The natural Xe gas transfer test for the ^{123}I production system using the enriched Xe-124 gas

HyunWoo Jung[a], KwonSoo Chun[a], Seyoung Oh[a], JunYong Choi[a], JaeJun You[a], SangKwon Bang[a], Byung Il Kim[a*]*
[a]Korea Institute of Radiologicaland Medical Sciences, 75, Nowon-ro, Nowon-gu, Seoul, 139-706 Korea
[*]Cocorresponding author:kimbi@kirams.re.kr ,kschun@kirams.re.kr

1. Introduction

In the ^{123}I nuclide production system consists of two parts: the loading process where the Xe gas is sent from the storage vessel to the target and the unloading process in which the Xe gas is sent back to the storage vessel. If there is a sufficient amount of Xe gas during the loading process, we can make a ready state to run the beam irradiation. Then the Xe gas in the target chamber goes though a nuclear reaction, which, through the breakdown and half-life, results in the iodine absorption in the target [1,2]. The remaining Xe gas is unloaded back to the storage vessel. After the unloading process, Iodine absorbed in the target chamber is retrieved through WPM(Wash Process Manifold). Once the retrieval is done, the remained moisture in the target chamber and system including valves and tubing was vaporized by the heaters and the rotary pumps; preparation for the next production is made [3]. In order to follow these procedures we tested the loading and unloading processes on the ^{123}I nuclide production system made by KIRAMS using Natural Xe gas [4].

2. Methods and Results

We use PLC to retrieve the needed data from ^{123}I nuclide production system, which we confirm and control at the PCVue.

We described two procedures: 1) testing loading the Xe gas from the storage vessel to the target and retrieving the Xe gas after the beam irradiation, and 2) drying the target system for the next production after retrieving ^{123}I using 500ml of distilled water.

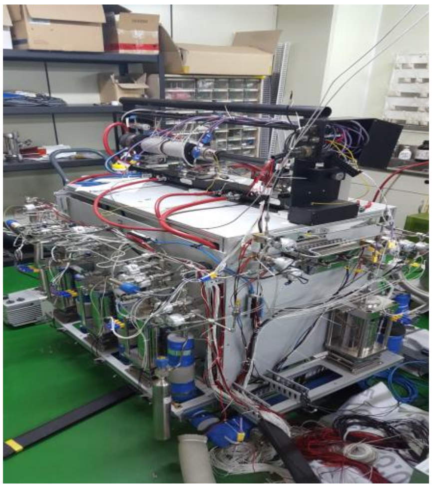
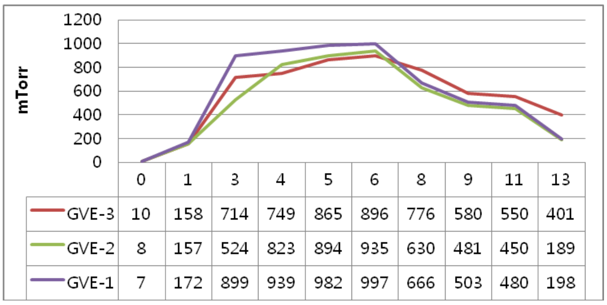


Fig. 1. KIRAMS I-123 Nuclide production system

2.1 Xe gas loading to target chamber

We use LN2 gas to transport the Xe gas to the target. The procedure consists of two parts. We do not directly inject the Xe gas into the target from the storage vessel; the long pipe pathway to the target enlarges the Xe gas volume, making it hard to deliver the sufficient amount of Xe gas [5]. Using the melting point of Xe gas, -117^{o}C, we cool the storage vessel and the loading vessel using LN2 gas, and heat the storage vessel to move the Xe gas to the loading vessel (Fig.3). We were able to confirm that most of the Xe gas moved to the loading vessel using the vacuum sensor. The values on the vacuum sensor started changing when only a minute passed since we started heating. The specific values of the vacuum sensor can be seen on Fig. 2; it is clear that after approximately 13 minutes, majority of the Xe gas transferred to the loading vessel.



