Feasibility of Metal Surface Decontamination by PFC Ultrasonic Method

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1. Introduction

Radioactively and loosely contaminated metal or equipment during or after the operation of the nuclear facility is one of the problems in the nuclear industry. Dry decontamination method would be a good solution not only to reduce the radioactive metal waste volume, but also generates the small volume of the secondary waste. In this study, decontamination performance of the PFC (per-fluorocarbon) ultrasonic decontamination method on the several kinds of metal specimen was investigated. We also performed the feasibility study of recycling the spent PFC.

2. Methods and Results

In this section some of the experimental methods, procedures and results are described.

2.1 Specimen Preparation

Several shapes of specimens were prepared. Tube type, plate type, double plate type and plate type welded with cylindrical stainless steel were prepared. The double plate type was used to simulate the crevice contamination. Plate type welded with stainless steel was used to simulate the material attached on the surface of hot cell. Before test, the surface of every specimen was cleaned with papers wetted with ethyl alcohol. For artificial contamination, a small amount of methyl alcohol which contains 10 wt% of 99.95% Eu_2O_3 powders were thrown down on the specimen surface. UV sensitive fluorescent pigments were added as a tracer. The trace elemental analysis of Eu_2O_3 is listed in Table 1.

Table 1. Trace Elements in Eu_2O_3 powders

Element	Tm	Y	Zr	Cu	Ca	Si
ppm	210	90	65	45	5	1

2.2Decontamination solution

PFC used was PF 5070 from 3M Company. Anionic surfactant used was Krytox from Dupont Company. The FT-IR spectrum of PFC + 0.1 vol% of anionic surfactant mixed solution is shown in Figure 1. Contrary to the spectrum of pure PFC solution, it shows peaks on carboxylic group.

2.3 Decontamination Test

Ultrasonic decontamination test equipment was designed and fabricated. The reactor size was 150(W) X 130(L) X 200(H) mm^3. The size of PFC reservoir was 150(W) X 130(L) X 200(H) mm^3. Specimen chamber in the reactor was rotated by the geared motor. The rotation speed could be controlled and it was in the range from 10 to 44 rpm. After the artificially contaminated specimen was put into the specimen chamber, the reactor was filled with PFC solution. Then the contaminated specimen was decontaminated by ultrasonic method. The weight of specimen was measured three times. It was measured as fabricated, after contamination and after decontamination. The method to estimate the decontamination efficiency is shown in elsewhere [1,2]. The outer surface of specimen was photographed.

Recycling of spent PFC solution was tested in the distillation equipment,

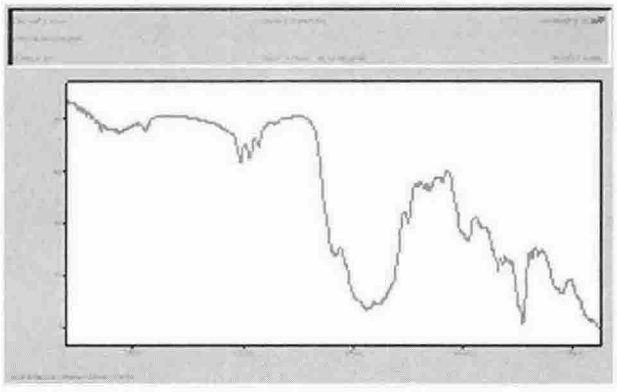

Figure 1. FT-IR spectrum of PFC + 0.1 vol% of anionic surfactant mixed solution.

2.4 Test Results

Photographs of specimen before and after decontamination are shown in Figure 2. As shown in Figure 2-(a), both of smooth and grooved surfaces were contaminated before decontamination. As shown in Figure 2-(b), however, the contaminated surfaces were fully decontaminated by ultrasonic method after 20 minutes' application. The decontamination performances on the other specimens were also same. It was also confirmed that all the contaminants were fully decontaminated from the weight measurement of the specimens. This means that PFC ultrasonic decontamination method is powerful to the loosely contaminated metal decontamination.

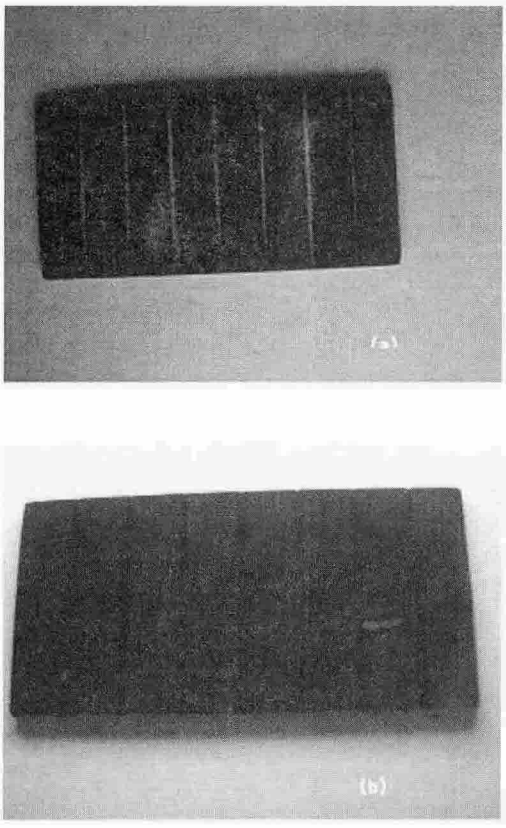

Figure 2. Photographs of specimen before(a), and after(b) decontamination.

From the result of the distillation test of spent PFC solution, it was found that more than 90 % of spent PFC can be reused by distillation. Because the latent heat and the specific heat are very low compared with water, it was very easy to distill and to recycle the PFC. It was also easy for PFC to evaporate, however, PFC should be treated very carefully.

3. Conclusion

Feasibility study on PFC ultrasonic method as a dry decontamination method was performed. For all the test specimens, the method showed good decontamination performances. We obtained the good results from the test of spent PFC distillation. Filtration test on the spent PFC solution is undergoing. If we combine and use the distillation method and filtration method, most of the spent PFC solution can be reused without the loss of decontamination performance. Considering the domestic situation, we must develop the efficient decontamination technologies to minimize the radio-active waste.

REFERENCES

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