Design of GPM system for reusing high purity xenon gas

HyunWoo Jung[a,b] , Tran Thi Dung [a,c,], Dong Hoon Lee [b], BongHwan Hong [a], Seungwoo Park [ac*]
Korea Institute of Radiological & Medical Sciences, 75, Gongneung-ro, Nowon-gu, Seoul Korea
[b]Tongmyong Univ, 428, Sinseon-ro, Nam-gu, Busan, Korea
[c]UST, 217, Gajeong-ro, Yuseong-gu, Daejeon, Korea
*Corresponding author: swpark@kirams.re.kr

1. Introduction

^{123}I is a radionuclide for diagnosing thyroid cancer and ^{123}I is a radioactive drug that can produce various radiolabeled compounds. As the demand of patients grows every year, the amount of therapeutic agent increases. In addition, ^{123}I is essential when producting FP-CIT or mIBG, a radiopharmaceutical. ^{123}I, which is mainly used to diagnose thyroid cancer, is produced only at nuclear institutes and it is supplied to the domestic market. When workers are producing radiopharmaceuticals, introducing automation systems to reduce radiation exposure, safety can be ensured and radiopharmaceuticals can be manufactured with greater accuracy.

The GPM (Gas Process Manifold) is a preparation part for transporting high purity Xenon gas. It has a storage vessel and a cold trap. HCS (Helium Circulation System) uses helium to clean and cool each part. When a cyclotron is irradiated on a ^{124}Xe gas target system, a developed system can transfer Xenon gas from the GPM to the target through the use of a possible nuclear reaction. Each hardware part, was designed using SolidWorks. These parts were controlled by PLC, and each sensor was scaled using PLC. In addition, the GPM, located directly below the target, must be completed in a short period of time in case high radiation failure. Therefore, we have pursued the convenience of maintenance and turned PLC into a more safer interface by using PC Vue.

2. Design and Method

It is important to irradiate the target with radioactive medicines by irradiating the beam, but recovering high purity Xenon gas and ^{123}I are also important. If it can not recover the expensive Xenon, even if we produce the medicine and sell it, the deficit will occur and the preparation for the next production will be very slow. Therefore, the line design by process method is very important. The process was designed according to the following three processes (1) beam pre-irradiation, (2) beam irradiation, (3) post-production, and the gas target and gas process manifold's Xenon gas transfer process the line design is described.

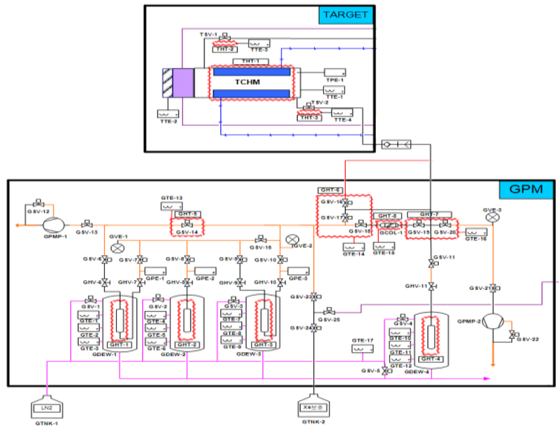

Fig. 2-1 Configuration diagram of GPM system

Xenon gas is stored in the GDEW-2 of Fig. 2-1 and then irradiated with beam energy of 30 MeV and 100 uA. After investigation, move to the same path as in Fig. 2-2 to recover the expensive high purity Xenon gas. It is important to remove any impurities in the gas before it is recovered and to recover all remaining gases in the line. In this study, Cold Traps for removing impurities are placed on both sides of storage vessel, which is high purity Xenon gas storage tank. Then, the cold trap is cooled by using liquid nitrogen and heater, and only the gas is stored in the cold trap by heating, and the impurities are sucked by using vacuum pump. The xenon gas with impurities removed is transported back to Storage Vessel and stored.

