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Neutralization and treatment of liquid radioactive waste in PRIDE facility

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1. Introduction

Liquid radioactive waste generated in PRIDE (PyRoprocess Integrated inactive DEmonstration) facility is mostly classified as an ultra-low level radioactivity. The reason is that nuclear material is generally located in a closed Ar-cell, and experiments are conducted using MSM(Master Slave Manipulator). In case of unavoidable direct handling of nuclear material, it is handled only in the designated space where which is sealed.

In PRIDE facility, there are things that have to be treated as liquid radioactive waste from the liquid remaining in the unused equipment. One of them is KOH solution which is stored inside the wet scrubber designed to remove Cl gas in the process of producing UCl3. To transfer liquid radioactive waste, the U concentration and pH must be analyzed. However, KOH solution is strongly basic, so neutralization must be performed for transferring to radioactive waste facility.

2. Methods and Results

2.1 Methods

Neutralization titration can be used to determine the concentration of an acid or base. This is based on the fact that acids and bases react in an equivalent ratio to neutralize. The neutralization reaction proceeds rapidly, but the neutralization point can be easily identified using an indicator and the acid or base can be quantified. To neutralize the KOH solution, HNO_3 were used as the standard solution and BTB solution was used as the indicator. In general, BTB, methyl orange, and phenolphthalein were used as indicators depending on the neutralization target and standard solution.

2.2 Experiment

To briefly explain the experiment, place the standard solution into a burette and place it on the top. Place the solution which is to be measured under the burette with Erlenmeyer flask, then inject the standard solution slowly. BTB solution(Standard solution) is blue when it is basic. Then, Stop adding the standard solution as soon as the color changes to green. Read the scale of the burette and calculate the concentration of the desired solution using the formula below. Based on the calculated concentration, the amount of HNO_3 required for neutralization is estimated and total neutralization is carried out.

Chemical reaction formula :

$$\mathrm{KOH(aq)} + HNO_3\mathrm{(aq)} \rightarrow \mathrm{KN}O_3\mathrm{(aq)} + H_2\mathrm{O(l)}$$

Equation : M × V = M' × V'

M : Concentration of HNO_3
V : Volume of input HNO_3
M' : Concentration of KOH
V' : Volume of KOH

2.3 Results

Chart. 1. ICP analysis to measure Uranium and pH test

	${}^{238}_{92}U$(Bq/mL)	pH (Before)	pH (After)
Sample No-01	< 0.00403	13.2	7.2
Sample No-02	< 0.00366	12.6	7.4
Sample No-03	< 0.00413	13.1	7.6

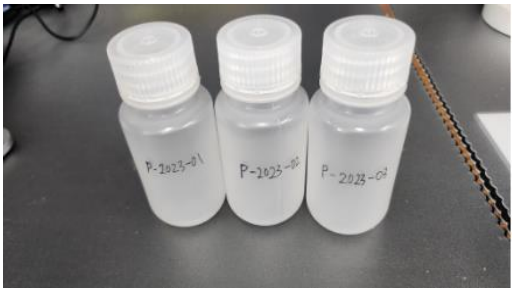

Fig. 1. Samples to measure Uranium concentration and pH

The neutralization of KOH solution was completed using the above theory and formula. Neutralization was performed using the method described above. After completed, pH and ICP analysis were requested to Radioactive Material Chemical Analysis Section in KAERI.

As you can see in chart.1, the final pH value was measured close to neutral. According to the KAERI's Regulation(Radioactive Waste Management Procedures), the allowable pH range for liquid radioactive waste transfer is 6 to 8. Since the experimental results showed that the value is in the allowable range, this waste has become transferable.

3. Conclusions

There are several types of liquid radioactive waste in the radiation controlled area in KAERI. In order to transfer radioactive wastes such as KOH solutions, not only the U concentration but also the pH level must be in the allowable range. There are various methods of neutralization, but when neutralization is performed using the above method, a desired pH level may be simple than any other method.

REFERENCES

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[2] The EBR-2 Fuel Cycle Story, Charles E. Stevenson, American Nuclear Society pp. 16-25.