Tritium Assay and Dispensing of KEPRI Tritium Lab.

S. H. Sohn, K. M. Song, S. K. Lee, K.W. Lee, B. W. Ko
KEPRI, 103-16 Munji-dong, Yusong-gu, Daejon, 305-380, shshon@kepri.re.kr

1. Introduction

The Wolsong Tritium Removal Facility(WTRF) has been constructed to reduce tritium levels in the heavy water systems and environmental emissions at the site. The WTRF was designed to process 100 kg/h of heavy water with the overall tritium extraction efficiency of 97% per single pass and to produce ~700 g of tritium as T_2 per year at the feed concentration of 0.37 TBq/kg. The high purity tritium greater than 99% is immobilized as a metal hydride to secure its long term storage. The recovered tritium will be made available for industrial uses and some research applications in the future. Then KEPRI is constructing the tritium lab. to build-up infrastructure to support tritium research activities and to support tritium control and accountability systems for tritium export. This paper describes the initial phases of the tritium application program including the laboratory infrastructure to support the tritium related R&D activities and the tritium controls in Korea.

2. KEPRRI Tritium Lab.

2.1 General Description

The KEPRI tritium lab. is classified as a radioisotope handling facility. The design of the tritium lab. should meet the safety requirements of minimizing tritium releases to environment and minimizing tritium radiation exposures. The tritium related systems are currently designed based on the design requirements of defense in depth, fail safe design, limit exothermic heat and consequences of malfunction, safely store tritium as a metal tritide and determine tritium quantity by PVT-c measurement.

Fig. 1 shows the general view of the KEPRI tritium lab. to safely handle tritium. The tritium lab. consists of a tritium assay and dispensing system(TADS), a tritium recovery system(TRS), a purge gas recombiner system (PGRS), a tritium calorimeter, glove boxes and air purged enclosures. The TRS is a metal-getter based, closed-loop for removal of tritium in the glove box atmosphere in the event of a tritium leak from the primary containment. The PGRS is designed to process the tritiated gaseous species to be oxidized to tritiated water on heated oxidizer beds, and the tritiated water is removed from the process stream by a dryer.

For component and equipment holding high tritium, the high-integrity glove boxes are provided and for component and equipment containing low tritium, the air purged enclosures are used for secondary enclosures, respectively.

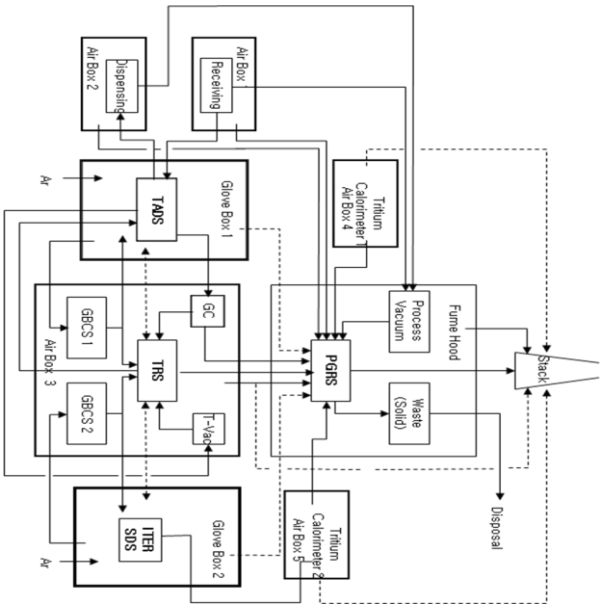

Fig. 1. General view of KEPRI tritium lab.

2.2 Tritium Assay and Dispensing System

The TADS has four major functions: (1) receiving and holding tritium, (2) metering and assaying, (3) dispensing, and (4) recovering tritium residual of process equipment. The TADS uses depleted uranium beds for storing and cleaning tritium, three metering vessels with temperature and pressure sensors, a gas chromatograph, a metal bellows pump, and a vacuum manifold. The TADS is presented in Fig. 2

