

Determination of ^{129}I in Simulated Radwastes Using Anion-Exchange Resin

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1. Introduction

There is a growing consensus that the regulation of nuclear waste management of alpha or beta decay nuclides such as ^{129}I has to be emphasized, and that a selection basis has to be made in terms of a disposal program of nuclear waste generated from a nuclear power plant and other nuclear facilities.

Generally, concentration of difficult-to-measure (DTM) radionuclides, such as ^{129}I , contained in nuclear wastes generated from nuclear power plants can be predicted from the scaled factor ($^{129}\text{I}/^{137}\text{Cs}$, $^{129}\text{I}/^{60}\text{Co}$) by measuring the radionuclide instead, such as ^{60}Co , ^{137}Cs which are relatively easier to measure. Therefore, the activity of ^{129}I has to be measured accurately in order to calculate the scaling factor (radioactivity ratio of ^{129}I and ^{137}Cs) in relation to the activity of the standard nuclide. The latter will then be used as described above. However, the radioactivity ratio of ^{129}I to ^{137}Cs varies widely, owing to many different classes of radioactive waste forms generated from nuclear power plants. Consequently, it can be concluded that a trustworthy chemical analysis is required to determine the characteristic scaling factors for each plant [1].

Xiaolin Hou et al. washed the samples with a KHSO_3 solution of 0.5 M and distilled water to measure the iodine content in natural water and seawater. I_2 and I^- were then separated from the other interfering ions using an anion exchange resin column (AG1-X4, Cl^- form) [2].

2. Experimental

5 g of a simulated radwaste, 5 mL of a phosphate buffer solution (pH 7) and 20 mL of distilled water were added into a plastic beaker containing 5.0 g of the anion exchange resins (AG 1-X4, 50-100 mesh Cl^- form). The resin solution was prepared and allowed to stand for 12 hours to wait for complete absorption into the resin. Next, 100 mg of KI were added to the solution, and the resin was transferred into a plastic column. 8 mL of a 7 % NaClO solution (oxidant) passed through the column, and the same procedure was repeated 2 times. The eluent was then

collected in a vial, 1.25 mL of 65% HNO_3 was added, and finally, the reducing agent (1000 mg, $\text{NH}_2\text{OH}\cdot\text{HCl}$) was added into the eluent solution. After the solvent extraction procedure was conducted with separatory funnel in which 35 mL of CHCl_3 contained was shaken for 3 minutes, the organic phase was separated and collected in a vial. After adding 5 mL of the 0.2 M NaHSO_3 solution into the separated organic phase, the solution was back-extracted to the aqueous phase. A precipitate formed by 0.2 M AgNO_3 in an aqueous phase went through an aging process for 5 minutes. After the centrifuging process, the final sample was now transferred to a planchet, and dried below 70°C . Its activity is measured for 10,000 seconds with a low energy photon spectrometry system.

3. Results and discussion

3.1 Optimum chemical condition for the separation and recovery of non-radioactive iodine

The recovery rate of iodine as a function of acidity (on the variation of pH in the eluent) was measured to find the optimum chemical conditions for the separation of non-radioactive iodine. The recovery rate of iodine was measured, while the acidity of the sample was controlled in the range between 0.0 and 1.6 M.

Fig. 1 shows the results of the optimum concentration of the acid for the extraction process with an organic solvent. The concentration range between 0.4 and 1.2 M provides the highest recovery rate, and the NaClO solution was used as an eluent to extract the iodine absorbed on the anionic resin. This may be due to the oxidation of iodide ions, under the high acidity condition, to non-volatile oxyiodate such as IO_3^- or IO_4^- , which are not extracted into the organic layer.

Fig. 2 shows the analytical results of the effect of the eluent concentration in the range of 2.0 ~ 12.0 % on the iodide recovery, using a column elution method. As shown, the concentration range of 8~10.0 % for NaClO was found to be suitable for the best elution of iodide from the anionic column.

3.2 Recovery rate of iodide by stage using ^{125}I tracer

Several stages of the separation process including oxidation, adsorption, elution, reduction, and extraction, were required to analyze quantitatively the iodine present in a concentrated liquid waste sample. Some contents of the iodine can be lost through various separation processes of physical or chemical reactions owing to its high volatile property. In this study, the recovery rate of iodine for each separation process was measured using a radioactive iodine isotope tracer added into the starting sample at the initial step to compensate for the calculation of the total recovery rate of iodine.

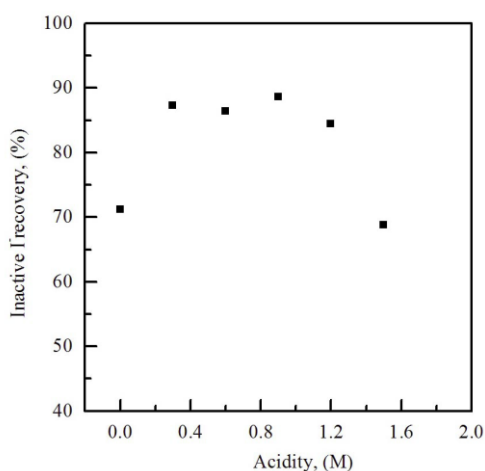


Fig. 1. Effect of Acidity on the Recovery of Iodide.

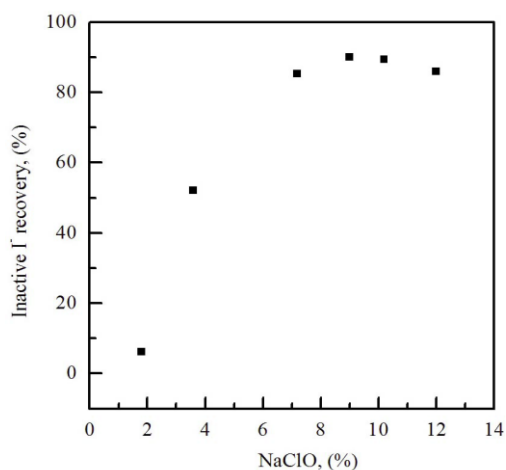


Fig. 2. Effect of Concentration of Eluent on the Iodide by Column Elution Method.

4. Conclusions

An analytical procedure and a chemical separation technique were studied for the quantitative determination of ^{129}I , which is classified as a

difficult-to-measure (DTM) nuclide. The recovery rate was measured by adding ^{125}I as an iodine tracer to the simulation sample to measure the activity concentration of ^{129}I . The optimum condition for the maximum recovery yield of iodine on the anion exchange resins (AG1-X4, 50-100 mesh, Cl^- form) was found to be pH 7.

REFERENCES

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