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Assessment of the operational window for JT-60SA divertor pumping under consideration of the effects from neutral-neutral collisions

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The JT-60SA device will start operation in 2019. One of the top research goals is to study high density plasma physics in view of a demonstration fusion power plant. In this context, this paper presents an integrated modelling of the divertor pumping system of JT-60SA.

The paper first presents a generic integrated workflow to assess the operational window of the pumping system. This approach is supposed to hold for any divertor pumping system, independent of the chosen magnetic configuration. Even today, to simulate such a system under consideration of all geometry details and through all collisionality regimes, is beyond the computational state-of-the-art. This is why such an assessment is usually done in a stepwise manner. The logical first step is a sensitivity study based on the ITERVAC code to identify the most relevant flow paths of the problem aiming for some sort of simplification. The next step is then to do a more accurate treatment of the sub-divertor neutral gas flow using a collision-free approach (such as NEUT2D), a simplified collisional approach (EIRENE) or a complete collisional approach (DIVGAS). At this level, the simplified treatment of the plasma as black hole is being dropped, and the boundary is described with ´real´ particle flux and temperature profiles along the upper divertor region. This information is typical output from a plasma edge code (such as SONIC or SOLPS). Towards the pump side, a capture coefficient is introduced which translates the pumping speed of the installed pumps together with the conductance limiting effect of the port and its installations into an effective pumping speed at the edge of the sub-divertor computational domain.

In the second part, the workflow is exemplified using JT-60SA in a challenging case for pumping, namely under the scenario #2 with moderate plasma density but strong gas puffing to result in collisional effects in the sub-divertor. It is shown how the value of the capture coefficient influences the density contours and it is revealed that already for Knudsen numbers between 0.1 and 1, the macroscopic properties in the sub-divertor deviate by more than factor two from the collision-free values.

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