Decontamination of Metal Surface by PFC Solution

Hui Jun Won, Gye Nam Kim, Wang Kyu Choi, Chung Hun Jung and Won Zin Oh
Korea Atomic Energy Research Institute, # 150, Dukjin Dong, Yu-Seong Gu, Daejon, nhjwon@kaeri.re.kr

1. Introduction

Metal waste which is radioactively and loosely contaminated is one of the problems in the nuclear industry. The contaminated metal surface of the hot cell should be decontaminated periodically to improve the working environment. Dry decontamination method would be a good solution to generate 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 on the recycling of the spent PFC solution.

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

2.2 Decontamination solution

PFC used was PF 5070 from 3M Company. Anionic surfactant used was Krytox from Dupont Company. The characteristic of PFC + 0.1 vol% of anionic surfactant mixed solution was analyzed by FT-IR..

2.3 Decontamination Test

Ultrasonic decontamination test equipment was designed and fabricated. The schematic diagram of the equipment is shown in Figure 1. 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.

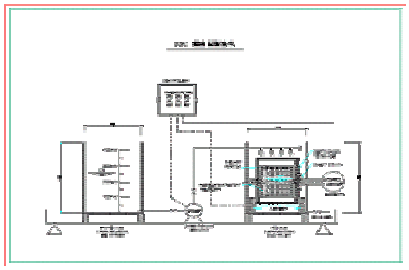

Figure 1. Schematic diagram of PFC ultrasonic decontamination test equipment.

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

2.4 Test Results

Photographs of crevice type specimen before and after decontamination are shown in Figure 2. As shown in Figure 2-(a), both of smooth and crevice surfaces were contaminated before decontamination. As shown in Figure

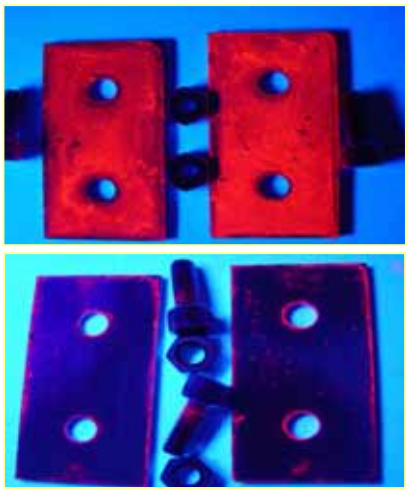

Figure 2. Photographs of crevice specimen before(a), and after(b) decontamination.

2-(b), however, the contaminated surfaces were decontaminated successfully by ultrasonic method after 20 minutes' application.

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. The decontamination performance on the rectangular type specimen according to the recycle time was also investigated. The result is shown in Figure 3. We confirmed that decontamination performance of PFC solution is not influenced by the recycle time.

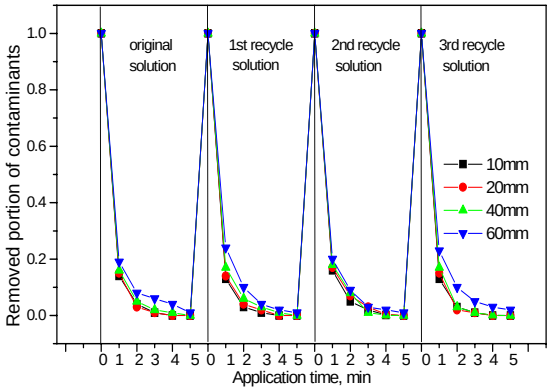

Figure 3. Removed portion of contaminants on the surface of the rectangular type specimen according to the time under various recycled time of PFC solution.

Because the latent heat and the specific heat are very low compared with water, PFC is easy to recycle. It was also easy for PFC to vaporize, however, PFC should be treated very carefully.

3. Conclusion

PFC ultrasonic decontamination tests on the crevice specimen and rectangular type specimen were performed. For all the test specimens, the method showed good decontamination performances. The spent PFC solution was recycled by distillation. The decontamination performance of PFC solution did not change after three times of distillation. From the result, it was concluded that decontamination process using PFC solution would be a good dry decontamination method. 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.

Acknowledgement

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