Transactions of the Korean Nuclear Society Autumn Meeting
Changwon, Korea, October 20-21, 2022

Current Status of Sr-82 Production Yield Improvement Using High Energy Proton Accelerator

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1. Introduction

The 1st and 2nd target irradiation experiments for the development of Sr-82 production technology using high-energy proton accelerators were conducted last year. [1] At that time, the operating conditions of the proton accelerator were 100 MeV of energy, 1~3 mA of peak current, 100 μsec of pulse width, and 1~2 Hz of repetition rate, and the irradiation time was 1~2.5 hours. The amount of Sr-82 obtained in the experiments were 2.0 and 43.4 μCi, and the separation and purification efficiency was 95.8% at maximum.

For animal PET imaging experiments, a generator having a concentration of several mCi or more is required, and for this, the production of Sr-82 at a higher concentration is essential. In this paper, the method applied to improve the production yield of Sr-82 and its results are mainly focused on.

2. Methods and Results

The factors that have the greatest influence on the yield of Sr-82 production are proton beam irradiation conditions and the amount of target material. This section describes the main methods applied to improve the Sr-82 production yield. The main contents are target improvement and long-time irradiation of the proton beam.

2.1 Target Improvement

As already mentioned above, under the same proton beam irradiation conditions, the production of Sr-82 is proportional to the amount of target. The target material previously used for Sr-82 production was 99.0% pure RbCl purchased from Alfa Aesar, and the size was 3 cm in diameter and 7.5 mm in thickness.

The previously used target cladding was designed and fabricated to contain one RbCl pellet. To improve the production yield of Sr-82, the design of the target cladding was changed to contain two RbCl pellets. As shown in Fig. 1 and Fig. 2, the design of the target cladding was changed so that the previously used RbCl pellet could be used without change.

According to the existing design, the energy of the proton beam incident on the RbCl pellet was about 52 MeV. As the design of the target cladding is changed, it is possible to obtain the effect of adding one more RbCl pellet to which a proton beam of about 90 MeV is irradiated.

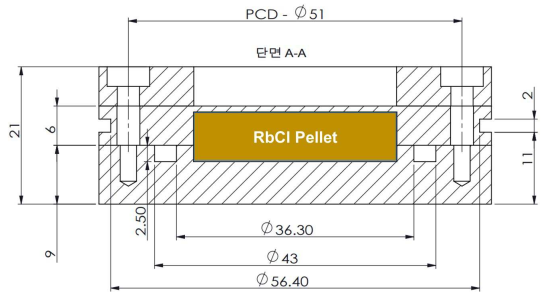

Fig. 1. Previous target cladding design for one RbCl pellet.

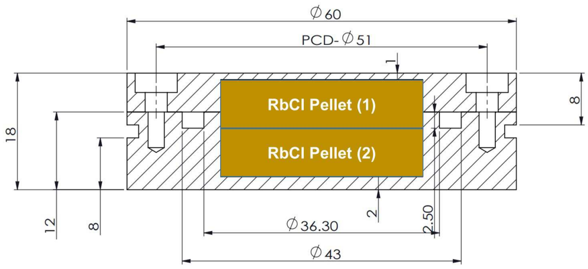

Fig. 2. Improved target cladding design for two RbCl pellet.

2.2 Long-Time Proton Beam Irradiation

Proton beam irradiation conditions on the RbCl target, such as beam energy, current, and irradiation time, are another important variable that determines the yield of Sr-82 production. In particular, since the production yield of Sr-82 increases in proportion to the beam current and the irradiation time, it is necessary to irradiate for a long time with a high beam current in order to obtain a high Sr-82 production yield.

Compared with the previous 1st and 2nd experiments, the peak beam current was increased 3 times to 3mA, the pulse width was increased 1.5 to 2 times to 300~400 μsec, and the repetition rate was changed to 5 or 10 Hz by increasing 2.5 or 5 times. In order to minimize the effect of radiation in the target handling and separation and purification process, it was divided into three targets, and the separation and purification procedure followed the established procedure. For the production of Sr-82/Rb-82 generators for animal experiments, Sr-82 made from these three targets will be collected and loaded onto a column.

Fig. 3 shows the profile of the beam irradiated to the target. The beam profile was measured using GafChromic film. The size and shape of the beam can be properly controlled, and the center of the beam tends to be somewhat biased upward, so it is necessary to make additional adjustments later.

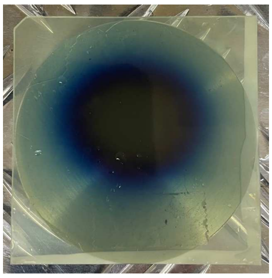

Fig. 3. The proton beam profile irradiated to the target.

The results of the experiments on the three targets are summarized in Table 1. As shown in the Table I, Sr-82 radioactive concentrations were 8.42 and 4.88 mCi at EOB and at the end of the separation and purification process, 20 days after EOB, respectively. The difference between the two values was mainly due to radioactive decay of Sr-82.

Table I: Experimental results for the three targets

Target	Irradiation Time [hrs]	Sr-82 Activity @ EOB	Sr-82 Activity* in 6M HCl
1	3	2.14 mCi	1.45 mCi
2	6	3.61 mCi	2.24 mCi
3	3	2.55 mCi	1.19 mCi
Total		8.42 mCi	4.88 mCi

* values measured at the time when the separate purification process is completed, 20 days after the EOB (End Of Bombardment)

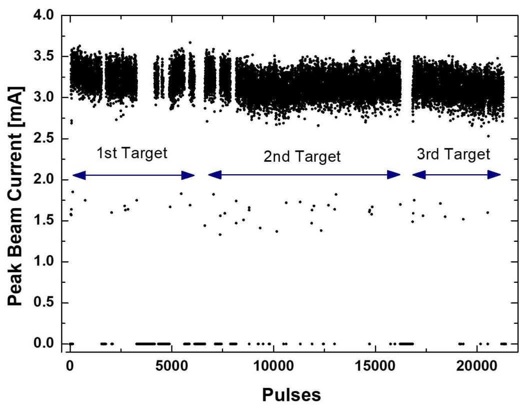

Fig. 4. Peak beam current trend during target irradiation time.

Fig. 4 shows the trend of peak beam current over a long target irradiation time. The beam current maintained a stable value between 3.0 and 3.5 mA.

3. Conclusions

To obtain Sr-82 required for the fabrication of several mCi Rb-82 generators available for animal PET imaging, target cladding and target irradiation conditions were improved and long-time target irradiation allowed Sr-82 to produce concentrations more than 100 times higher than before. The obtained Sr-82 radioisotopes were used in the production of the generator column.

ACKNOWLEDGEMENT

This work was supported by MSIT (Ministry of Science and ICT) and by the National Research Foundation of Korea (NRF) under Grant number NRF-2017M2A2A2A05016601. The authors would like to thank Dr. Yeong-Su Ha, who collaborated to develop a cold model process for the separation and purification of Sr-82.

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