

## Application of the Dispersant for Removal Sludge at the YongGwang Unit 6

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### 1. Introduction

Corrosion products that make their way to the secondary side of pressurized water reactor (PWR) steam generators (SGs) via the feedwater can deposit on the SG tubes. These deposits can inhibit heat transfer, lead to thermal-hydraulic instabilities through blockage of tube supports, and create occluded regions where corrosive species can concentrate along tubes and in tube-to-tube-support-plate crevices. The performance of the SGs can be compromised not only by formation of an insulating scale, but also by the removal of tubes from service due to corrosion.

Over the past 30 years, utilities have been employing two basic approaches to reduce the quantity of corrosion product material in the SGs:

- Reduce the ingress rate by lowering the source term
- Remove corrosion products which have accumulated in the SGs

A third approach which is now becoming available-alone or in combination with other approaches-is the use of online dispersant addition to aid in preventing corrosion products transported in the feedwater from adhering to SG internal surfaces. By inhibiting the deposition of the corrosion products, dispersants can facilitate more efficient removal from the SGs via blowdown[1].

This research presents the results of the dispersant trial implemented during the 8<sup>th</sup> fuel cycle at YG Unit 6 SG #2 for 4 months.

### 2. Methods and Results

During the course of the trial, numerous chemistry measurements were recorded to characterize the effectiveness of the dispersant and also confirm that no unacceptable side effects accompanied dispersant addition. These measurements included the following

- Changes in chemistry during application PAA
- The measurement of blowdown filter differential pressure and Efficiency of Iron Sludge Removal in the SG

#### 2.1 Injection Point Location and Injection Skid

The injection point of PAA is located in the final feedwater where is to preclude the possibility of injected PAA dispersing iron oxide deposits present on heater surfaces, releasing them into the feedwater.

The injection equipment used to add PAA during the YG Unit 6 SG#2 includes a semi-bulk container with the as-delivered PAA product, a mixing tank, preexisting chemical injection pump(for wet-lay up) and tubing and valves to make the necessary connections. The equipment and its arrangement are shown schematically in Figure 1.

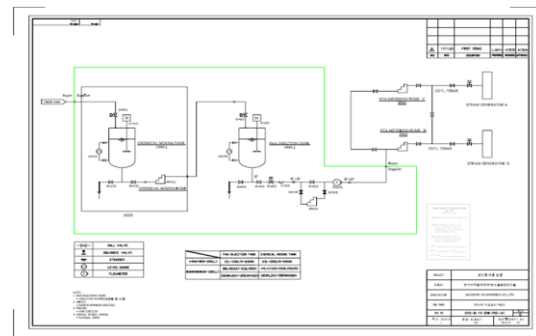


Fig. 1. The Schematic of PAA Injection Skid

#### 2.2 Chronology

The full scale PAA trail at YG unit 6 #2 began at 10:30 February 1, 2012 with the injection of 0.5% solution of PAA at about 6 l/hr. The initially injected solution yielded a nominal average PAA concentration 0.25 ppb in the final feedwater with the plant operating at 100% power.

The application of PAA plan is as followed

- 0.25 ppb for 1 week(Feb 1-8)
- 1 ppb for 1 week(Feb 9 – 16)
- 1.5 ppb for 2 week(Feb 16 – Mar 2)
- 2.5 ppb for 3 week(Mar 2 – Mar 23)
- 4 ppb for 4 week(Mar 23- Apr 20)
- 0 ppb for 1 week(Apr 20 – Apr 27)
- 4 ppb for 5 week(Apr 27 – May 31)

#### 2.3 Secondary Water Chemistry

##### 2.3.1 Cation Conductivity

The most noticeable decomposition products from PAA will be the low molecular weight organic acids. The organic acids were detected by cation conductivity.

The measurements, shown in Figure 2, reveal gradual increases of up to about 0.24 uS/cm.

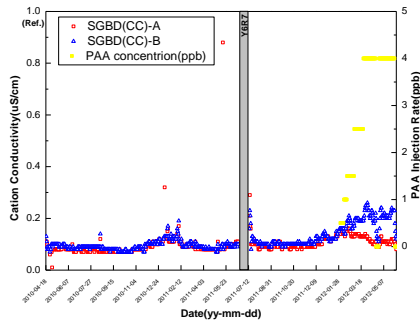


Fig. 2. YG Unit 6 Measured BD cation Conductivity during Application PAA Trail.

