The Evaluation and Investigation of Combustion Adjustment Testing for Reducing the NOx Emissions of Hsieh-Ho Unit 4

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1.Abstract:

In recent years, the Environmental Protection Agency of Keelung City has constantly requested Hsieh-Ho Power Plant (HHPP) to adopt proper measures to reduce the NOx emission of unit 4- 10% to 15% emission cut before the end of June, 2019.

To fulfill the mission, the following matters had been handled and the NOx emission had successfully reduced before the deadline：(1) 2 pre-combustion seminars held, (2) carrying out combustion equipment checks and preparatory work during the time period of overhaul, (3) completing the adjustment, and balancing sliding air among burners, (4) 130 rounds of boiler combustion optimization adjustment in two stages, under stable unit load conditions of 155 MW and 440 MW.

2.Research Methods

1. Comprehensive analysis of the NOx control mechanism of Hsieh-Ho unit 4 for the discussion of the NOx combustion optimization strategy.

2. Manpower coordination and improvement project planning during the time period of overhaul:

(1) The secondary air volume flow rate of each burner (24 burners in total) is adjusted and improved in advance by equalizing the flow rate.

(2) The electric control mechanism of OFA damper has been refurbished, so that it can be operated remotely from the control room.

(3) Each OFA damper mode (7, 8, x) is adjusted and planned in advance.

3. Coordination of construction schedule and on-site cooperation of each combustion adjustment:

(1) A team of 6 members from the research institute and the factory teams work together and share the work schedule

(2) Cooperate with the phase-in application for the fixed load maintenance of the boiler of Hsieh-Ho unit 4 (according to the dispatching center);

(3) Cooperate with boiler setting operation regularly and acquire relevant data (including PI, environmental NOx);

(4) Arrange boiler fuel oil sampling and testing in both phases.

4. Establish a flue gas multi-grid analysis system (NOVA PLUS) at the exit of the economizer (ECO) to assist in the on-line diagnosis and analysis of boiler combustion adjustment (Figure 1).

5. Design and build a combined air-conditioning room to provide multi-grid measurement and analysis of flue gas to avoid frequent downtime of the analyzer due to high temperature (> 46 °C) in the high load (440 MW) combustion adjustment stage.

6. Verify and reorganize the setting combination of each burner, overfire air damper, and equipment.

7. Carry out measurement and analysis of the full opening of the main air damper (sliding air damper) of the burner in the boiler windbox, and implement the adjustment and improvement of the secondary air flow rate of 24 burners.

8. Implement low-load (155 MW) and high-load (440 MW) combustion adjustments in stages, and perform immediate debugging and analysis of the main operating parameters of the boiler in compliance with the regulations of operational safety and environmentally friendly emissions (Figure 2).

9. On the premise of keeping the operation margin, under the conditions of low load of 145 MW, 155 MW and high load of 440 MW, the optimal DeNOx combustion control set parameter groups (Figure 3) are developed to provide reference for the operation on duty.

10. According to the research experience of successfully solving the high combustion vibration case of Hsieh-Ho unit 1 in 2018, the high combustion

vibration mode detection and preliminary vibration control of Hsieh-Ho unit 4 has been completed.

3.Results and Applications

1. After combustion optimization in stages (Figure 4), the NOx reduction of the boiler reaches 16% (from 169 ppm to 141 ppm) at a high load of 440 MW and 25% (from 109 ppm to 81 ppm) at a low load of 155 MW.

2. The improvement result of this plan is the same as that of adding FGR (NOx reduction by 10% ~ 15%), saving 360 million NTD in equipment improvement. The tangible benefits are extremely significant.

3. After achieving the NOx reduction as scheduled, Hsieh-Ho unit 4 has been able to smoothly increase the power supply and enhance the reserve capacity of the power system every year under the scheme of total air pollution control since 2019, which effectively mitigates the pressure of tight power supply.

Hsieh-Ho Power Plant	Multi-grid analysis of flue gas at ECO outlet							
Unit	A(Left)				B(Right)			
4								
Load	Monitoring point	O_2	CO	NO	Monitoring point	O_2	CO	NO
155MW	A1	2.7	2.0	104.0	B1	2.7	3.0	99.0
Date	A2	2.7	1.0	72.0	B2	2.6	2.0	108.0
3/13	A3	2.8	1.0	108.0	B3	2.5	1.0	121.0
Time	A4	1.9	0.0	111.0	B4	2.0	1.0	109.0
14:40	A5	1.6	0.0	107.0	B5	1.6	8.0	108.0
Group	A6	2.5	4.0	111.0	B6	2.3	4.0	101.0
0313-5	A7	2.2	1.0	106.0	B7	3.5	2.0	107.0
	A8	1.2	0.0	104.0	B8	4.1	2.0	105.0
	A9	2.3	3.0	105.0	B9	2.0	2.0	103.0
	A10	1.7	1.0	103.0	B10	1.8	1.0	108.0
	Average(Left)	2.2	1.30	103.1	Average(Right)	2.5	2.6	106.9
Note:	1.Please leave blank the points with measurement problems and explain the problems and possible reasons after remarks							
	2.When the measurement value is found to be different from other values, mark with different colors first							
	3.The unit of O_2 is %, the unit of CO is ppm in 6% O_2 base, and the unit of no is ppm in 6% O_2 base							

