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Experimental and numerical studies on a gas flowing calorimetry for tritium accountability

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A pressure, volume, temperature, and concentration (PVT-c) method, which is widely used to measure the amount of tritium owing to its effectiveness, requires a desorption process from uranium tritides and a transfer process to a measurement tank in the tritium storage and delivery system (SDS) for a tokamak-type nuclear fusion reactor. In addition, the repeated processes for the PVT-c, including the heating of the SDS bed, increase the potential risk of tritium release. For this reason, the application of other tritium measurement methods without the desorption and transfer processes is needed for the SDS bed. In this study, we designed and fabricated a uranium hydride bed with gas flowing calorimetry. Gas flowing calorimetry does not require desorption or transfer processes. Experiments on obtaining the calibration curve for the relationship between the amount of tritium and the difference in gas temperature in the calorimetry have been carried out. In addition, characteristics including the resolution, convergence, and reliability of the gas flowing calorimetry in a uranium hydride bed were obtained. Furthermore, the calorimetry was modeled and simulated under various steady state and transient conditions through a Multi-dimensional Analysis of Reactor Safety (MARS) code. The calorimetry loop consists largely of a uranium hydride bed, a circulation pump, flow controllers, chillers, heaters, buffer tanks, pressure gauges, thermocouples, and resistance temperature detectors. The uranium hydride bed contains 1893.75 grams of depleted uranium as a tritium storage material. A direct current power supply was used to simulate the decay heat of tritium.

Co-author: JUNG, Kwangjin (University of Science and Technology)

Presenter: JUNG, Kwangjin (University of Science and Technology)

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