Surfactant Analysis of Simulated Laundry Waste for Treatment of Radioactive Laundry Waste

Dong Yeon Kim*, Sung Hyeon Kim, and Ki Tae Kim
NILEPLANT.Co.LTD., Eneojisaneop 4-ro 19-21, Seosaeng-myeon, Ulju-gun, Ulsan, Republic of Korea
**dorcusmaster@naver.com*

***Keywords : Radioactive Laundry Waste, Surfactant, MBAS**

1. Introduction

Radioactive laundry waste generated from nuclear power plants contains surfactants, and surfactants capture radioactive metal ions to form polymer micelles, so it is difficult to remove radionuclides contained in laundry waste using general radioactive ion capture technology. To solve this problem, a method of using an oxidizing agent to decompose the surfactant and then using a cation exchange resin to remove the radioactive metal ions is emerging as a technology for treating radioactive laundry waste .

Among them, technology to decompose organic substances such as surfactants using photocatalysts has been developed and is being used for various purposes. In order to treat radioactive laundry waste, an accurate analysis of the surfactant concentration of radioactive laundry waste, which is the subject of technology development, is required. Therefore, this paper contains the results of surfactant analysis of simulated radioactive laundry waste to provide basic data needed for the development of radioactive laundry waste treatment technology.

2. Analysis method

Radioactive laundry waste produced at nuclear power plants is a mixture of washing wastewater generated in the process of washing work clothes worn by workers and wastewater generated in the process of showering after radiation workers perform radiation work. Therefore, in order to analyze the surfactant in radioactive laundry waste, the characteristics and amount of wastewater flowing into the radioactive laundry waste storage tank must be determined.

2.1. Assessment of Laundry Waste Generation

To prepare simulated radioactive laundry waste, laundry detergent and fabric softener, which are most commonly used in homes, were purchased. It was confirmed that powdered soap was used in nuclear power plants to prevent reattachment of contaminants, so powdered soap was also used. The amount of detergent was added according to a constant volume ratio by applying the standards specified in the user manual of each product, and it was assumed that half of the amount of laundry detergent and powdered soap was used each.

The capacity of the large washing machine used in nuclear power plants is 500 liters, and it is said that a total of 1,050 liters of laundry wastewater is generated during the washing process. It is known that the number of workcloths used in one washing operation is 25.

2.2. Evaluation of Shower Waster Generation

The detergents used by workers were shower body wash and shampoo/rinse combination detergent, which are known to be most commonly used in shower rooms, and produced simulated radioactive laundry waste.

The amount of shower water generated was evaluated as the amount of shower wastewater generated when one worker who performed work in the radiation control area took a shower after work and left the radiation control area. Although the shower time may vary depending on the season and person, the average shower time was assumed to be 10 minutes based on data available on the Internet, and the water supply volume was assumed to be 7 liters per minute, which is the water supply for a water-saving shower head.

In the case of body wash used in the shower process, it was assumed that the volume discharged per pump was 4 ml and that each person pumped and used about 2 times. In the case of shampoo/rinse, it was assumed that 2.5 ml would be discharged with one pump and that the hair would be washed after two pumps.

2.3. Preparation of Simulated Radioactive Laundry Waste

If a large washing machine was used, 25 sets of work clothes could be washed, so it was assumed that 25 workers would have showered. Since 25 sets of work clothes can be washed using a large washing machine, it was assumed that 25 workers would have showered. Based on this, 10L of simulated radioactive laundry wastewater in the form of a mixture of laundry wastewater and shower wastewater was prepared by calculating the amount of detergent introduced above. The prepared simulated radioactive laundry waste was sampled three times and the anionic surfactant concentration was measured using an anionic surfactant meter.

In addition, because there was a need to measure the initial anionic surfactant concentration contained in the detergent used to prepare the simulated radioactive laundry waste, the anionic surfactant concentration

contained in 1ppm of each laundry detergent and shower detergent was measured.

2.4. Anionic Surfactant Concentration Measurement

Anionic surfactant concentration can be easily evaluated by measuring MBAS(methylene-blue active substances) concentration, but nonionic surfactant concentration is difficult to measure immediately because specific analysis equipment must be used. For this purpose, an anionic surfactant meter using the MBAS measurement method was used. Figure. 1 shows a photograph of the surfactant concentration measured using a surfactant meter and a photograph of a sample bottle into which the measurement solution was injected.

Fig. 1. Anionic surfactant measurement scene and sample bottle injected with measurement solution

In general, the measurement range of an anionic surfactant meter is very low, so the concentration was measured after sufficiently diluting the sample.

3. Results

3.1. Detergent Surfactant Concentration Analysis Rresults

As a result of measuring the concentration of anionic surfactant contained in laundry detergent and shower detergent that make up the simulated radioactive laundry waste, the concentration of anionic surfactant contained in 1ppm of laundry detergent, fabric softener, and powdered soap was very low at 0.00018 ~ 0.00060ppm. On the other hand, the concentration of anionic surfactant contained in 1 ppm of body wash and shampoo/rinse was found to be 0.0182 to 0.55 ppm, which is hundreds to thousands of times higher than that of laundry detergent.

3.2. Simulated Radioactive Laundry Waste Analysis Results

The measurement results of the anionic surfactant concentration of the simulated radioactive laundry waste are shown in Table I below.

Table I: Concentration of anionic surfactant contained in simulated radioactive laundry waste

No	Anionic surfactant [ppm]	average [ppm]
#1	92.5	89.67
#2	93	
#3	83.5	

4. Conclusions

In this study, detergents expected to be included in radioactive laundry waste from nuclear power plants were purchased and the simulated composition of radioactive laundry waste was evaluated based on the amount used.

As a result of the analysis, it was confirmed that laundry detergents are mainly composed of nonionic surfactants, and shower detergents are mainly composed of anionic surfactants. Accordingly, it is believed that the concentration of surfactant contained in radioactive laundry waste can vary significantly depending on individual shower time and amount of shower detergent rather than the amount of laundry detergent.

In addition, the anionic surfactant concentration was measured to be an average of 89.67 ppm, so it is planned to manufacture the anionic surfactant concentration of the simulated radioactive laundry waste at a level of 100 ppm for future radioactive laundry waste treatment.

ACKNOWLEDGEMENTS

This work was supported by the Technology develop ment Program(RS-2023-00268455) funded by the Mini stry of SMEs and Startups(MSS, Korea)

REFERENCES

[1] D. Y. Kim, S. H. Kim and S. W. Shin, “Characterization of Radioactive Laundry Waste to Develop the Movable Radioactive Laundry Waste Treatment Facility ”, NILEPLANT Co., Ltd., TC-2307004, 2023.

[2] J. B. Kim et al., “A study on the Combined Proc e ss of UV Photo - ox idation / Ev aporation for Laundry Radw aste T re atment”, The 2000 Korean Nuclear Society Spring Conference, April 18 - 20, 2000