

## Influence of dispersant(PAA) injection into secondary system in nuclear power plant

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### 1. Introduction

Corrosion products induce the material degradation in the secondary system and depress the thermal performance of the power plants. Dispersant injection was applied to reduce the accumulation of the corrosion products in some foreign PWRs [1]. Polyacrylic acid (PAA) is considered as a dispersant in a domestic power plant. This study is to evaluate the dispersion efficiency and the possible corrosion concerns of PAA when the chemical is used in the secondary system of PWR.

### 2. Methods and Results

#### 2.1 Dispersion studies

Dispersion efficiency is tested using a settling test procedure. A colloidal suspension of the corrosion product oxide (50 ppm magnetite), containing the dispersant (PAA) under test at the desired concentration was prepared. 10 ppb, 100 ppb, 1000 ppb PAA in the water solution ( $>17 \text{ M}\Omega$ ) were tested to compare the dispersion efficiency at room temperature. The particle size of the magnetite ( $\text{Fe}_3\text{O}_4$ , SIGMA-ALDRICH, USA) is about 20~30 nm. The pH was controlled at 9.7~9.8 by using ETA.



Fig. 1. Settling test results as a function of PAA concentration (50 ppm magnetite, 7 days suspension)

The dispersion efficiency increases as the PAA concentration increases. The amount of the suspended magnetite in 10 ppb PAA solution is much less than in 1000 ppb solution after 7 day suspension tests.

#### 2.2 Corrosion studies

General corrosion tests were carried out to evaluate the effects of PAA injection on the corrosion resistance of the materials in secondary system of PWR. Corrosion tests were carried out in high temperature water solution of 100 ppb PAA concentration at  $300^\circ\text{C}$ . Corrosion test condition is shown in table 1.

Table 1. Corrosion test condition

| Chemistry              |                            | Temp.( $^\circ\text{C}$ ) | Time                     |
|------------------------|----------------------------|---------------------------|--------------------------|
| PAA                    | 100 ppb/0                  | 300 $^\circ\text{C}$      | 30 days<br>~<br>180 days |
| ETA                    | pH control                 |                           |                          |
| $\text{N}_2\text{H}_4$ | 25 ppb                     |                           |                          |
| $\text{O}_2$           | Deaerated ( $\text{N}_2$ ) |                           |                          |
| pH                     | 9.7~9.8                    |                           |                          |

General corrosion test result for various carbon steels (SA-106 Gr.B et al.) is showed in Fig. 2. KAERI test results were showed with the results of various other researchers. General corrosion behavior of all carbon steels in Fig. 2 has a similar trend irrespective of the PAA addition. Corrosion rate decreases as time increases. Corrosion rate after 180 days in both solution of with and without PAA addition is about 0.2 mpy (mils per year) which is negligible amount of corrosion in secondary system of PWR. The corrosion rate decrease is due to the formation of protective oxide layer. As shown in Fig. 3, the stable oxide layer of thickness about 5  $\mu\text{m}$  is formed on both surfaces of the steels in the solution with/without PAA. Based on the test results, it is reasonable to conclude that the 100 ppb PAA injection does not deteriorate the formation of protective oxide and does not influence the corrosion behavior of carbon steels in secondary system of PWR significantly.

