IFERC Newsletter

IFERC-N-2023-12, 7 July 2023
International Fusion Energy Research Centre, Rokkasho, Aomori 039-3212, Japan

Status of DEMO R&D Activity

Highlights on Tritium Technology

Task 1 has focused on three main activities: (i) [Sub-task 1-1] Analysis of Plasma Wall Interaction using JET DT Samples for Evaluation of Tritium Inventory and Tritium Recovery, (ii) [Sub-task 1-2] Development of Conceptual Design of TEP (Tokamak Exhaust Processing) Systems for DEMO and (iii) [Sub-task 1-3] Development of Tritium Inventory Evaluation Tool for DEMO Fuel Cycle Design.

In sub-task 1-1, work concentrated on the analysis of samples from the third ITER-Like Wall campaign (ILW-3) and the comparison to the situation after ILW-1. There are three very important outcomes:

- the first-ever determination of T distribution in the gaps of castellation in the beryllium limiters from a few locations in JET;
- a comparison of specific T activities in dust and in the divertor tiles – complete comprehensive studies;
- a new set of results on sputter-assisted XPS (X-ray Photoelectron Spectroscopy) surface analyses of Be limiters: (i) depth profiling of Be, C, O, W; (ii) evolution of the Be and BeO features under Ar sputtering.

In sub-task 1-2, EU-DEMO fuel cycle has progressed into the concept design phase, prompting a minor update to its high-level architecture (Fig-1). This update now reflects the technology selection of the tritium conditioning system at the same PBS (Plant Breakdown Structure) level as the breeding blanket variant selection. Additionally, the system block for “fuel separation” was split in two blocks and renamed as “fuel separation” and “torus vacuum” to better reflect the core functionality. For this architecture a steady-state mass balance tool has been developed that allows configuration with interface and system performance data and returns flat-top flowrates and composition for the inner fuel cycle, as well as time averaged flowrates for the outer fuel cycle.

In sub-task 1-3, the EU-DEMO fuel cycle operational tritium inventories at the end of the pre-concept design phase have been assessed in detail for each system block (Fig-2). 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; R1: Fuel circulation through the plasma chamber, R2: Isotopic rebalancing of the circulated fuel, R3: Processing of extracted tritium, and R4: Processing of recovered tritium. 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.

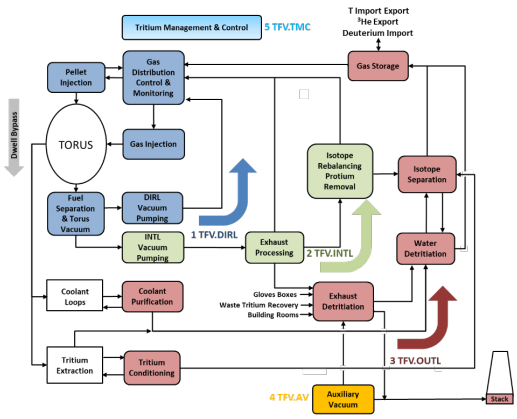
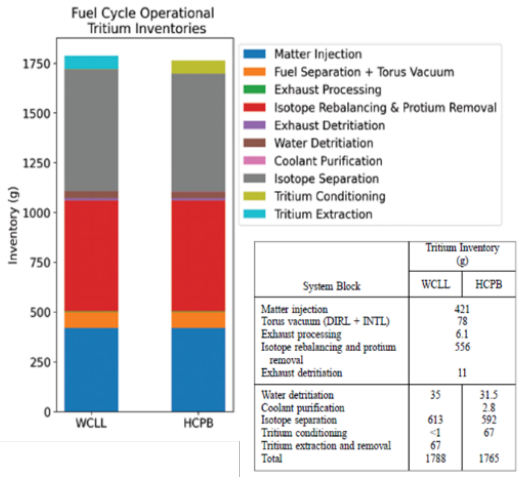


Fig-1: Updated Block Diagram of EU-DEMO Fuel Cycle for conceptual design



System Block	Tritium Inventory (g) WCLL	HCPB
Matter injection	421	
Torus vacuum (DIRL + INTL)	78	
Exhaust processing	6.1	
Isotope rebalancing and protium removal	556	
Exhaust detritiation	11	
Water detritiation	35	31.5
Coolant purification		2.8
Isotope separation	613	592
Tritium conditioning	<1	67
Tritium extraction and removal	67	
Total	1788	1765

Fig-2: Evaluated reference operational tritium inventories in the EU-DEMO fuel cycle.

(DEMO R&D Task-1 TROs)