Reliability Improvement by Applying Hydrazine Free Operation and High-AVT(LO) to Sub-critical Pressure Drum Type Steam Power Plant

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BLCP Power plant Unit 1 and Unit 2 in Thailand are sub-critical pressure drum type steam power plants. Both the Units changed their water treatment method from the conventional AVT(R) (All Volatile Treatment (Reducing)) and PT (Phosphate Treatment) to the latest environmentally-friendly High-AVT(LO)(All Volatile Treatment (Low Oxygen)), which is free from hydrazine and sodium phosphate. This paper presents this change, which resulted in good operational achievements.

1. Introduction

Hydrazine, which is used to remove oxygen that causes corrosion in steam power plants, is designated as a mutagenic (suspected carcinogenic) chemical. Therefore, safer oxygen scavengers and water treatment without oxygen scavengers are being adopted overseas.

In general, sub-critical pressure drum type steam power plants adopt AVT(R) using ammonia and hydrazine for the feedwater system and PT using sodium phosphate for the boiler water. BLCP power plant Unit 1 and Unit 2 in Thailand also adopt AVT(R) and PT. And then, they changed water treatment method to High-AVT(R), which has a higher feedwater pH than conventional AVT(R), to suppress FAC (flow-accelerated corrosion). However they have stopped hydrazine injection from the perspective of the hydrazine free operation, and changed the water treatment method to High-AVT(LO). After this change, good operational results have been achieved and are presented in this paper.

2. Overview of High-AVT(LO)

Table 1 compares conventional AVT(R) and PT with High-AVT(LO).

AVT (All Volatile Treatment) is roughly divided into AVT(R) and AVT(O). Conventionally, All Volatile Treatment is called AVT(R) ((Reducing)), which uses ammonia for pH adjustment and hydrazine for oxygen scavenging (as a reducing agent), has been adopted in Japan. On the other hand, AVT(O) is a hydrazine free water treatment method that uses only mechanical deaeration through devices such as a condenser and deaerator to remove oxygen from feedwater. Furthermore, High-AVT(LO) is a treatment method that exceeds the feedwater quality management standard (upper limit: pH 9.7) defined in the existing JIS B8223(1) standards and the dissolved oxygen concentration is low. High-AVT(LO) has been applied to domestic and overseas combined cycle plants and has achieved good operational results.(2)

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Table 1 Compares conventional AVT(R) and PT with High-AVT(LO)

Water treatment method	Chemical used			Feed water pH
	Feedwater		Boiler water	
	Ammonia	Hydrazine	Sodium phosphate	
AVT(R)+PT	Used	Used	Used	8.5 to 9.7
High-AVT(LO)	Used	Unused	Can be unused*	9.8 to 10.3

*Note: Used when seawater leakage in some cases.
AVT (O) : All Volatile Treatment (Oxidizing)
AVT (LO) : All Volatile Treatment (Low Oxidizing)
AVT (R) : All Volatile Treatment (Reducing)
PT : Phosphate Treatment

At the 2013 JIS revision committee, in which Mitsubishi Hitachi Power Systems, Ltd. participated, the standardization of High-AVT water treatment was promoted and adopted as a revision plan. High-AVT water treatment method, which is the latest environmentally friendly water treatment technology, can maintain higher pH simply by injecting ammonia into the feedwater, so the use of hydrazine and sodium phosphate under normal operation can be stopped[(2)]. Furthermore, since the feedwater pH of this water treatment is higher, pipe thinning caused by FAC is relieved compared with conventional AVT(R) and PT. The dissolution of iron is also reduced, so the increase in the iron concentration in the feedwater can be suppressed and a reduction in scale adhesion can be expected.

Figure 1 shows the iron potential-pH diagram. For both AVT(R) and High-AVT(LO), the oxide, in which iron is stable, is considered to be magnetite (Fe_3O_4).

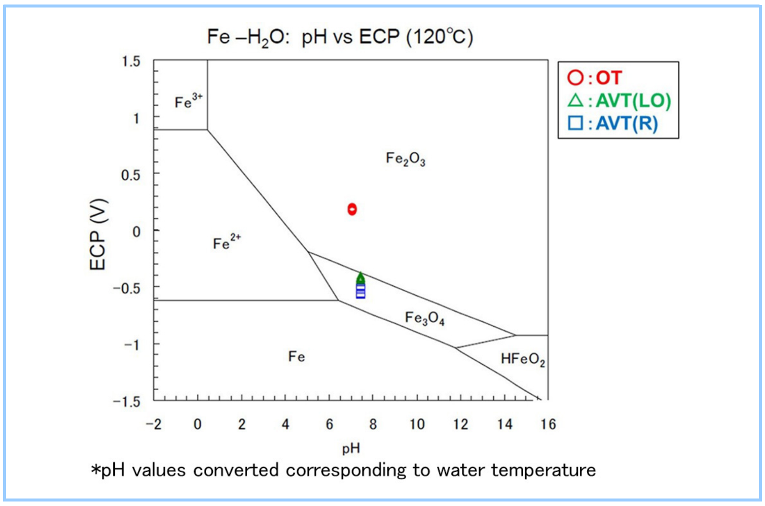

Figure 1 Iron potential-pH diagram
AVT in the figure indicates High-AVT.