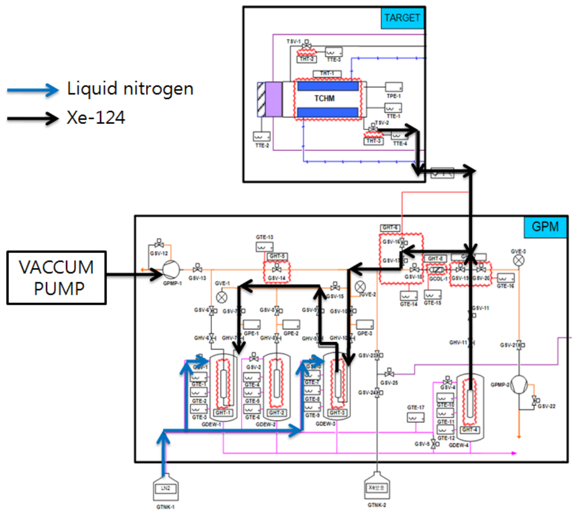

Fig. 2-2 Recovery path of high purity xenon gas

3. Results and Discussion

The most important thing when the high purity xenon gas moves from a GPM to a storage vessel or a cold trap is the degree of vacuum. The high purity xenon gas is heated from the target to the heater moves due to the pressure difference when moving to a storage vessel cooled with LN2 gas. So even with a little leaks, a significant amount of high purity Xenon gas will be in the GPM pipelines. Therefore, a vacuum test was performed to prevent this loss of high purity xenon gas.(Fig. 3-1) Vacuum tests were performed at the GPM portion using a rotary pump. The vacuum sensor was connected to three parts to test the degree of vacuum of each part.

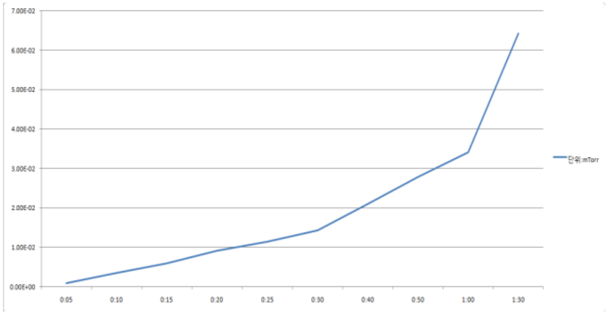

Fig. 3-1 Recovery path of high purity xenon gas

4. Conclusion

In the hardware, each pressure sensor, vacuum sensor, thermoelectric sensor, valve, etc. were arranged according to the required position, and the manufactured hardware was confirmed to have sufficient stability. The valves part required for the GPM (Fig. 4-1) were closed according to the process sequence of ^{123}I and the degree of vacuum was checked by pump, and a satisfactory degree of vacuum was obtained. The cold trap was cooled and heated, and only the gas was stored in the cold trap, and the impurities were sucked by the vacuum pump.

Fig. 4-1 Recovery path of high purity xenon gas

REFERENCES

[1] Mahunka, I. , Ando, L. , Mikecz, P. , Tcheltsov, A. N. , Suvorov, I. A. , Iodine-123 Production at a Small Cyclotron for Medical Use, JOURNAL OF RADIOANALYTICAL AND NUCLEAR CHEMISTRY, Vol.213 No.2 1996

[2] Lenz, J. , Gas target coupled density/proton heat load iterative CFD analysis for a Xe124 production target, Nuclear Instruments & Methods in Physics Research. Section A, Vol.655 No.1 2011

[3] Sumiya, L. C. , Sciani, V. , Evaluation of irradiation parameters of enriched 124Xe target for 123I production in cyclotron, Applied radiation and isotopes, Vol. 66 No. 10 2008

[4] Tárkányi F, Qaim SM, Stöcklin G, Sajjad M, Lambrecht RM, Schweickert H, (1991) Excitation functions of (p,2n) and (p,pn) reactions and differential and integral yield of 123I in proton induced nuclear reactions on highly enriched 124Xe. Applied Radiation and Isotopes, : 221-228.