Decontamination Technology of Spent Resin From PHWR

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1. Introduction

Spent resin from Pressure Heavy Water Reactor(PHWR) are stored in concrete storage tanks near the reactor. Spent resin storage tanks have been reaching saturation point due to the prolonged operation time of nuclear power reactors.

Therefore, it is necessary to develop a proper method to handle and transfer the spent resin. However, because the spent resin contains a large amount of β-nuclides(^{14}C, ^{3}H) and ɣ- nuclides(^{60}Co, ^{137}Cs), the spent resin is currently under long-term storage.

Particularly with ^{14}C, which is mainly generated from $^{17}O(n, \alpha)^{14}C$ reaction in reactor system [1], it requires proper decontamination method because it emits high radiation due to its large amount that is bond to the anion resin in $H^{14}CO_3^-$ and $^{14}CO_3^{2-}$ form.

This paper focuses on introducing the ^{14}C desorption, as well as removal, technique within the spent resin storage.

2. Experiment method

2.1 ^{14}C adsorption experiment

Before proceeding with the desorption and precipitation experiment, in order to evaluate the adsorbability of ^{14}C and produce model sample of the spent resin from PHWR, ^{14}C standard solution was added to the anion resin to measure the amount of ^{14}C within the anion resin.

2.2 ^{14}C desorption and precipitation experiment

Then, in order to desorb ^{14}C that has been bonded to the anion resin, sulfuric acid solution was used because ^{14}C gets released in gaseous form of CO_2 at low pH [1]. The core technique in decontaminating ^{14}C is desorbed in $^{14}CO_2$ form from the anion resin, collecting the generated precipitate to remove ^{14}C. Such method can be verified through two stages. First stage is about generating precipitate within $Ca(OH)_2$ aqueous solution by desorbing the ^{14}C bond to the anion resin at low pH condition, and the second stage is about assuring if the precipitation of ^{14}C from the first stage had been done properly by collecting ^{14}C from the generated precipitate. The experimental equipment was installed as below for the first stage experiment.

Fig. 1. ^{14}C desorption and precipitation equipment.

The CO_2 gas, which was generated after injecting sulfuric acid into the previously produced ^{14}C adsorption sample resin, was collected by using NaOH solution. Also, N_2 gas and vacuum pump were subsidiarily used to smooth out the flow of and minimize the external release of the generated CO_2. ^{14}C was re-collected by using the below equipment after collecting and natural drying $CaCO_3$ that was generated at the first stage.

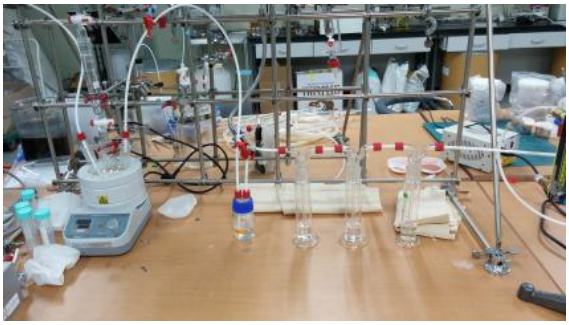

Fig. 2. Precipitate oxidation and collection equipment.

The CO_2 gas was generated by reacting $CaCO_3$ with HC1, and the generated $^{14}CO_2$ was collected with NaOH solution. The effectiveness of precipitation was verified by measuring the amount of ^{14}C within the generated $CaCO_3$ from the first experiment. Like the first experiment, in order to smooth out the flow of the generated CO_2, N_2 gas and vacuum pump were subsidiarily used.

3. Results and discussion

Table 1. Anion resin before and after the experiment; ^{14}C activity of $CaCO_3$

1st Performance	^{14}C activity(Bq)		Recovery factor
Anion Resin Before Desorption	39	Amount of Desorbed ^{14}C: 37.3	72%
Anion Resin After Desorption	1.7		
Precipitated $CaCO_3$ Powder	27		
2nd Performance	^{14}C activity(Bq)		Recovery factor
Anion Resin Before Desorption	65	Amount of Desorbed ^{14}C: 63.2	81%
Anion Resin After Desorption	1.8		
Precipitated $CaCO_3$ Powder	51.25		

As shown in the above table, the total amount of ^{14}C within the anion resin changed from 39 Bq, 65 Bq to 1.7 Bq, 1.8 Bq after the experiment, meaning that almost all ^{14}C was desorbed. Also, it was assured that ^{14}C amount within the generated precipitate is 27 Bq, 51.25 Bq, meaning that 72%, 81% of the desorbed ^{14}C was collected.

4. Conclusion

Through the desorption and precipitation experiment of ^{14}C bond to the anion resin, it was affirmed that ^{14}C can be collected by using $Ca(OH)_2$ aqueous solution, and it can be predicted that there will be considerably less amount of secondary waste than the ^{14}C adsorption using the LiOH filter.

Thus, from now on, if the spent resin from PHWR is decontaminated by applying these techniques, it will be effective towards developing the technique to dispose of and transfer spent resin with minimum amount of secondary waste.

REFERENCES

[1] Ho-Yeon Yang, besides 7, “Ion Adsorption Charateristics of IRN-150 Mixed Resin and Removal Behavior of ^{14}C”, J. of the Korea Radioactive Waste Society, 4(4), 373-384 (2006).