IFERC Newsletter

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Status of DEMO R&D Activity

Highlights on Tritium Technology

Task 1 (T1) on R&D on Tritium (T) Technology has focused on three main activities: (i) [Subtask 1-1] Analysis of plasma wall interaction using JET DT samples for evaluation of T inventory and T recovery, (ii) [Subtask 1-2] Development of conceptual design of TEP (Tokamak Exhaust Processing) systems for DEMO, and (iii) [Subtask 1-3] Development of T inventory evaluation tool for DEMO fuel cycle design.

Work in subtask 1-1 has been concentrated on the analysis of samples from the third ITER-Like Wall campaign at JET (ILW-3) and, on the comparison with the situation after ILW-1. Taking into account important results related to Beryllium limiters and Tungsten divertor reported in the newsletter IFERC-N-2023-12, the PA (Procurement Arrangement) was amended to extend the analysis period until February 2025.

In subtask 1-2, JA will make a remote gas analysis system using a laser Raman system with an optical fiber bundle and apply to measure hydrogen concentration of components for direct recycling loop and TEP application. In this context, to demonstrate the feasibility of remote measurement, a 10 m long optical fiber was procured to implement remote analysis and the new optical analysis system was developed to improve sensitivity. A sensitivity test was carried out with H_2, HD and D_2 mixed gas. Figure 1 shows the initial result of improved sensitivity for HD. In each gas species, a linear relationship between gas concentration and intensity was obtained, and it was confirmed that the sensitivity was improved by about a factor of 2.

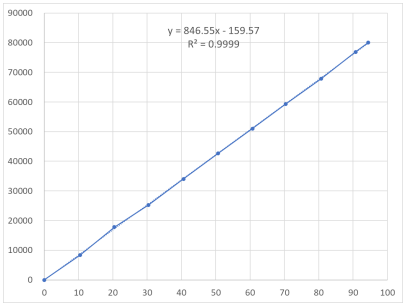

Fig.-1: Relationship between gas concentration (horizontal line) vs intensity (vertical line)

The EU-DEMO fuel cycle has progressed into the concept design phase, prompting a minor update to its high-level architecture. The design of the 3-loop fuel cycle plant has been chosen so as to rigorously separate the different fuel cycle tritium processing functions: machine gas throughput (blue blocks in Fig.-2), fuel rebalancing (green blocks), tritium extraction (red blocks) and tritium recovery (purple blocks).

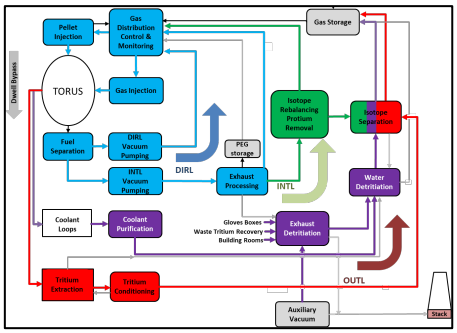

Fig.-2: Updated block diagram of the EU-DEMO fuel cycle for the conceptual design

In subtask 1-3, JA has modified the steady-state analysis code of ISS (Isotope Separation System) of the cryogenic distillation cascade type and WDS (Water Detritiation System) of combined liquid phase chemical exchange column with solid polymer tritiated water electrolyzer. The logic was reorganized and reconstructed as a computation code source with equivalent functionality. The same initial conditions were entered into the modified code and the old code, and the output values were verified to match.

The EU-DEMO fuel cycle operational tritium inventories at the end of the pre-conceptual design phase have been assessed in detail for each system block. Based on this evaluated reference point, a tool to predict the total operational inventory for other parameter values in the fuel cycle functional interfaces has been developed. The interface parameters are defined according to the four primary tritium-processing tasks that the fuel cycle has to accommodate: fuel circulation through the plasma chamber, isotopic rebalancing of the circulated fuel, processing of extracted tritium, and processing of recovered tritium.

(DEMO R&D Task-1 TROs)