국내 원자력발전소 증기발생기 화학세정 적용에 대한 고찰

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The status of the oxygenated treatment application in Power Plant

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1. Introduction

Since the first application of OT (oxygenated treatment) at a real power plant in 1980 in Korea, KEPCO(Korea Electric Power Corporation) research institute has attempted to review the data collected from sites and to evaluate the performance. OT was firstly applied at Ulsan power plants in 1980. AVT (all volatile treatment) was employed during commissioning and early operation period. Differential pressure of boiler occurred frequently over the limitation values, 43 bars despite optimum AVT chemistry being practiced. AVT was converted to OT to deal with pressure drop problem at that time. The boiler pressure drop deceased to the initial operation stage and the pressure has remained in constant with the application of OT. OT was adopted to solve operating problem as a trouble shooting at that time.

KEPCO has adopted super-critical boiler, 500MW coal firing unit as a standard model in the late 1990s. The emergence of super-critical boiler has required the optimum water treatment, because the fast scale growth rate was expected. And also the short of interval in chemical cleaning and the short of regeneration frequency in polisher were observed. Therefore, the optimum water treatment in feed water has been studied by KEPCO research institute. The basic philosophy of KEPCO research institute is to choose the optimum water treatment based on not trouble shooting in operation but economic savings to reduce the operating costs.

In this paper, the current status of OT for fossil power plants in Korea is summarized. The lessons learned and operational experiences with respect to OT impact are discussed. And also current issues in Korea are briefly described.

2. The experience of oxygenated treatment in power plant

The first large-scale application of OT in Korea was at Ulsan power station in 1980. Ulsan power station consists of three 200MW for unit 1-3 and three 400MW for unit 4-6, subcritical boilers. Boilers for unit 1-3 are Babcock, France and boilers for unit 4-6 are Steinmuller, Germany. The feed water system is all ferrous with stainless steel tubing in the high pressure heaters and carbon steel tubing in the low pressure heaters. Condenser tubes are aluminum brass.

There are three possible choices for feed water treatment such as AVT(R), AVT(O) and OT. They have three distinctly different characteristics in feed water treatment. First, AVT or AVT(R), where uses ammonia and reducing agents such as hydrazine. The oxidizing-reducing potential, ORP, will be in the range -300 to -350mV (Ag/AgCl/sat.KCl). Second, AVT(O), where the reducing agent has been eliminated. Here, the ORP will be around 0mV but could be slightly positive or negative. Third, OT, where oxygen and ammonia are added to the feed water. Here, the ORP will be around +100 to +150mV.

They have been started with AVT. Units 4-6 were converted to OT from AVT, but unit 1-3 have continued AVT. Unit 4-6 suffered from pressure drop at boiler due to ripple roughness scale inside of boiler tubes at the commissioning period. To preclude such problems, they were chemically cleaned twice yearly whereas unit 1-3 were cleaned about every 25,000hours. Finally the feed water treatment had been changed to OT to solve this problem.

The primary objective of conversion was to reduce the pressure drop of boiler. The reduction of pressure drop in boiler has been achieved at Ulsan power station with the application of OT. The pressure drop was reported to be at 35 bars after conversion, compared to 52 bars experienced before the conversion. A major benefit of the conversion is the improvement in boiler pressure drop. This improvement is shown in figure 1.

