that for Ni target the radiation fraction is always large (>0.85%) independent on the level of seeding.For all targets however, the core radiation (line+bremsstrahlung+synchrotron) remains the main energy loss channel.

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