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Status of RI Production Facilities using the Proton Beam in KOMAC

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1. Introduction

Korea Multi-purpose Accelerator Complex (KOMAC) has the high-power linear proton accelerator. KOMAC is operating 6 target rooms of the pre-designed 10 target rooms: one is included in a 20-MeV and the others are included in 100 MeV beam lines. One of applications using the proton accelerator is the radio-isotopes production. One which is called as TR101 of 100 MeV target rooms has the plan to produce radio-isotopes (RI). This beam line has been developed at KOMAC in 2015. And the commissioning of this beam-line was started with operation license for a maximum 30 kW beam power in 2016. The RIs considered to be produced at KOMAC as the initial step are a Sr-82 which can be produced from RbCl target, and a Cu-67 which can be produced from Zn or ZnO target. [1] In order to produce the RIs, we are planning three facilities and their operation licenses are going on separately. They consist of follows: one is the facility for a utilization of RI, other one is the facility for a proton beam irradiation with the specialized target and last one is the facility for RI purification from the irradiated target. KOMAC already got the permissions of the operation for the RI utilization and the beam irradiation facility. Their construction has been also finished, but the separate purification facility is remained.

2. Major Facilities for RI production at KOMAC

The layout of the major facilities for RI production is shown in Fig. 1 at KOMAC. The proton beam irradiation facility for RI production and RI purification facility are located in the accelerator building due to continuum process.

Fig. 1. Layout of the major facilities for RI production at KOMAC

2.1 Proton Beam Irradiation Facility

The specification of the RI beam line is shown in Table 1, and its layout and major component picture is shown in Fig. 2. [2]

The proton beam irradiation facility consists of the beam transport system, the hot cell, the target transport system, and the target cooling system.

A beam transport system has bending magnets, beam diagnostics and beam window. The two sets of a proportional type counter were installed before and after the bending magnet as a beam loss monitor, and the beam window with 0.5 mm thickness was installed to isolate target cooling water from beam line vacuum. As shown in the middle of a right of Fig. 2, a target chamber is located after the beam window and an iron shielding for fast neutron is installed at the end of the target chamber in the target room.

A target for the RI production is seated in the target holder, which is moved into the target chamber using the target transport system from inside a hot cell. The target transport system has a 200 mm diameter pipe, inside of which is filled with the circulating deionized water and the guide rail to drive the target holder. The deionized water is a role for shielding of a prompt neutron, and target cooling.

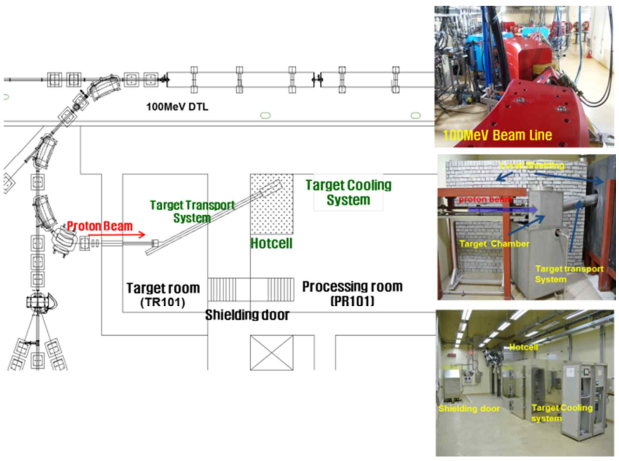

Fig. 2. Layout of the RI beam line

A hot cell has two cells with 15 cm thickness of lead wall and 380 mm lead glass windows: one cell is used for sitting the target into or removing it out from the target holder, the other is for target handing or moving to the separate purification facility. The hot cell is shown behind the cooling system in the bottom of a right of Fig. 2.

Table I: Specification of the RI Beam Line

Parameter	Value
Energy [MeV]	103
Peak current [mA]	20
Rep. rate [Hz]	30
Ave. current [uA]	300
Pulse width [us]	500
Target Dia. [mm]	100
Beam window	AlBeMat

2.2 RI utilization Facility

RI utilization facility has the plan to use not only the two RIs produced at KOMAC also but H-3 and P-32 to study on a biological effect by radio-isotopes and to develop radioactive labeling compounds.

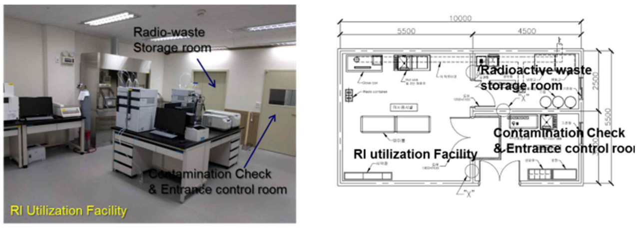

Fig. 3. Layout of RIs utilization facility

3H-thymidine is used to measure a cell proliferation. Chromic phosphate P-32 is used to treat cancer or related problems. All chemical processing for an open radioactive source is handled inside a RI hood. According to the processing sequence for RI, it was placed a radio-TLC scanner for RI labeling check, a gamma counter for nuclide analysis, a dose calibrator for activity amount measurement, a centrifugal separator, CO_2 incubator, a clean bench, and etc. This facility separates into three zones according to their use: RI utilization zone, radioactive waste storage zone and entrance and contamination check zone.

2.3 RI Purification Facility Plan

The most important thing in designing the RI purification facility is the prevention of spread of a contamination to other clean zones. The RI purification facility will be operated with a separate entrance and management system to distinguish it from the other areas where a sealed radioactive isotope or a radiation generator is used in the accelerator building. In order to separate the air condition of the RI handling area, the air of its area should be exhausted separately to prevent air from flowing back to the existing facility.

The concept of air conditioning for each zone is shown in Fig. 4. Dampers are installed in each area to control the amount of air supply and exhaust, so that the air conditioning amount can be adjusted in order to prohibit an air flow back in each area. The differential pressure gauges are installed between Zone A and Zone B, and between Zone B and Zone C, so that the differential pressure between each zone can be checked.

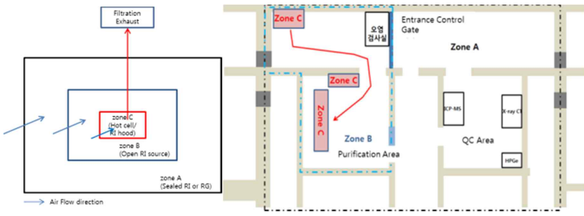

Fig. 4. Purification area for RI production

This facility is underway to be reviewed in safety aspects for the operation license by KINS (Korea Institute of Nuclear Safety). After the license has been gotten, a chemical process and related devices would be developed.

3. Radiation Safety Consideration

Radiological impact assessments were studied on each facility for RI production. Based on this assessment, a radiation safety report was drawn up, reviewed by the national authority institution, KINS and the beam irradiation facility in 2016 and RI utilization facility in 2017 respectively are already approved.

The licensing for the purification facility is underway as of 2018, and the results of radiological impact evaluation are summarized as follows. The equivalent dose for external exposure is less than 2.3 mSv per year. It means that the value to be taken through the whole process, but not means to be taken to one person. And as an aspect of internal exposure evaluation, the result is also below 0.74% of the derived air concentration by regulation.

4. Conclusions

The facilities for RI production of KOMAC were developed. The main facilities are the beam irradiation facility, the RI utilization facility, and RIs purification facility. The beam irradiation facility and RI utilization facility are already got the permission license of the operation. Their construction has been also finished, but the separate purification facility construction is remained. Its operation license for RI production permission and a purification process development are underway.

ACKNOWLEDGMENT

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