

Dynamic Tritium Inventory Analysis of the Fuel Cycle for a Fusion Power Plant

Abstract

In a fusion reactor, tritium management, accountancy and recovery are critical challenges that must be addressed immediately to envisage a closed fusion fuel cycle (FFC) system. In this work a dynamic integrated fuel cycle model will be developed to calculate the tritium inventories as a function of time in various sub-systems of fuel cycle including the cryopumping station, fuel processing units, tritium breeding blankets, hydrogen isotopes recovery, separation and storage systems. The developed model would enable the quantification of the key parameters, such as tritium start-up inventory, doubling time, reserve inventory, establishing essential criteria for the continuous fusion power plant operation. Since ITER and future commercial fusion power plants are expected to operate in a pulsed mode, unsteady state simulations are considered in the present study to provide realistic estimates of the tritium inventories at a wide range of operating conditions. As a next step, the dynamic physics based modeling of one of the components of FFC, HIRS is performed to accurately predict the qualitative performance of individual components in the system. The integrated FFC model would be developed using Object Oriented Programming (OOP) in Python and benchmarked with data reported in literature. Verification of test cases for different components would also be performed using the developed code.

Deliverables:

1. Report on literature survey of gas mixture flow and inventories in fusion fuel cycle.
2. A comprehensive database on the process parameters, residence times, process components, operation and functions of all the components in the fusion fuel cycle.
3. Python scripts with code operating manual and tutorials for the verification test cases.
4. A consolidated report on the dynamic tritium inventories in FFC.

Academic Project Requirements:

1) **Required No. of student(s) for academic project: 1**

2) **Name of course with branch/discipline: M.Sc. Physics**

3) **Academic Project duration:**

(a) **Total academic project duration: 36 Weeks**

(b) **Student's presence at IPR for academic project work: 1 Full working Days per week**

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