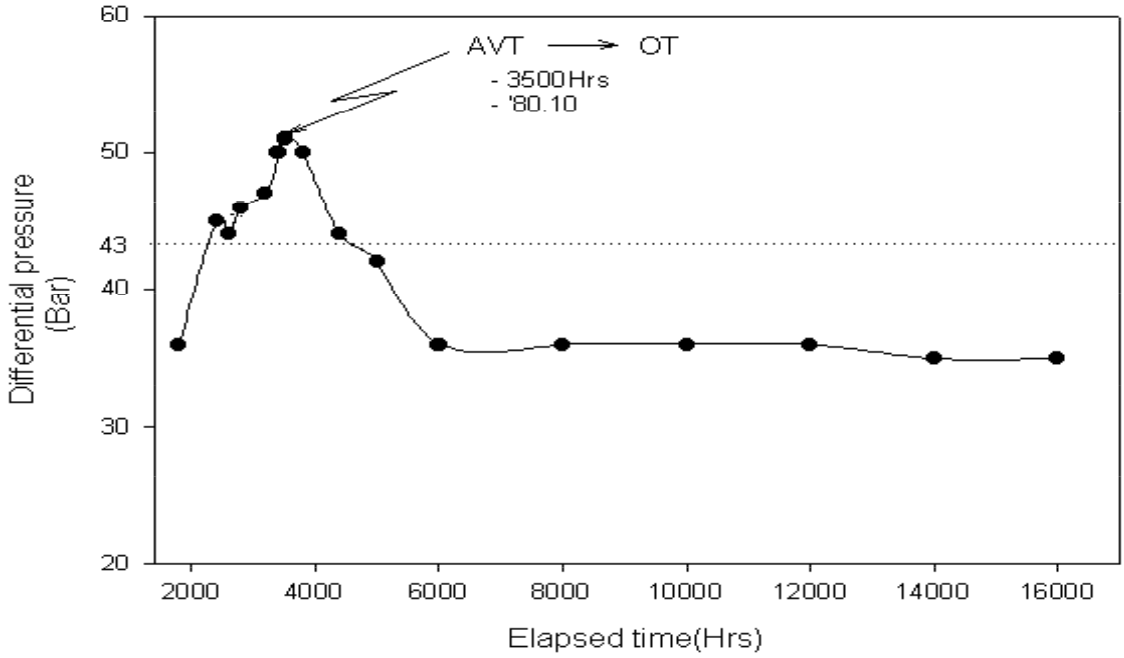


Figure 1. Boiler pressure drop of Ulsan unit 5 as a function of operating time

Water wall tubes have been periodically extracted and deposit analysis was performed to evaluate the scale growth rates. Figure2 shows scale growth rate as a function of operating time at Ulsan unit 4 for comparative periods of operation for OT and AVT. Significant improvement in scale growth rate was achieved with OT. The accumulation of corrosion product deposition on the boiler water walls was significantly reduced. It was resulted in minimization of corrosion products transport and mitigation of any possibility for FAC (flow accelerate corrosion) in the feed water train. Chemical cleaning frequencies were extended to between six and eight years due to the reduced deposit rates achieved by OT.

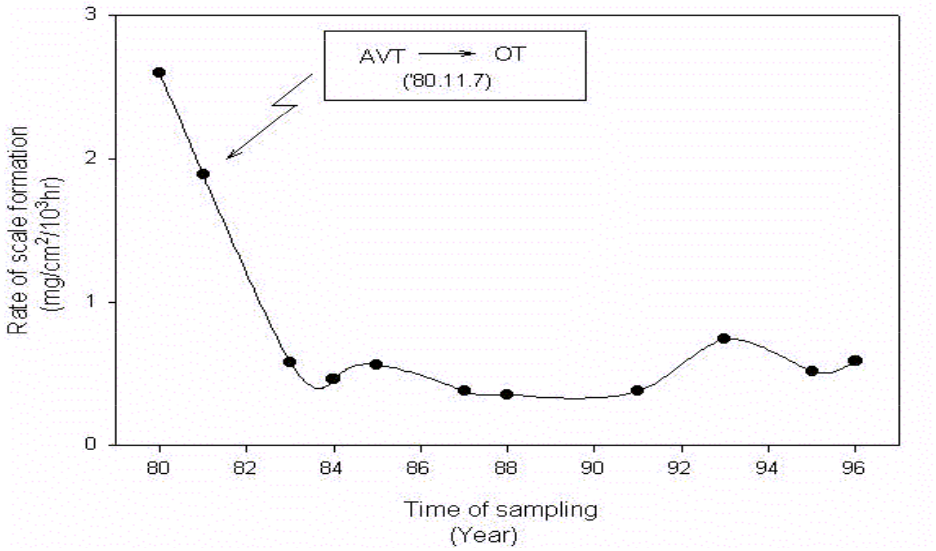
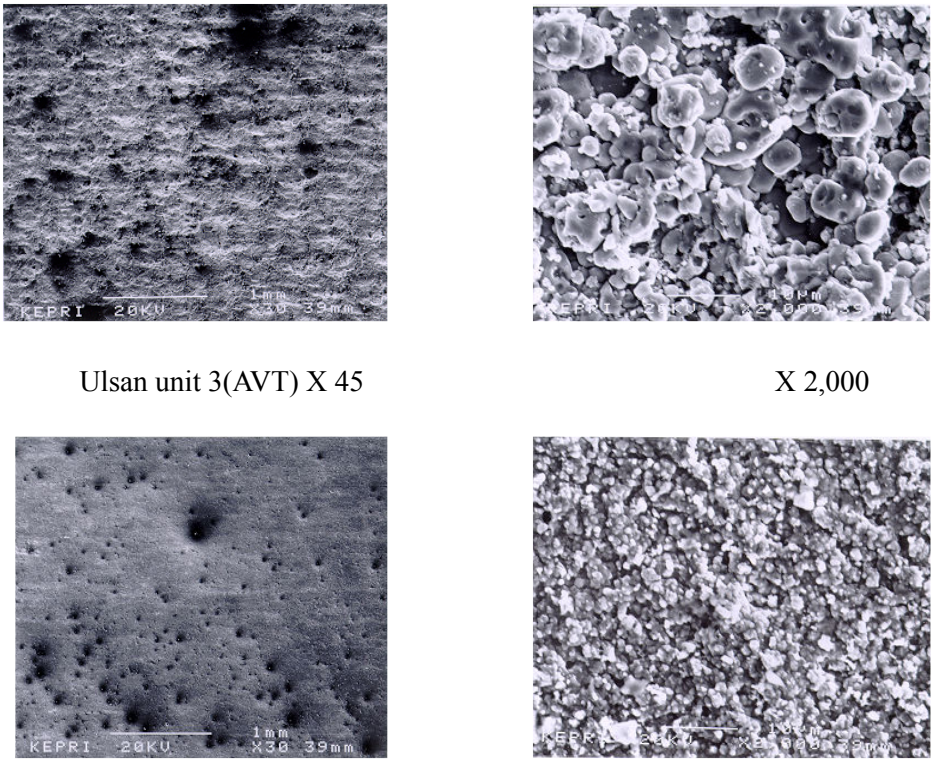


