role of neutral particles   
in determining the divertor operation mode in iter

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The main purposes of the divertor are relocating the zone of plasma-surface interaction further from the plasma core in order to reduce the impurity influx to the core and compressing the neutral gas to improve the pumping efficiency. However, the localization of the interaction leads to strong concentration of the power flow on the divertor targets. Without special means aimed at enhancing energy dissipation in the divertor, the peak power loads on the targets in ITER could reach the values ~100 MW/m2 that is an order of magnitude higher than those acceptable with the present level of the heat removal technology [1]. In the ITER project, the required dissipation level is to be achieved by divertor operation in the “detachment” mode [2], when the energy and particle flows to the divertor target decrease and the particle recycling on the targets is partially replaced by plasma recombination in the divertor volume [3].

Since the recombination intensity depends strongly on the temperature and density of the plasma and ionisation of the neutrals in the course of recycling requires power, the plasma flow onto the target can be reduced by enhancing the radiation power by adding impurities, or by increasing the fueling rate. In the calculations performed using the SOLPS4.3 code package [4], the authors studied the efficiency of both these approaches for ensuring the operational mode of ITER that satisfies both the requirements of achieving the reactor parameters (the fusion power, the fusion gain Q) and the limitations stemming from technological issues of the divertor design. In particular, a possibility of separate control of the plasma density in the core and divertor, using pellet injection and gas puffing, is found. The controlled fueling by gas puffing is shown to be a more efficient way of the divertor control than the impurity injection. The results of these studies are considered in the presentation.

References

[1] R.A. Pitts, A. Kukushkin, A. Loarte, et al., Phys. Scr., 2009, T138, 014001.

[2] G. F. Matthews, J. Nucl. Mater., 1995, 220-222, 104.

[3] A.S. Kukushkin, H.D. Pacher, R.A. Pitts, J. Nucl. Mater., 2015, 463, 586.

[4] A.S. Kukushkin, H.D. Pacher, V. Kotov, et al., Fusion Eng. Des., 2011, 86, 2865.