Study on the Characteristics of Electro-Decontamination by Pilot Scale Equipment

Ki-Chul Kim*, Dong-Yeon Kim, and Jung-hyun Lee
KEPCO KPS, 96-1 Gilchon-Gil, Jangan-Eup, Gijang-Gun, Busan, Republic of Korea
*KICHKIM@kps.co.kr

1. Introduction

Electro-decontamination technology can be used for decontamination of the primary system of the nuclear power plant by directly applying current to the metal and simultaneously removing the base material and the oxide film.

In this study, data on the weight loss and thickness reduction of STS304 specimens, which are caused by temperature and voltage, were selected for commercial electro- decontamination process equipment, and a pilot scale electro-decontamination process was conducted to evaluate decontamination efficiency .

2. Process equipment

The electro-decontamination pilot equipment used in this study was designed based on the mock-up of the shape reduced to 75%, while the cold leg reactor coolant system pipes connecting the steam generator and the reactor coolant pump in the power plant system was cut to 1 m. The volume of electro-decontamination tank is 900 (L) x 900 (W) x 1,000 (H), 810L.

3. Experiments

3.1 Experimental method

The specimens used were STS304 (35*13*3㎜), and three pieces were vertically mounted on the PIPE type mock-up. The electrode is indirectly connected for process automation and is shown in Fig. 1. The electrolyte was used with 4 M H_3PO_4. The temperature of the electrolyte was increased to RT (10 °C), 40 °C and 60 °C, and the voltage was applied at 4, 6, 8 and 10 V for each temperature. The process time was 1 hour and the current was measured every 10 minutes. After the test, thickness reduction was calculated using the weight measurement and weight loss method of the specimen.


Fig. 1. PIPE type mock-up and jig(L).
Fig. 2. Electro-decontamination tank(R).

3.2 Thickness reduction calculation

The mole of metal for weight loss before and after the electro-decontamination process of STS304 specimen is expressed as $\alpha\ mol_{M^{n+}}$, and the formula for thickness reduction can be summarized as follows.

$$d_{M^{n+}} = \alpha\ mol_{M^{n+}} \times \frac{F.W(g/mol_{M^{n+}})}{density(cm^3/g)} \qquad (1)$$

After the electro-decontamination process, the weight loss for each of the three specimens in each experiment was added up and averaged, and the weight of the measured metal was substituted into the above formula to calculate the thickness reduction of the specimen.

3.3 Experimental result

As a result of experiments at three temperature conditions through electro-decontamination process, the current density also increased with increasing voltage. In addition, weight loss and thickness reduction were also found to increase, and data for each experiment are shown in Tables 1, 2, and 3. At the same voltage, the thickness reduction was found to be high as the temperature increased, and was shown in Fig. 3.

Table 1. Measurement results of current density by voltage and temperature

Voltage [V]	Current density [mA/cm^2]		
	RT	40 ° C	60° C
4	2.01`	5.08	5.16
6	8.29	17.87	21.13
8	19.61	32.08	34.68
10	31.23	46.66	50.99

Table 2. Measurement results of weight loss by temperature and voltage

Voltage [V]	Weight loss [mg]		
	RT	40 ° C	60° C
4	`6.6	13.5	17.8
6	24.8	52.1	69.8
8	39.9	91.9	119.5
10	42.4	154.6	181.2

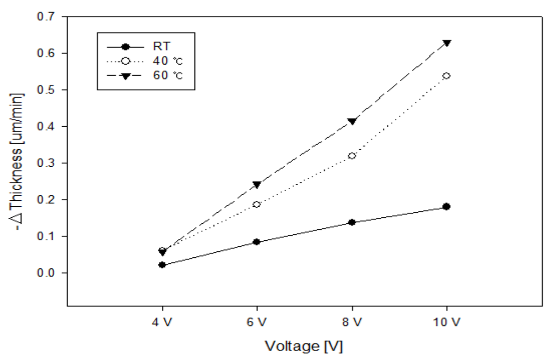

Fig. 3. Experimental results in relation to voltage and temperature.

4. Conclusion

From the results of this experiment, it was confirmed that the results are similar to the experimental results at the laboratory scale in relation to the voltage increase [1]. The measurement revealed that the average thickness removal rate was 24 μm per 1 hour on the surface area of 1.5 m^2. Therefore, it is expected that it will exhibit excellent decontamination efficiency even in the process of commercial scale.

Future research will be carried out to enhance decontamination efficiency about complex shaped segmentation by using arrangement of electrodes.

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