Evaluation of Oxide Removal Rate by Oxidation/Reduction Continuous Process Based on Permanganic acid-Oxalic acid

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1. Introduction

Nuclear power plant widely applied dilute chemical solvent to remove deposited radioactivity and thereby lower exposure of plant personnel to radiation[1]. The oxide film layer formed on the surface of the structural material of the Light-Water-Reactor was composed of metal oxides of iron, nickel and chromium. The chromium oxide was dissolved by the oxidizing process(alkaline permanganate and nitric permanganate) and iron and nickel in metal oxides were dissolved by the reduction reaction(oxalic acid, citric acid et al)[1].

In this study, oxide removal rate and surface change of specimen were evaluated by decontamination process based on permanganic acid-oxalic acid.

2. Methods

This study evaluated the surface change of the test specimen and the oxide removal rate through continuous decontamination process. The experiment was carried out under the following conditions.

- Test specimen type : SUS304, SA508, Alloy600
- Consecutive times: 1~3cycles
- Test equipment : System decontamination process equipment (Fig. 1)
- Oxidation / reduction process conditions

	Agent	Concentration	Time	Temperature
Oxidation	$HMnO_4$	300ppm	5hr	95℃
Reduction	$C_2H_2O_4$	2000ppm	4hr	

The surface of the specimens was carried out using videoscope and the weight of the test specimens before and after decontamination was measured to evaluate the oxide removal rate and decontamination factor(DF).

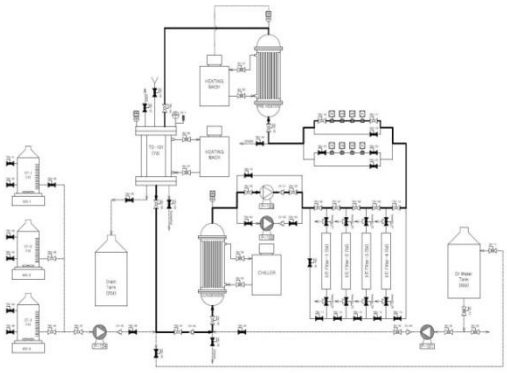

Fig. 1. Schematic Diagram of system decontamination process equipment.

3. Results and Discussion

3.1 Surface analysis of the specimen

For analyzing the surface of the specimen before and after decontamination, videoscope was used. The results of videoscope analysis were shown in Fig. 2.

The pre-decontamination specimens were confirmed that black oxide layer was formed. After the third decontamination, the oxide film of SUS304 was completely removed. In case of SA508, an iron oxide was formed on the surface, and local corrosion and pitting occurred[2]. The oxide film of Alloy 600 was partially removed[3].

Fig. 2. Videoscope analysis of test specimen surface(x60).

3.2 Evaluation of oxide removal rate by oxidation/reduction process

The removal rate of oxide film on the surface of test specimens was evaluated through a continuous decontamination process based on permanganic acid-oxalic acid. Table 1 and Fig. 3 show the oxide removal rates after the contamination process. In the case of SUS304, it was confirmed that the oxide film was completely removed when the decontamination process was performed for 3cycles. For SA508, the removal rate of the oxide film was more than 100% after 2cycles. The oxide films of Alloy 600 were partially removed after 3cycles. As the decontamination process was repeated for the three specimens, the removal rate of oxide film increased.

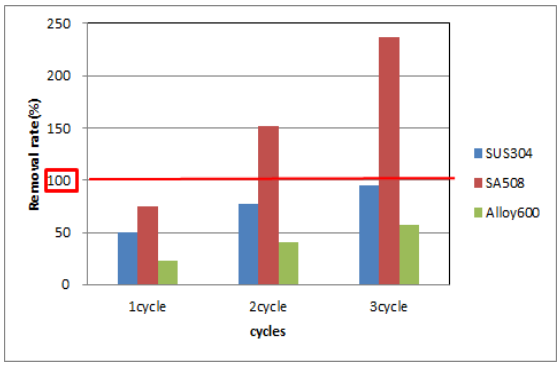

Fig. 3. Removal rate of oxide film of specimen according to the number of continuous decontamination process.

Table 1. The weight of the test specimens before and after decontamination

Type	Before	1cycle		2cycle		3cycle	
		%	DF	%	DF	%	DF
SUS304	0.327	50	2	78	4.5	95	21
SA508	0.993	75	4	152	-	237	
Alloy690	0.208	22	1.3	40	1.7	57	2.3

4. Conclusions

In this study, the removal rate of the oxides film on the test specimen was evaluated. From the experiment result, it was confirmed that the removal rate of the oxide film increased as the decontamination process was repeated. When the continuous process was repeated three times, SA508 removed not only the oxide film but also the base material. Oxide film of Alloy 600 was partially removed. As a result, in case of SUS304 and SA508, decontamination process should be performed 2~3times to remove the oxide film. For Alloy 600, decontamination process should be performed more than 3 times to remove oxide film.

ACKNOWLEDGMENTS

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