Effect of the Addition of Oxalic Acid to the Phosphoric Acid Electrolyte on the Electro-decontamination Behavior of the SUS Metal Surface

Kim Dong-Yeon*, Hyun-Kyu Lee, Won-Zin Oh, and Sang-June Choi
Kyungpook National University, 80 Daehakro, Bukgu, Daegu, Republic of Korea
*east.kite@knu.ac.kr

1. Introduction

As Kori Unit 1 is going to shut down permanently in June 2017, the securing of decontamination technology related to waste reduction occurring in the decommissioning process of nuclear power plants is being discussed as an important issue.

Electro-decontamination has a high decontamination factor and excellent decontamination effect on metals, which can be effectively used to primary system of nuclear power plants. Recently, there is a tendency to use an electrolytic decontamination process with phosphoric acid which is excellent in electrical conductivity and stability. This phosphoric acid electrolytic decontamination can be reused as a decontamination agent through the regeneration process as well as reducing waste.

Oxalic acid dissociates into electrolytes and regulates the pH by supplying hydrogen ions. In addition, oxalic acid precipitates from divalent metal ions such as Fe^{2+}, Ni^{2+} and radioactive species $^{60}Co^{2+}$, $^{59}Fe^{2+}$ metal oxalate, reducing the concentration of metal ions in solution.

This study was carried out to investigate the effect of oxalic acid on the decomposition reaction of metal when the dissociation of oxalic acid in the electrolysis reaction of SUS304 causes the precipitation reaction.

2. Experiments

2.1 Experimental method

For the electro-decontamination test of SUS metal, SUS304 pipe (I.D 9.7 cm, H 13 cm) was used for cathode and anode was used as a sus304 having a surface area of 10 cm for the experiment. 1 L beaker was used as a reactor for electro-decontamination reaction. TEX-300 product of Toyotech was used as a power supply. As the electrolyte, phosphoric acid of 2 M, 5 M and 8 M concentrations were used as the base solution, Experiments with and without 0.5 M oxalic acid injection per concentration of phosphoric acid were carried out and compared.

The solution information for each experiment is shown in Table 1.

Table 1. Solution information of each experiment

No	H_3PO_4	$H_2C_2O_4$
1-1	2 M	/
1-2	2 M	0.5
2-1	5 M	/
2-2	5 M	0.5
3-1	8 M	/
3-2	8 M	0.5

The voltage was constantly applied at 4 V for each experiment and the voltage application time was 1 hour. As the experimental data, the weight of the anode before and after the electro-decontamination was measured three times, and the average was recorded. At this time, the decomposition efficiency of SUS metal was evaluated through weight loss.

In addition, SUS metal decomposition efficiency was calculated by recording the electric power used for electrolytic decontamination of water and metal through the current measured during electrolytic decontamination.

2.2 Experimental result

As a result of electro-decontamination of SUS metal, it was confirmed that metal oxalate was formed in the experiment in which oxalic acid was injected.

Tables 2 and 3 show data on the weight loss of the anode and the electro-decontamination efficiency through the current in each experiment.

Table 2. Weight loss of SUS304

No	Initial weight [g]	Post weight [g]	Weight loss [g]
1-1	15.8596	15.5915	0.2681
1-2	15.7282	15.2581	0.4701
2-1	16.3194	15.6975	0.6219
2-2	16.3228	15.6258	0.6970
3-1	16.3148	15.5853	0.7295
3-2	16.3225	15.4944	0.8281

Table 3. Current density of Metal and Water

No	J_{Metal} [A/cm^2]	J_{Water} [A/cm^2]
1-1	0.03416	0.2681
1-2	0.05989	0.4701
2-1	0.07924	0.6219
2-2	0.08881	0.6970
3-1	0.09295	0.7295
3-2	0.10552	0.8281

Fig. 1. Metal oxalate.

The weight loss of SUS304 anode before and after the experiment was measured. In the oxalate infusion experiment, the weight loss was increased compared to the not-injected experiment. The results of the average current density measurement also show that the addition of oxalic acid increases the current for electro-decontamination of metals and water.

3. Conclusion

The effect of oxalic acid on the electro-decontamination behavior of the SUS metal surface was investigated in the phosphoric acid electrolyte system .

Addition of oxalic acid to the electrolyte is considered to increase the oxidative dissolution rate of the SUS metal. It is also thought that the addition of oxalic acid improves the current density.

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