3. Overview of Power Plant

The BLCP power plant is located in the Map Ta Phut Industrial Park in Rayong Province in southeastern Thailand, about 2.5 hours by car from Bangkok, the capital, as shown in **Figure 2**. **Table 2** lists the main facilities of BLCP power plant Unit 1 and Unit 2. The rated output per unit is 717 MW and each unit has a subcritical pressure drum type boiler.

The commercial operation of Unit 1 was started in October 2006 and that of Unit 2 commenced in February 2007[(3)]. Thereafter, pipe thinning caused by FAC had occurred in each part of the boiler feedwater pump (BFP) and surrounding piping from sometime around September 2012. In March 2013, the water treatment was changed to High-AVT(R), the feedwater pH of which is made higher with use of ammonia, to suppress FAC. The water treatment of Unit 1 and Unit 2 was then again changed to High-AVT(LO) in September and October, respectively, 2017, which was accompanied by the stop of hydrazine injection. Sodium phosphate injection has been also stopped.

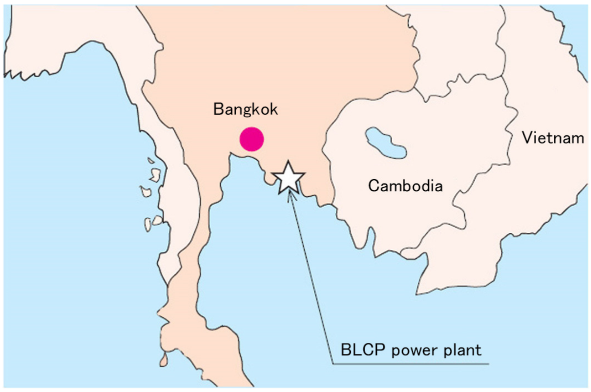

Figure 2　Location of BLCP power plant

Table 2 The main facilities of BLCP power plant Unit 1 and Unit 2

Item	Specifications	
	Unit 1	Unit 2
Start of commercial operation	October 2006	February 2007
Boiler	Pulverized coal fired, forced circulation single-drum radiant reheat type boiler	
Fuel	Coal (bituminous coal), Diesel oil (for starting up)	
Maximum continuous evaporation	2285t/h	
Boiler outlet steam condition	17.26MPa ×541/541°C	
Turbine	Tandem-compound quadruple exhaust flow reheat regenerating condensing turbine	
Rated output	717 MW (at generator terminal)	

4. Evaluation of Operation

Figure 3 depicts the water quality trend before and after stopping hydrazine injection. The hydrazine injection was stopped with the pH maintained at 9.8. The dissolved oxygen concentration in the feedwater after stopping hydrazine injection was about 5 ppb, which indicated that the operation was as planned without hydrazine.

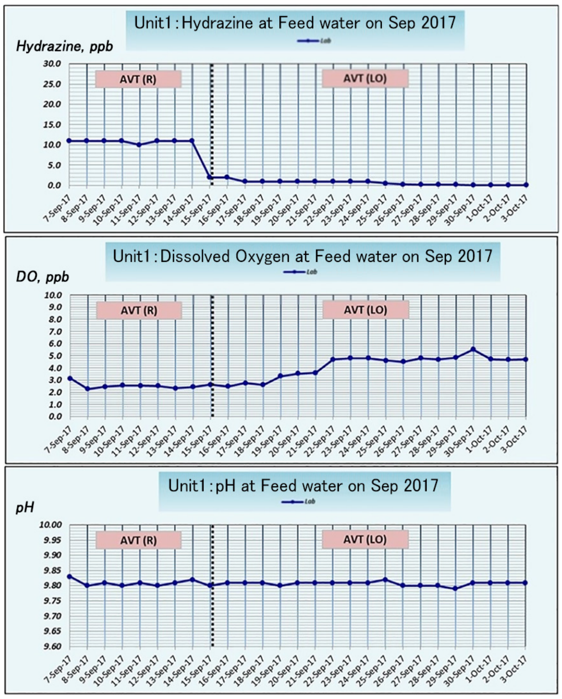

Figure 3　Water quality trend before and after stopping hydrazine injection.
AVT in the figure indicates High-AVT

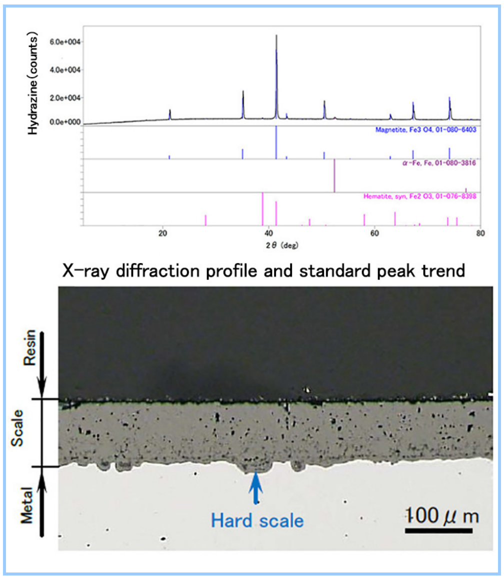

Figure 4　X-ray diffraction results of the inner surface scale of a boiler wall tube and the peak trend of the identified substance（After about 10 months of operation after stopping hydrazine injection）

