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The Optimizing Study for Separation Process of ^{64}Cu from ^{67}Ga Waste Product

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1. Introduction

The radioisotope of ^{64}Cu is suitable for applications [1] in both PET imaging and targeted radiotherapy owing to its unique decay scheme, which combines EC (41 %), β^--decay (49 %, E_max: 0.57 MeV), and β^+-decay (19 %, E_max: 0.66 MeV). A long enough half-life of 12.7 h with its annihilation radiation (0.511 MeV) makes it to study the kinetics of small and large molecular carriers with PET imaging and it is also considered as therapeutic potential due to Auger electron emission. The production of ^{64}Cu is readily achieved by proton bombardment on Ni coated on the copper plate target or chemical separation from ^{67}Ga waste products. In this study, it was found out that a reasonable quantity of ^{64}Cu is co-produced during the production of ^{67}Ga from enriched ^{68}Zn including many other radioisotopes (see table 1). Using anion exchange method, the chemical separation of ^{64}Cu from the waste products of ^{67}Ga is carried and report about hundred milicuries of ^{64}Cu could be achievable within 1 hour after EOB.

Table 1. Characteristic gamma-ray emissions for co-produced radioisotopes

Isotope	Emission (abundance, %)
^{67}Ga	93.3(38.0), 184.6(24.0), 300.0(16.0)
^{67}Cu	91.3(7.0), 93.4(16.0), 184.5(40.0)
^{57}Ni	127.3(15.0), 511, 1377.6(84.9)
^{57}Co	122.1(85.2), 136.5(11.1)
^{55}Co	477.2(16.0), 931.0(73.0), 1048.3(18.0)
^{64}Cu	**511, 1345.8(0.48)**

2. Methods and Results

2.1. Co-products of several radioisotopes during ^{67}Ga production

The ^{68}Zn target material was plated onto a nickel coated copper target [2]. The ^{67}Ga was produced via the ^{68}Zn(p,2n) ^{67}Ga reaction using a 200 uA beam of 30 MeV protons for 9 hours. After irradiation, the ^{67}Ga was separated from the ^{68}Zn target. The washed solution (called after "waste") 350 ml of the eluent contains a majority of the radioactive by-products (shown in Table 1), which was used in the present study. The solution was heated to evaporate and dissolved in 0.2M HCl in 96 % methanol and then transferred onto an anion exchange column. A gamma-spectrometer with HP Ge(Li) detector coupled to PC-base MCA was taken from the solution as shown in fig.1, corresponding to characterized their emission and abundance for each product given in table 1.

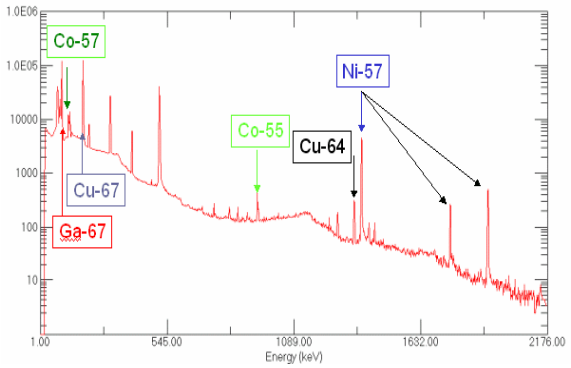

Figure 1. A spectrum obtained from the waste of products after dryness. Gamma spectrometry of the ^{67}Ga waste showed that ^{55}Co, ^{57}Ni, and ^{57}Co, as well as $^{67/64}$Cu are co-produced during the ^{67}Ga production. An established method was used both in the separation of these radioisotopes from the ^{67}Ga production and the purification of the ^{68}Zn target material [2].

2.2. Separation of ^{57}Ni, $^{55/57}$Co and ^{64}Cu from the waste solution

The separation method of metals with aqueous HCl solutions and anion exchange resins is well established [3]. For the separation sequence of ^{64}Cu from other radionuclides, similar procedures are employed– the metals forming anionic complexes are adsorbed on the anion exchange resin at high HCl concentration and eluted progressively with acid solutions.