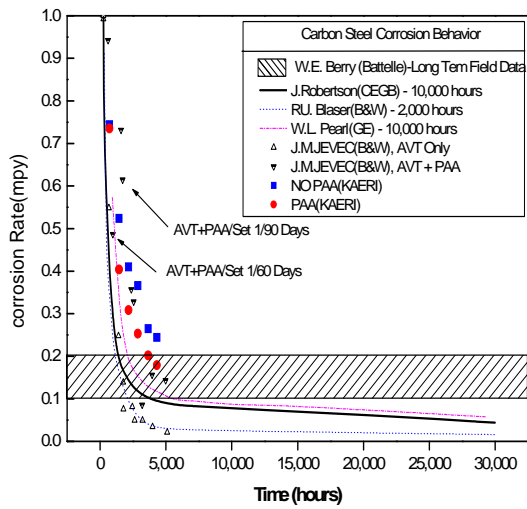
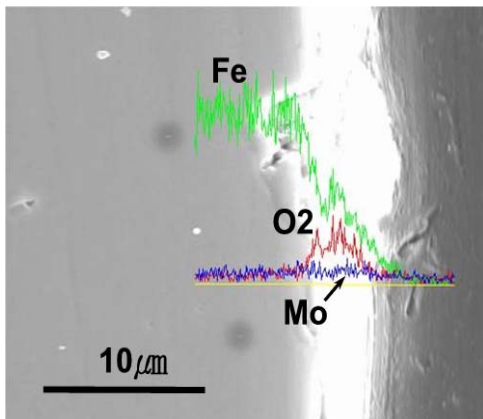
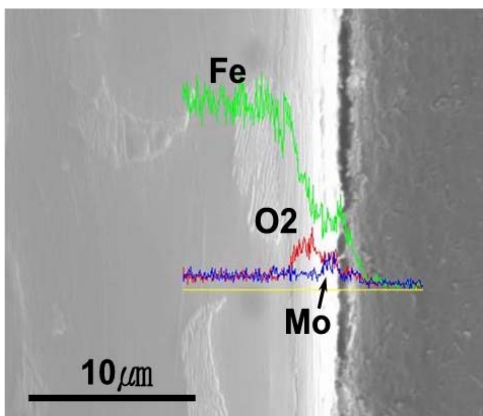


Fig. 2. Corrosion rate of carbon steels in high temperature water of various PAA concentrations (B & W and KAERI data).



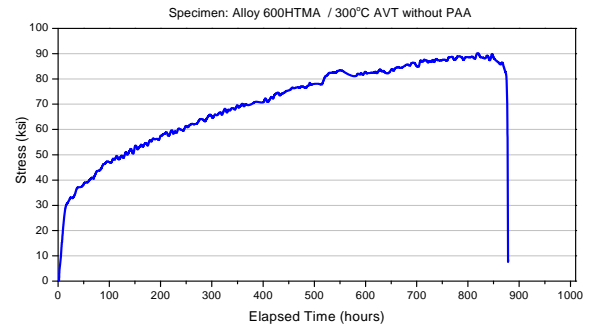
a) No PAA



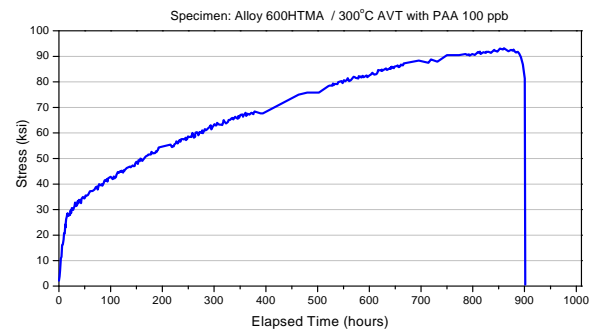
b) 100 ppb PAA

Fig. 3. The protective oxide formation on carbon steels in with and without PAA solution after 180 days of tests.

CERT is also carried out to investigate the SCC behavior of Alloy 600 with PAA injection. The test results are shown in Fig. 4. The tests showed that the PAA injection does not affect the SCC characteristics in high temperature water.



a) No PAA



b) 100 ppb PAA

Fig. 4. CERT results of Alloy 600 HTMA in high temperature water with and without PAA.

### 3. Summary

The PAA addition increases the dispersion efficiency of magnetite. As PAA concentration increases, the amount of the suspended magnetite increases.

The effects of PAA injection on the corrosion behavior of the materials in secondary system were evaluated. PAA injection does not influence the corrosion resistance of the materials of secondary system significantly.

### REFERENCES

[1] EPRI 1015020, Dispersants for Tube Fouling Control, Volume 5: PWR Application sourcebook, 2007