Improvement in the chemical yield of purified ^{109}Cd for fee-based distribution at the RIKEN AVF cyclotron

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Since October 2007, we have distributed fee-based ^{109}Cd ($T_{1/2}$ = 469.4d) ,produced via the ^{109}Ag(d,2n)^{109}Cd reaction using the RIKEN AVF cyclotron, to the general public.[1] After irradiation, ^{109}Cd was chemically separated from the Ag target and reaction byproducts. We have employed a separation method involving AgCl precipitate and anion exchange in HCl.[2] However, a considerable percentage of the produced ^{109}Cd tends to be lost by inclusion and adsorption on the AgCl precipitate in this method. F. W. E. Strelow[3] and M. K. Das[4] applied another technique using hydrobromic acid (HBr) for ^{109}Cd separation. Better chemical yield could be expected because the precipitation step was not required in this method. In order to improve the chemical yield for ^{109}Cd separation, we studied a similar technique using anion exchange in HBr without AgCl precipitation for the chemical separation of ^{109}Cd from the irradiated target in the present work.

Cadmium-109 was produced by irradiating a silver plate in natural isotopic abundance (chemical purity: >99.99%; size: ø15 mm; thickness: 0.6 mm) using a 24-MeV deuteron beam from the RIKEN AVF cyclotron. The irradiation time was 37 h, and the average beam intensity was 9 μA. During the irradiation, the target was continuously cooled with helium gas and water.

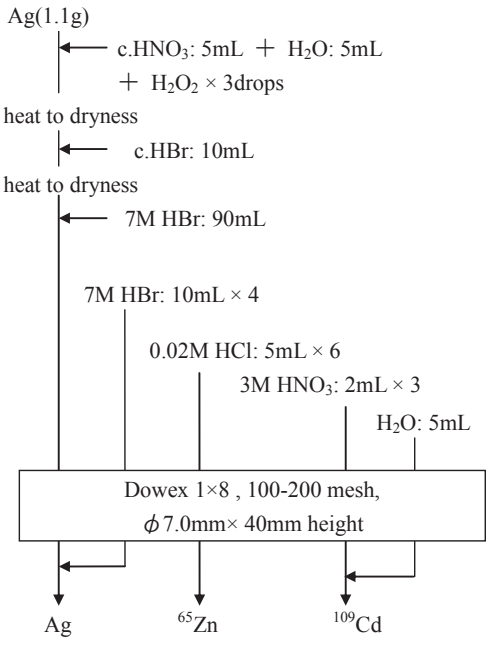

Fig. 1. Chemical separation scheme for ^{109}Cd.

After the irradiation, ^{109}Cd was chemically separated from the Ag target according to the procedure shown in Fig. 1.

The Ag target was dissolved in 5 mL of concentrated nitric acid, 5 mL of water, and three drops of hydrogen peroxide solution. The solution was evaporated to dryness. The residue was dissolved in 10mL of c. HBr. This solution was also evaporated to dryness. The residue was dissolved in 90 mL of 7 M HBr. This 7 M HBr solution was passed through the anion-exchange column (ø7 mm × 40 mm height) packed with Dowex 1X8 (100–200 mesh, Cl^- form). ^{109}Cd was adsorbed on the resin, and Ag was eluted. Then the column was washed with 7 M HBr and 0.02 M HCl. ^{109}Cd was adsorbed on the resin and the unwanted ^{65}Zn was eluted. Finally, ^{109}Cd was eluted with 3 M HNO_3 and H_2O.

The present results are shown in Table 1,together with those obtained in our previous study. The specific radioactivity and radionuclide purity were measured by γ-ray spectrometry using a Ge detector. The chemical impurity was also estimated by ICP-MS for a control sample treated using the same chemical process as the irradiated Ag target. Chemical impurities were found to be 57 ppm for S and 87 ppm for Ca. The others were below 10 ppm. As shown in Table 1, the chemical yield obtained in the present work was significantly improved from 80% to 98%.

Table1. Comparison of the results of the ^{109}Cd purification between our previous[2] and the present work.

	Our previous work	This work
Chemical yield (%)	80	98
Specific radioactivity[*1] (MBq/μg)	94	93
Decontamination factor of Ag	3×10^6	7.6×10^6
Radionuclidic purity	>99.9%	>99.9%

*1 (Beam intensity :10 μA, irradiation time: 48 h)

References

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