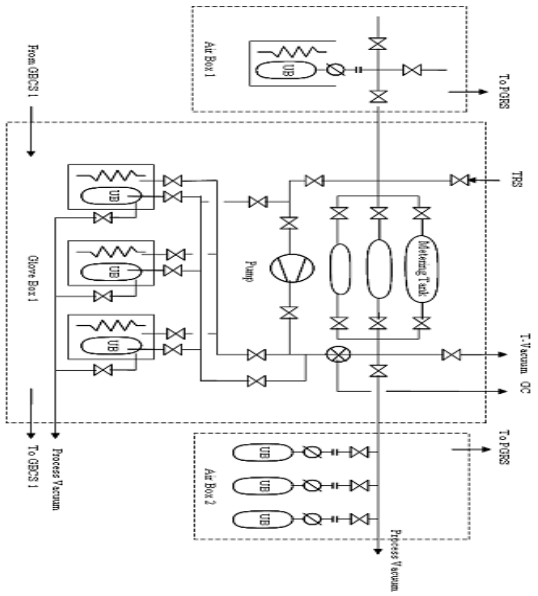

Fig. 2. Tritium assay and dispensing system

2.3 Tritium Metering and Assay

The tritium is assayed to determine purity and total quantity by PVT-c(pressure, volume, temperature and concentration) measurements. Metering vessels are used to determine tritium quantity by PVT measurements. There are three metering vessels sized 5 L, 0.5 L and 0.005 L. The Operating pressure ranges 10 Pa∼100 kPa and maximum quantities per batch for each vessel are 370 TBq, 37 TBq and 3.7 TBq at 1 atm. Table 1 shows gas metering vessels and tritium quantities for each vessel.

Table 1. Gas metering vessels and quantities

Volume (liter)	Max. quantity a batch (TBq @ STP)	Total quantity (TBq of 10 batches)
5	370	3700
0.5	37	370
0.05	3.7	37

It is essential to provide composition analysis by Gas Chromatograph(GC). The GC should have FeOH-coated activated alumina column, accuracy of 3% at 99% T_2, a sampling valve of mini volume(500 ㎕). Carrier gases for the GC are Ne for analysis operation and He for standby, respectively.

A calorimeter is a technique for measuring the thermal power produced by nuclear decay of any radioactive material. It is a non destructive assay for tritium quantification. Table 2 shows technical specifications for the calorimeter for KEPRI tritium lab.

Table 2. Technical specifications of tritium calorimeter

Range	1 mV ~ 26 W (324 mW/g·T)
Sensitivity	155 μV/mW
Measuring time	Less than 30 hours
Type	Dual cell symmetric heat flow
Measuring element	Peltier element

2.4 Tritium Monitoring System

There are many tritium monitors, a bubbler and a surface activity monitor for tritium monitoring and radiation protection at KEPRI tritium lab.. The tritium monitors made of ion chamber are installed to measure tritium concentrations in the room air, the glove box atmosphere, the tritium related systems, and the stack air. The sample flow rate through chamber of 1 L is 2 L/sec. The bubbler is the stack monitor to collect moisture from stack air. The HTO concentration of the moisture sample is measured by Liquid Scintillation Counter. The bubbler for the stack monitor is shown in Fig. 3.

KEPRI tritium lab. has a central tritium monitoring system to monitor in-air tritium levels at the lab. and to collect and storage the tritium data. The central tritium monitoring system consists of local ion chambers, a main system for data processing, and a display monitor.

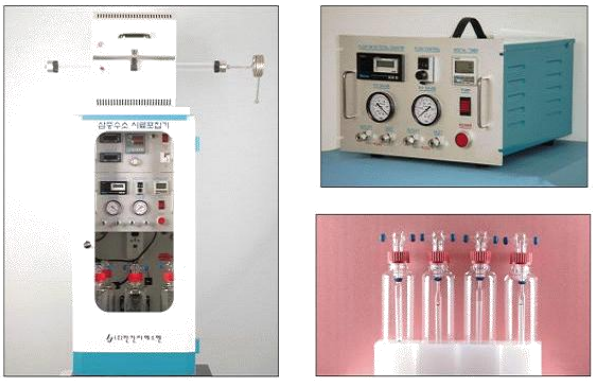

Fig. 3. Bubbler for stack monitor

3. Conclusions

The WTRF has been constructed to minimize the tritium inventory and emissions at Wolsong heavy water reactors. We expect to sell the recovered tritium for industrial uses and fusion research in the future. Then KEPRI is pushing the tritium application program to build up the laboratory infrastructure to support the tritium related R&D activities, and the tritium control and accountancy for tritium export. The KEPRI tritium lab. will have capabilities to receive, assay and dispense tritium to the various tritium related experiments. The detailed design of the tritium lab. is being developed and then the tritium lab. is scheduled to start operation in 2010.

REFERENCES

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