### 2.3.2 Total Organic Carbon (TOC)

Routine total organic carbon (TOC) measurements will also provide a backup for overfeed of the dispersant. The polyacrylic acid dispersant is 50% carbon. However, the organic amines normally used for pH control also contain a significant fraction of carbon (~40%). Since the organic amines are present in part per million levels, the TOC is normally at ppm levels. This will mask the contribution from normal levels of dispersant[2]. The measurements, shown in Figure 3, reveal no effect to apply the dispersant.

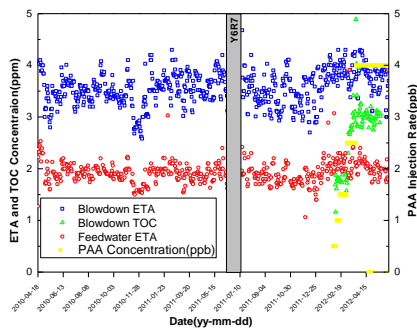


Fig. 3. YG Unit 6 Measured BD Total Organic Carbon during Application PAA Trail

## 2.4 Iron Removal Efficiency

### 2.4.1 The Change of Blowdown Filter Differential Pressure

To estimate of iron removal efficiency, we measured the blowdown filter differential pressure. Figure 4 shows filter differential pressure during the application PAA trail. The blowdown differential pressure to be injected PAA increases as the time passed. But the blowdown differential pressure to be not injected is not changed. So We can expect this phenomenon which is resulted from the removal iron sludge interacted PAA in SG.

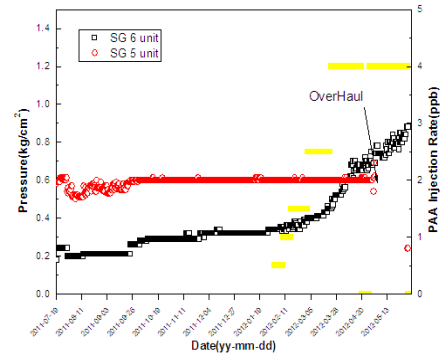


Fig 4. YG Unit 2 Measured BD Filter Differential Pressure during Application PAA Trail

### 2.4.2 The Measurement of Iron Concentration at Hotleg and Downcomer

The application PAA trail of YongGwang demonstrated that dispersant addition is capable of increasing the Hotleg iron removal rate from average 1.45 ppb to 3.63 ppb and the Downcomer iron removal rate is from average from 7.29 ppb to 23.30 ppb. Figure 5 shows the results of iron removal rate at the Hotleg and Downcomer.

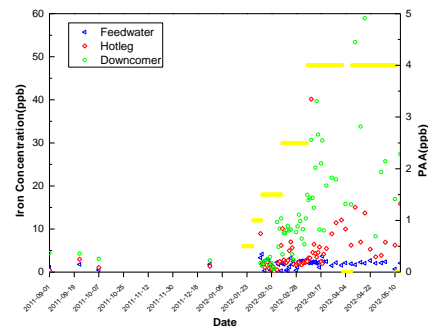


Fig 5. The Efficiency of iron removal at the Hotleg and Downcomer during YG Unit 6 Dispersant trial.

## 3. Conclusions

PAA appeared to have a small effect on the measured blowdown cation conductivity, raising it by 0.24 uS/cm . Total Organic Carbon has no change during the injection dispersant trial.

The most important result of the application PAA trial is the substantial improvement in hotleg and downcomer iron removal rate from 1.45 to 3.63 ppb and from 7.29 to 23.30 ppb, respectively.

## REFERENCES

- [1]M. Kreider, A. Miller, L. Wilson, P. King, Dispersant for Tube Fouling Control-Volume 4: Long-Term Trial at McGuire Unit 2: Implementation and Results(2005-2006). EPRI, Palo Alto, CA: 2007.1015021
- [2] K.Fruzzetti, M. Kreider, A. Miller, Dispersants for Tube Fouling Control, Volume I:Qualification for a Short-Term Trial at ANO-2, EPRI, Palo Alto, CA, and Entergy Operations, Russellville, AR: 2001. 1001422.