IFERC Newsletter

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International Fusion Energy Research Centre, Rokkasho, Aomori 039-3212, Japan

Status of DEMO Design Activity

Highlights on divertor and power exhaust studies for DEMO

Task-2, Divertror and power exhaust, has three sub-tasks: EU-DEMO divertor simulations by SONIC and SOLPS-ITER (Task 2-1), He and particle exhaust studies for JA DEMO and EU DEMO (Task 2-2), and Common definition of engineering design criteria, assumptions and material data for EU and JA Divertor (Task 2-3).

Regarding Task 2-1, SONIC simulation (Ar seeding and He exhaust) for EU-DEMO divertor continued in order to understand energy and momentum dissipation mechanisms and to compare with SOLPS-ITER results. Both results showed that peak q_{target} could be reduced to be smaller than 10 MWm^{-2} when it appeared in the detached region (T_e^{div}, T_i^{div} ~1 eV) (Fig.-1). On the other hand, SONIC peak q_{target} was larger than SOLPS-ITER due to larger plasma heat flux and surface recombination load. Therefore, plasma parameters, radiation loss and impurity transport were examined along the field-lines. SONIC results showed that radiation loss was significantly enhanced below X-point for near-separatrix, but it was locally above the target for the peak q_{target} position. Volume recombination and neutral transport such as charge exchange and elastic collision were responsible for the momentum loss, thus comparison of energy and momentum dissipations between SONIC and SOLPS is in progress.

Dissipation factors of the power-balance in the EU-DEMO divertor were also compared for improvement of the simulation models and application to reduced model for core-edge modelling in EU.

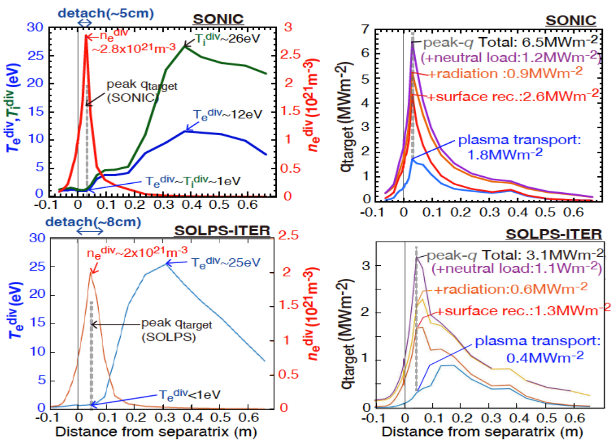

Fig.-1: EU-DEMO divertor simulations at outer target by SONIC & SOLPS-ITER codes.

Concerning Task 2-2, He exhaust study was added to benchmarking between SOLPS-ITER and SONIC for EU-DEMO: He was exhausted from Core-Edge boundary (r/a = 0.98) and Ar was seeded above the outer target. Impurity transport in EU-DEMO were studied. Both Ar and He were accumulated in the inboard SOL and divertor. In-out asymmetries of C_{Ar} (=$n_{\mathrm{Ar}}/n_{\mathrm{i}}$) and C_{He} (=n_{He}/n_{i}) were decreased inside the separatrix (Fig.-2): Ar penetrated from inboard-SOL to core-edge (C_{Ar}= 0.3-0.5%). C_{He} at the core-edge was 0.4% (outer edge) -1.4% (inner edge), but these values were smaller than SOLPS-ITER. Neutral and gas collision model was introduced in neutral transport to investigate influences on pumping and detachment. EU continues the SOLPS-ITER assessment for the divertor liner of the EU-DEMO divertor: a review of divertor structure and its impact on plasma, e.g. heat loads, erosion pattern, and identification of key design parameters for the geometry optimization.

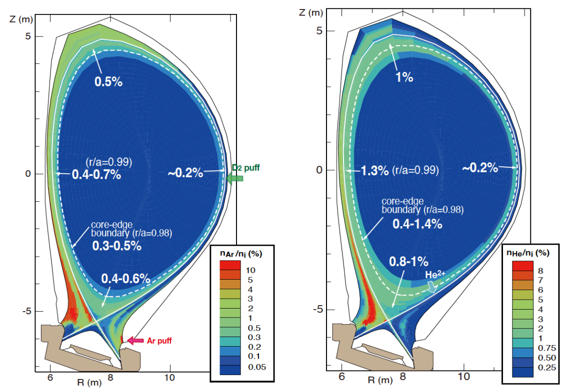

Fig.-2: Ar & He concentrations by SONIC code: (left) $C_{\mathrm{Ar}} = n_{\mathrm{Ar}}/n_i$ and (right) $C_{\mathrm{He}} = n_{\mathrm{He}}/n_i$

As for Task 2-3, in 2023, progress of divertor engineering design, design bases for two coolant temperatures and circuits (coolant conditions are different between EU and JA DEMOs) were summarized, and design options were discussed.

The joint review paper including results and discussions of Task 2-1 & Task 2-3 was published in https://doi.org/10.1016/j.nme.2023.101446

Above results were presented in IAEA FEC 2023 (London).

(DEMO Design Task-2 TROs)