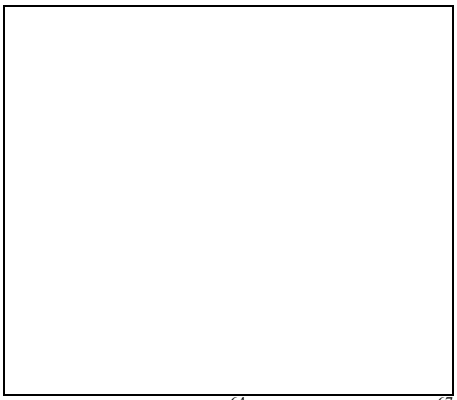

Figure 2. A sequence of ^{64}Cu separation from ^{67}Ga waste solution.

The schematic steps for the chemical separation of ^{64}Cu from the waste solution are shown in fig.2. First, the separation of ^{57}Ni and $^{55/57}$Co was achieved by successive washed of 0.2 M HCl in 96 % methanol (30 ml) and 1.3 M HCl in 55 % isopropyl alcohol (30 ml), respectively. Then the $^{64/67}$Cu was eluted using 0.5 M HCl in 50 % isopropyl alcohol (30 ml), typical elution profile is shown in fig. 3

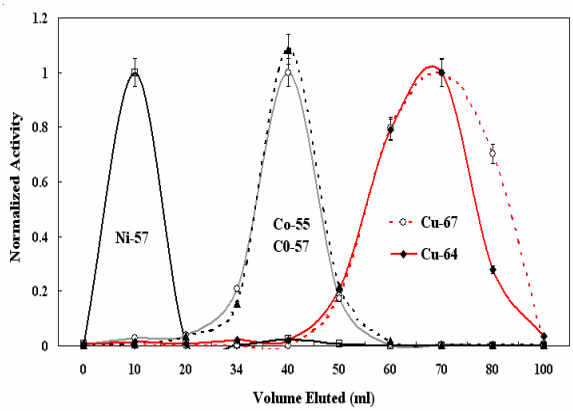

Figure 3. Separation of radioisotopes from ^{67}Ga waste using anion exchange method

3. Results and discussion

The reasonable amount of ^{64}Cu (120 mCi) is expected to achievable with the present method at EOB. Figure 4 shows the gamma spectrum obtained from the final separated product, which indicates only copper nuclides of ^{64}Cu and ^{67}Cu and the rest of metals are removed completely. However, it is unable to separate from ^{64}Cu and ^{67}Cu. The production rate of ^{64}Cu is to be estimated about 500 mCi and the separation yield is estimated to 24 %, which has to be enhanced by optimized process.

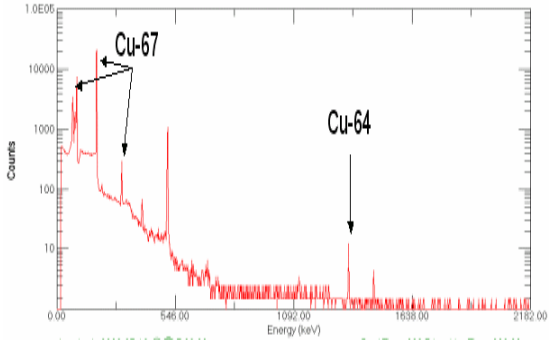

Figure 4. The gamma spectrum obtained after separation. Copper radionuclides were separated from other metals.

Several factors are should considered to improve the quantity of products and to apply waste management with more convenient method. During the separation of the ^{64}Cu, the processing time required to evaporate the waste solution, which contained highly radioactive nuclides has to be reduced for protecting the operator and preventing the losses by natural decay. With these reasons, an optimized automatic system is proposed as indicated at Fig. 5.

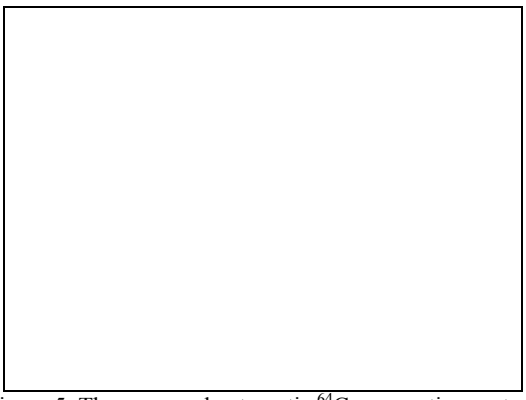

Figure 5. The proposed automatic ^{64}Cu separation system

The variation in separation yields of ^{64}Cu radioisotopes extracted from the waste solution of ^{67}Ga is believed to be largely dependent on the HCl concentration and the loading cation exchange column during the process. The optimized condition has to be studied more for the next step.

Acknowledge

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