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First multi-fluid modelling results of super-X divertor in DEMO with Ar seeding

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As a large fusion machine with high power density, DEMO requires sufficient capability of power handling at its boundary region. Apart from applying impurity seeding to actively dissipate power via radiation to cope with this demand, exploring divertor configurations that may be more advantageous than the conventional single-null in handling high power flux crossing the separatrix is also desired to lay the foundation for DEMO divertor design.

The Super-X divertor (SXD) configuration features large plasma wetted area due to large total flux expansion as well as large Rdiv, which is very preferable to achieve lower peak heat flux at the target. It also has long midplane to target connection length, which further increases the wetted area due to longer time for cross field transport of particles and heat. This configuration, owing to its well baffled long divertor leg, should give good divertor closure for neutrals. Namely neutrals do not easily leak from the divertor leg to the main plasma. SXD also has large divertor volume which means potentially higher maximum radiated power from the divertor. Besides, due to the aforementioned features, the plasma in the divertor is cooler, meaning higher efficiency for volumetric losses. These features make SXD an interesting configuration to be explored in DEMO.

This contribution will present the first results of an exploration into argon seeded DEMO plasma in SXD configuration, using the multi-fluid plasma boundary modelling code SOLPS-ITER. In the study, engineering parameters like the deuterium fuelling and argon seeding rates are scanned, inducing a broad range of divertor plasma conditions. Hence, it allows for a systematic investigation of divertor detachment, i.e. the onset, the parameter window, the stability etc., in the SXD configuration in DEMO environment. The parameter scans also enable insights into how the radiation distribution and the enrichment of argon impurity in the DEMO SXD dictates/is dictated by the divertor plasma conditions. On the other hand, with increased connection length from midplane to the outer target, the partition of Psep at the low-field-side midplane between the inner and outer divertor will change. At some point, the connection length to the outer target may get long enough to make the inner divertor a concern of power exhaust, now receiving more power. This is also looked at in this contribution.

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