Figure 1 Multi-grid analysis of flue gas at ECO outlet

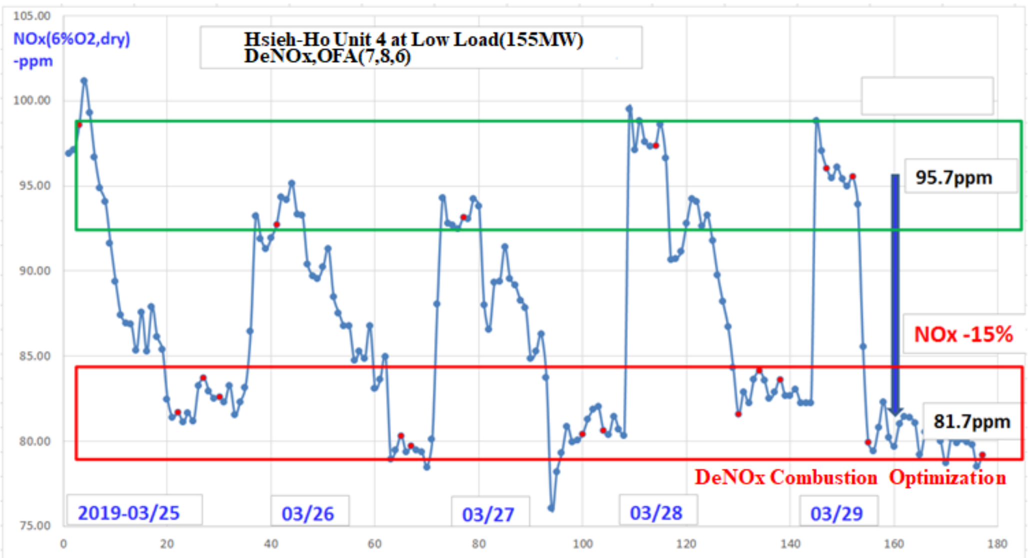

Figure 2 Low load [155MW] De-NOx optimized combustion adjustment and back test.

LOAD	O2 Trim	NOx Port	Oil Tmp	Stm-Oil Dp	GRF DA-7	NOx	OP	O2 R/L	CO	Stack O2	Fur Virb
MW	%	%	℃	kg/cm2	%	ppm	%	%	ppm	%	μm
145 (8-b)	33	45	102	1.2	15	76.6	15.2	2.5/2.0 (2.0/2.2)	(25/67)	7.6	250 (6R)
155 (10-a)	35	45	102	1.2	10	79.5	14.4	2.3/1.9 (2.2/1.9)	(89/29)	7.4	265 (6R)
440 (29-3)	46	45	104	1.4	7	141.4	14.8	1.2/1.3 (1.4/1.5)	(87/36)	4.4	324 (9R)

Figure 3 Optimal operation parameters of DeNOx under various loads.

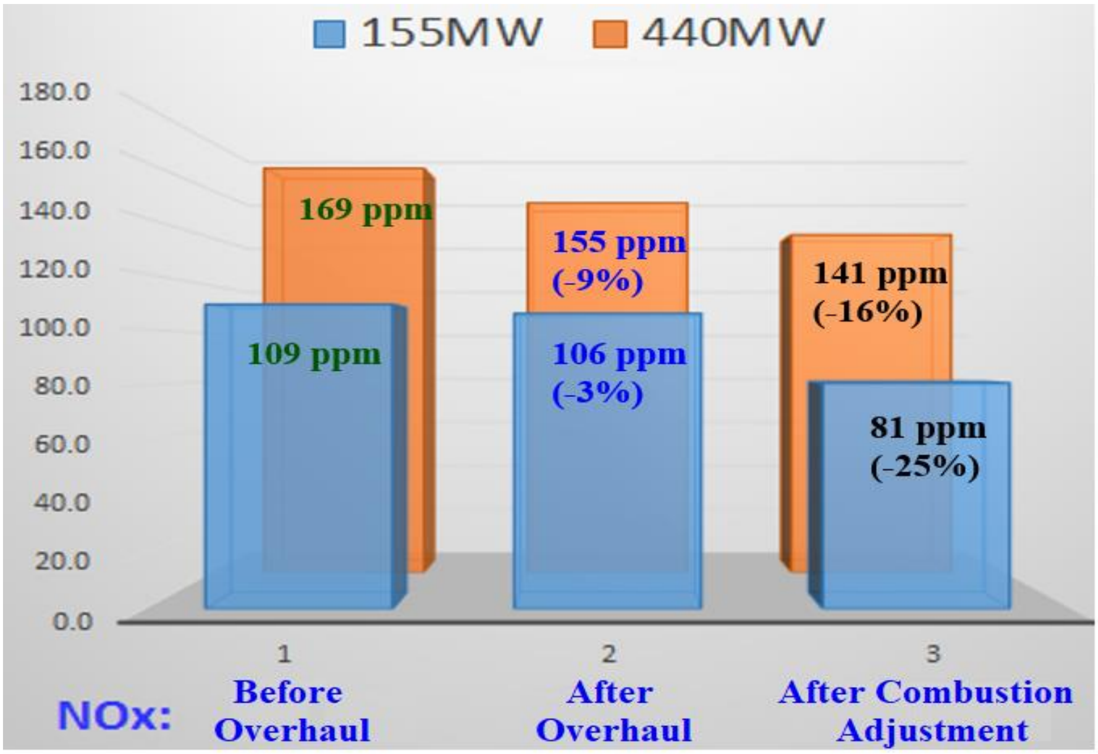

Figure 4 The effect of DeNOx after overhaul and combustion adjustment of Hsieh-Ho Unit 4.