

Process Modeling of Hydrogen Isotopes Recovery System for Application in Fusion Reactors

Abstract

Effective recovery and purification of hydrogen isotopes is essential for the continuous operation of a fusion reactor. In the fusion fuel cycle, one of the reacting nuclei, tritium is produced in the breeder blanket system. A prototype Hydrogen isotopes Recovery System (HIRS) is being developed in Institute for Plasma Research, Gandhinagar to recover trace levels of hydrogen isotopes from helium gas. There are several components like heat exchangers, adsorbers, hot metal beds, membranes and storage systems in HIRS. In this project, the process modeling of the HIRS with all the components will be performed. This includes selection of appropriate thermodynamic models for the gas mixture, determination of the flow rates, composition of gas mixture in every stream, transport properties and integrated energy balance of the system. At a component level, the mass and energy balances to determine pressure, composition, temperature, profiles, energy requirements, recovery and regeneration conditions would be performed. A sensitivity analysis will also be performed by varying the operating parameters to monitor how system output changes and would be utilized for potential optimization and techno-commercial evaluation. Finally, a preliminary assessment of capital and operating costs, utility requirements, and equipment sizing is performed to demonstrate the overall viability of the system.

The selected project student is expected to work on the development of a fully converged process flow sheet of HIRS, generation of data sheets on the thermodynamic properties, flow rates, composition, and energy states of all streams verified against conservation laws. This also includes the sensitivity analysis plots for the major component (adsorber, membrane, metal beds) providing the profiles for temperature, pressure, concentration gradients, and separation efficiency. A comprehensive report including verification test cases should also be submitted along with the analysis file

Academic Project Requirements:

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

2) Name of course with branch/discipline: M.E./M.Tech Other

3) Academic Project duration:

(a) Total academic project duration: 32 Weeks

(b) Student's presence at IPR for academic project work: 2 Full working Days per week

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