Figure 2. Rate of scale formation at Ulsan unit 4

Morphology formed by OT was investigated to compare before and after conversion to OT.

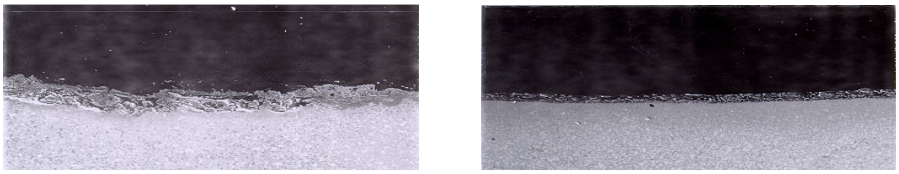
Figure 3 illustrates appearance of deposits on the water wall tubes under OT condition and AVT condition. Grain size of scale formed by OT is much smaller and smoother than that of formed by AVT. And also figure 4 shows cross section of scale formed water wall tube. Figure 4 shows that scale formed under OT condition is thinner than that of AVT condition. These kinds of appearances are strongly inhibited to diffuse iron ion into the fluid boundary layer.



Ulsan unit 3(AVT) X 45 X 2,000

Ulsan unit 5(OT) X 45 X 2,000

Figure 3. Appearance of deposits on the water wall tubes under OT and AVT condition



Ulsan unit 3(AVT) X45 Ulsan unit5(OT) X45

Figure 4. Cross sectional photographs of scales under OT and AVT conditions

There is nothing particularly unique about either the configuration or materials of construction of boiler and turbine systems operating with OT in Korea. There have also been no reported materials problems related to OT at the long term operation on OT.

In conclusion, the comparison of operating experience from plants applying AVT and those using OT demonstrates clearly the superiority of OT over AVT. The superiority is more evident in plants of super-critical boiler which have converted to OT from AVT. The next section provides an overview and economic advantage for super-critical boilers following conversion.

3. Conclusions

The primary objectives of the OT application were to remedy presently operating problem such as boiler pressure drop when OT was introduced firstly into Korea in 1980. However, OT has been now applied for the economic savings as an optimum water treatment since 1990. All core thermal plants which are once-through boiler more than 500MW have been currently converted to OT. Field experience over the last twenty years in Korea that conversion plants to OT or AVT(O) have clearly shown a very large economic advantages for both once-through and drum units.

The basic KEPCO research institute policy is to obtain the economic savings and minimization of environment impact with the optimization of cycle chemistry. The author feels strongly there will be an increasing number plants that will control the feed water chemistry with oxidizing conditions such as OT or AVT(O). Nuclear plants are currently also considered to apply oxidizing conditions in feed water system.

[References]

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