Design of Solid Targetry System for the Isotope Production at KOMAC

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1. Introduction

Korea multi-purpose Accelerator Complex (KOMAC) has a plan to construct the new proton beam irradiation facility for the production of radioisotopes. Sr-82 and Cu-67 were selected as the target isotope in this facility, they are promising isotope for the PET imaging and cancer therapy. To produce Sr-82 by 100-MeV proton irradiation, RbCl were chosen as a target material due to their high melting point and easy separation [1].

For the facility construction, we have designed targetry system which consists of target, target transport system and target cooling system. This paper describes the details of targetry system.

2. Methods and Results

2.1 Target Design

The conceptual design of targetary system is shown as Fig.1. Target stacks consist of the RbCl target for the Sr-82 production, which were capsulated by stainless steel cladding and the dummy target for the stopping the incident proton beam, which was made of aluminum metal disk. Target stacks are supported and cooled at inside of target holder.

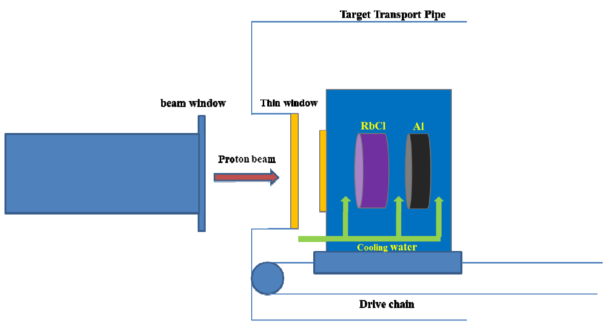

Fig.1. Conceptual design of Targetary

To design RI target, we have derived the optimum thickness of target materials considering the beam energy loss by the beam window, cooling water and target claddings through SRIM calculation [2].

First we fixed the thickness of the STS beam window, each cooling channel and target capsulations as 0.5 mm, 5 mm and 0.3 mm. and then, we optimized the thickness of RbCl and dummy target by using the iterative SRIM calculation.

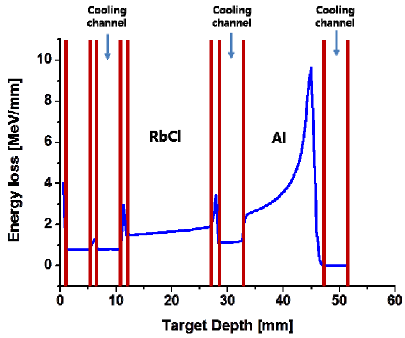

Fig. 2.Target thickness considering energy loss

Table 1.Material and thickness of RI target

	Layer	thickness [mm]	Energy [MeV]
1	Beam window (AlBeMet)	0.5	~ 99.39
2	Air gap	100	~ 99.3
3	beam window (SUS)	0.5	~ 97.25
4	Water gap	5	~ 93.43
5	beam window (Al)	0.5	~ 92.6
6	cooling water	5	~ 88.64
7	SS cladding	0.3	~ 87.31
8	RbCl	16	~ 60.51
9	SS cladding	0.3	~ 58.8
10	cooling water	5	~ 53
11	Al dummy	14	~ 0
12	cooling water	5	0

2.2 Target cladding fabrication

RbCl pellet was made by first vacuum drying RbCl powder for at least 24 hours and then pressing this powder in a mold with 300 ~ 380 MPa pressure to achieve the theoretical density. This RbCl pellet is encapsulated in stainless steel cladding with o.d. of 60 mm and i.d. of 50 mm with 0.3 mm window. To prevent the leakage of the radioactive species inside target, the cladding is fabricated by laser welding. Figure 3 shows the fabricated RbCl pellet and the welded target cladding.

Fig. 2. The fabricated RbCl pellet and target cladding

2.3 Target carrier design

The RI targets are mounted inside the target carrier for their transportation from hot-cell to target irradiation chamber. Inside of target carrier, there is cooling water gap between two targets. And then, the fast water flow can induce vibration of target stack. Thus the fabricated target stacks have to be mounted robustly at the target holder.

