Mass Production of ^{64}Cu with $^{64}Ni(p,n)^{64}Cu$ Nuclear Reaction

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Introduction

^{64}Cu ($T_{1/2}$ = 12.7h, β^- decay: 40%, β^+ decay: 19%, E.C. decay: 41%) is one of the most useful radioisotope in nuclear medicine due to its multiple decay mode and the intermediate half-life. Several nuclear reactions, i.e., $^{64}Ni(p,n)^{64}Ni$, $^{68}Zn(p,\alpha n)^{64}Cu$ and $^{64}Ni(d,2n)^{64}Cu$ have been investigated for ^{64}Cu production[1,2]. The highest production yield could be obtained with proton irradiation on the enriched ^{64}Ni target. Therefore for mass and routine production, the ^{64}Ni target fabrication by using electroplating[3], the reliable chemical separation of ^{64}Cu from the irradiated ^{64}Ni target and the effective recovery process for the recycling of very expensive enriched material (^{64}Ni enrichment : 96%, $20,000/g) and so on are absolutely necessary to be established. In this work, we report our mass production method of ^{64}Cu with enriched ^{64}Ni and Cyclone-30 accelerator.

Methods

^{64}Cu was produced with high current cyclotron via $^{64}Ni(p,n)^{64}Cu$ nuclear reaction at 200μA, 18MeV proton beam. Nickel target was prepared by electro-plating of enriched ^{64}Ni (25% of enrichment) on Au coated Cu cooling plate. After proton beam irradiation, Ni target was dissolved with circulation of 50ml of 5N HCl on the dissolving device (home made) and 90°C heating. Water was added to ^{64}Ni solution to dilute the normality of hydrochloric acid to 0.5N. Radiochemical separation of ^{64}Cu from Ni target solution was performed with 0.01% dithizone in CCl_4 solvent extraction and back extraction with 7N HCl[4]. Purification of back extracted ^{64}Cu solution was carried out with AG1-x8 (Bio-Rad) anion exchange resin. For ^{64}Ni recycling, ^{64}Ni from the aqueous phase of solvent extraction and the electrolyte of electroplating was recovered by using AG1-x8 anion and AG50w-x8 (Bio-Rad) cation resin[5].

Results

With the electroplating cell designed by ourselves and the electrolyte, consisting of 1.5g ^{64}Ni(25% enrichment), 1.0g boric acid and 2.0g NaCl in 90ml distilled water, the smooth and uniformed Ni target (thickness : > 50mg/cm^2, area: 1 x 10cm^2) was obtained with applying 200mA of constant current on the cathode for 5hrs. The cathode current efficiency was about 50%. There was no damage on Ni surface during more than 200μA proton beam irradiation. The chemical separation yield of ^{64}Cu with solvent extraction and anion exchange resin was more than 90% and the radionuclidic purity was more than 99% 1 day after bombardment. The ^{64}Ni recovery yield was quantitative and measured with ^{57}Ni activity produced with $^{58}Ni(p,2p)^{57}Ni$ nuclear reaction and AA spectroscopy.

Conclusion

^{64}Cu production yield was about 9mCi/μAh corrected on 96% enrichment at EOB with $^{64}Ni(p,n)^{64}Cu$ nuclear reaction and Cyclone-30. The chemical separation yield and the radionuclidic purity of the final ^{64}Cu solution was more than 90% and 99%, respectively. The ^{64}Ni recovery yield performed with ion exchange resin was more than 98%.

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