	0	1	3	4	5	6	8	9	11	13
GVE-3	10	158	714	749	865	896	776	580	550	401
GVE-2	8	157	524	823	894	935	630	481	450	189
GVE-1	7	172	899	939	982	997	666	503	480	198

Fig. 2. Vacuum sensors value when the xenon gas to moved from the storage vessel to the loading vessel

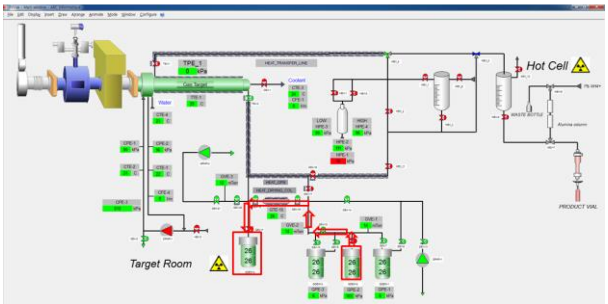


Fig. 3. Xe gas loading (storage vessel to loading vessel)

After confirming that most of the Xe gas transferred into the loading vessel, we heat the vessel to move the gas to the target. It took approximately 10 minutes to move the Xe gas from the vessel to the target.

Table I: Target pressure

Time(min)	TPE-1 Pressure
0	0 kPa
5	317 kPa
8	543 kPa
10	546 kPa

We did not use the GVE-3 sensor in this process to prevent the volume expansion from opening the GSV-20 valve that was needed to use the GVE-3 sensor. To keep the gas volume minimal, we closed the GSV-20 valve and used the pressure sensor to measure the amount of Xe gas. The 546 kPa from the TPE-1 sensor in Table I shows that sufficient amount of Xe gas transferred to the target. The actual amount needed for beam irradiation for the target is 320 kPa, which took approximately 5 minutes to reach.

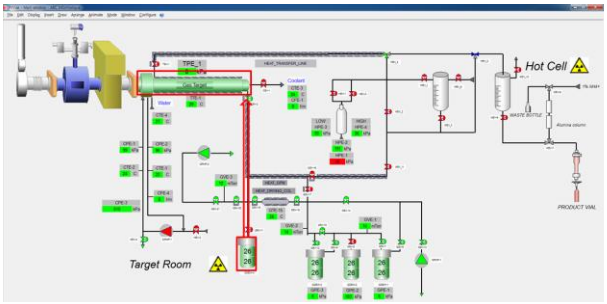


Fig. 4. Xe gas loading (loading vessel to target)

2.2 Xe gas unloading to storage vessel

The Xe gas unloading process is retrieving the Xe gas excluding the ^{123}I on the target wall to the storage vessel. The retrieval process was the exact reverse process of the loading process; we used Cold Trap to retrieve as much Xe gas as possible.

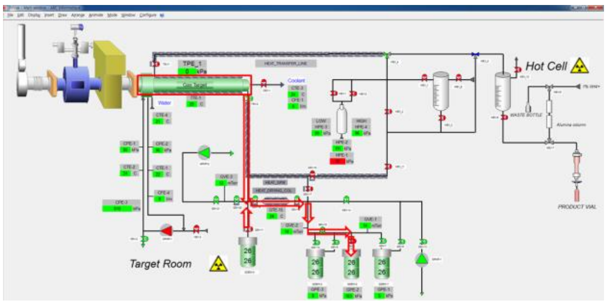


Fig. 5. Xe gas unloading (target to loading vessel)

Fig. 5 illustrates the retrieval process of the Xe gas to the storage vessel. The residual Xe gas from the loading vessel is retrieved during the beam irradiation and when retrieving the gas to the storage vessel after the irradiation we cool the vessel and open the TSV-2 valve to make a pressure difference, which in return transfers the Xe gas to the storage vessel. To retrieve any remaining gas along the line we used Cold Trap while using a pump to eradicate any unnecessary residues. The trapped Xe gas was safely transferred to the storage vessel. We were able to confirm that the final vessel's pressure was same as the initial amount of Xe gas.

3. Conclusions

In the ^{123}I nuclide production system, loading the Xe gas to the target is equally as important as retrieving the ^{123}I. In addition, unloading the Xe gas is also important in order to make the most use of the expensive Xe gas. Through the experiment we were able to conclude that the amount of Xe gas after the loading and unloading process was almost quantitative, and we were able to expect a lot of ^{123}I production through the sufficient amount of Xe gas, up to 546 kPa, in the loading process.

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