Figure 4 presents the X-ray diffraction results and the peak trend of the substance of the inner surface scale of a furnace wall tube after about 10 months of operation after stopping hydrazine injection. The oxide film was composed of a single phase of magnetite (Fe_3O_4), and no scale modification or abnormal growth was observed. After the change to the High-AVT water treatment method, the scale adhesion amount tended to be saturated shown in **Figure 5**, and the speed of the pressure drop increase of the high pressure feedwater heater decreased shown in **Figure 6**. Accordingly, it is presumed that the dissolution amount of iron from the system piping such as the low pressure feedwater heater becomes lower and the amount of bringing in and adhering to the high pressure feedwater heater and the boiler decreases.

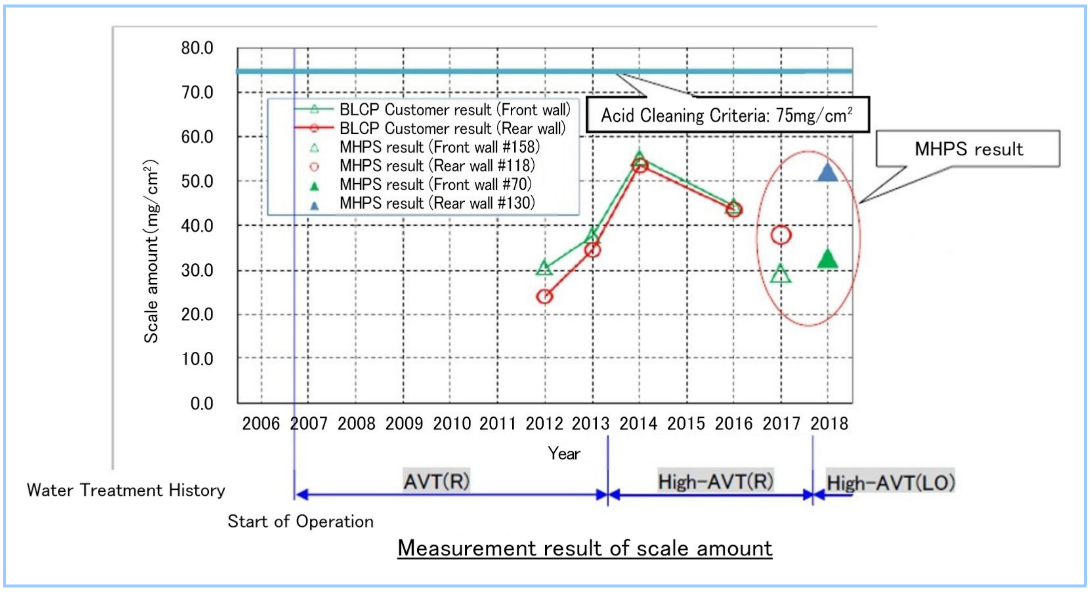

Figure 5 Amount of scale adhesion after the change to the High-AVT

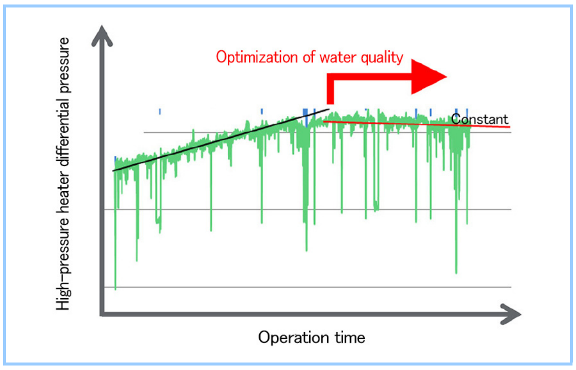

Figure 6 Pressure drop of high-pressure heater

5. Conclusion

BLCP Power Station Unit 1 and Unit 2 in Thailand are sub-critical pressure drum type steam power plants. Both the Units changed their water treatment method of the feedwater and boiler water from the conventional AVT(R) and PT to High-AVT(LO), and they have been operating without any problems up to now. High-AVT(LO) provides a water treatment option especially for overseas sub-critical pressure drum type steam power plants where hydrazine is tightly regulated.

Furthermore, in the case of this water treatment method, since the feedwater pH is higher compared with conventional AVT(R) and PT, the dissolution of iron is reduced, so a reduction in scale adhesion can be expected.

References

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(3) Asada et al, Design and Construction Overview of the Biggest Coal Fired Power Plant in Thailand (BLCP Power Plant), Developed by Private Companies as IPP Business, Mitsubishi Heavy Industries Technical Review Vol.44 No.4 (2007)