Isolation of ^{76}Br from irradiated $Cu_2{}^{76}Se$ targets using dry distillation: evaluations and improvement for routine production

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Introduction

^{76}Br is of interest for *in vivo* PET imaging applications. Its relatively long half-life (16.1 h) allows use not only on small molecules but also proteins which have slow excretion as carrier molecules. Irradiation using a low energy proton beam (~ 20 MeV) on an enriched $Cu_2{}^{76}Se$ target, followed by dry distillation with thermal chromatography, is one of the best methods to obtain sufficient amounts of ^{76}Br for clinical applications[1,2]. However, the thermal chromatography is plagued by poor reproducibility and appears unsuitable for automation of its production, leading us to remove the thermal chromatography from the dry distillation. In this investigation we employed H_2O solution to collect ^{76}Br and optimized the distillation condition using a small amount of ^{77}Br (57.0 h). We also produced large amount of ^{76}Br under the optimized conditions to evaluate the dry distillation method.

Material and Methods

Target preparation and dry distillation were conducted based on the methods described in previous reports[1,2]. To produce ^{77}Br, $Cu_2{}^{nat}Se$ target was irradiated with 20 MeV proton beams (5 µA) accelerated by AVF cyclotron in the Japan Atomic Energy Agency. The following two systems were used in the dry distillation optimization studies; (1) an initial system was composed of two furnaces, a main and an auxiliary furnace. Temperature of each furnace was set at 1050 °C (main) and 200 °C (auxiliary) respectively; (2) the second system was made of one large furnace composed of heating and cooling area. Temperature of the heating area was varied from 1050 to 1120 °C. In both systems PTFE tubing, leading to a H_2O solution (15 mL), was inserted into the apparatus. The irradiated target was heated under streaming Ar gas (30 mL/min.). An enriched $Cu_2{}^{76}Se$ target (^{76}Se enrichment: 99.67%) was used for ^{76}Br production. Radioactivity was measured on a high-purity germanium (HPGe) detector coupled to a multichannel analyzer. TLC analyses were conducted on Al_2O_3 plates (Merck) using 7:1 acetone:H_2O as the eluting solvent.

Results and Conclusion

Low efficiency (33 %) of ^{77}Br recovery was observed in the initial system. Distribution of radioactivity inside the apparatus showed that 35 % was trapped in the PTFE tube and the quartz tube. The recovery yield was increased up to 54 % when the auxiliary furnace was turned off, indicating that the temperature gradient inside the quartz tube is suitable to carry ^{77}Br effectively to the H_2O trap. We initially used a quartz boat to place the irradiated target in the furnace, but found that using a reusable tungsten backing was better (FIG. 1a). However, we found that recovery yield was dramatically reduced to 18 %. The studies where the temperature was varied showed that releasing efficiency was increased up to 100 % at the temperature of 1120 °C. Good recovery yield (~ 77 %) was achieved after optimizing the temperature gradient (FIG. 1b). Using the optimized setup, ^{76}Br production runs (n = 6) have been conducted, allowing us to recover up to 39.8 MBq/µAh (EOB) of ^{76}Br. High specific activity (~4400 GBq/µmol) was obtained in the final solution. TLC analysis showed that chemical form obtained was bromide. We concluded that the dry distillation using H_2O trap is capable of providing enough high purity ^{76}Br for clinical applications.

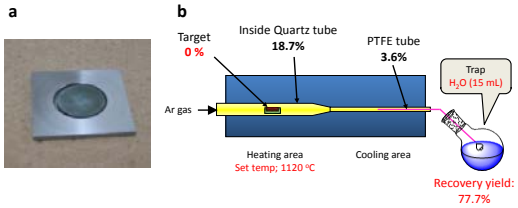

FIGURE 1. a) Cu_2Se target put in a tungsten backing; b) Illustration of optimized dry-distillation apparatus and distribution of radioactivity

References

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