This fabrication of target stack is conducted in the processing hot-cell remotely for the radiation safety. These fabricated target stacks are should be transported from Hot-cell to irradiation chamber for the proton beam irradiation. Thus target stack have to be mounted in the target carrier. Figure 4 shows designed target carrier and their fabrication concept.

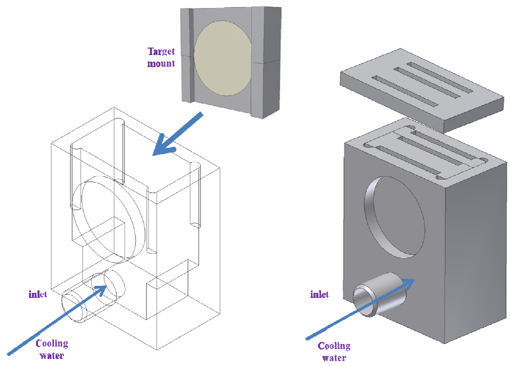

Fig. 4. Target carrier and Fabrication

2.4 Target transport system

Figure 5 and 6 describes the conceptual design of the target transport system. For the transportation of target carrier between the hot-cell and irradiation chamber, target carrier is driven by the motor with chain and sprocket system thorough the target transport pipe. The oscillations of target carrier during its motion are controlled by constraining by two guide rail which attached inside of transport pipe.(Fig. 5 and 6) All structural materials are stainless steel due to the transport pipe is filled with deionized water.

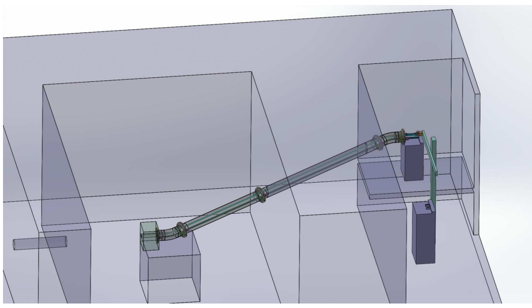

Fig. 5. Configuration of target transport system

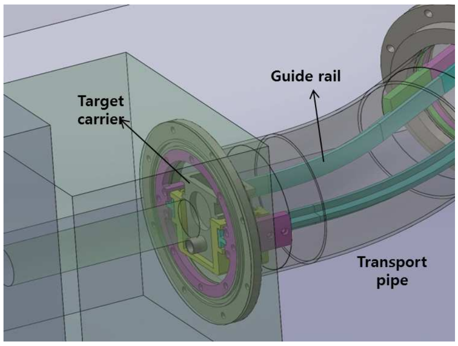

Fig. 6. The detailed view of target transport mechanism

2.5 Cooling system

For the target cooling, the flow rates of coolant are 85.7 L/min and the coolant was selected the de-ionized water to prevent the corrosion. The cooling system consists of air-cooled chiller, water purification filter and dissolved oxygen remover (Fig. 7.).

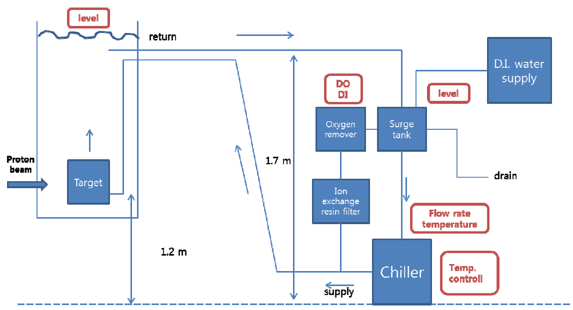

Fig. 7. The Schematic drawing of cooling system

3. Conclusions

In this paper, we described the design of the solid targetry system for the isotope production by using the 100-MeV proton irradiation. For Sr-82 production, RbCl target and aluminum dummy target was prepared. These target stacks are contained in the target carrier, which could transport by drive chain and guide rail system.

Acknowledgements

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