Experimental Analysis of an Regenerative Air Preheater In Boiler TPS- 1 Expansion

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Abstract: *An air pre-heater is a general term to describe any device designed to heat air before another process (for example, combustion in a boiler) with the primary objective of increasing the thermal efficiency of the process of the flue gas in a regenerative pre-heater. This project analysis how operation parameters of a regenerative air preheater can be optimized in order to increase its efficiency and consequently the overall efficiency of a boiler. As mention in phase-1 project the case study of RAPH is implemented in this work for the reduction in air leakage by 30% and in order to improve the efficiency of RAPH-2 in Unit-I, TPS-I (Expansion) of the Regenerative Air Pre-Heater was improved by reducing the leakage of air into flue gas in the RAPH, and i t is minimized by replacing the ordinary radial seals into "Flexible Seals" and also by proper maintenance of the RAPH and it is implemented for the experimental analysis. For this purpose, the RAPH in thermal power station -1 expansion at neyveli is considered and studied for a period and suitable remedies have been suggested.*

Keywords—Air preheater, Regenerative air preheater, boiler, and sealing

I. INTRODUCTION

Modern high capacity boilers are always provided with an air preheater. Air pre-heater is an important boiler auxiliary which primarily preheats the combustion air for rapid and efficient combustion in the furnace serving as the last heat trap for the boiler system, a regenerative air preheater typically accounts for over 10% of a plants thermal efficiency on a typical steam generator. Considering this, when evaluating the performance of an air preheater one should take into account all of the process variables. A very good method to improve the overall efficiency of a thermal power plant is to preheat the air. If the incoming air for combustion is not preheated, then some energy must be supplied to heat the air to a temperature required to facilitate combustion. As a result, more fuel will be consumed which increases the overall cost and decreases the efficiency. There are many factors, which contribute to the deterioration of air preheater performance like high seal leakage, deterioration of heat absorption characteristics of basket elements due to fouling or plugging. Close monitoring of air preheater performance and proper instrumentation would enable timely detection of performance degradation. The combustion air preheater for the large fuel-burning furnaces used to generate steam in thermal power plants The organization of this paper is as follows: Section I gives an Introduction and an outlay of the scope of the work. Proposed methodology is elaborated in Section II. Problem Identification is given in Section III, Study On Performance Improvement Of Air Preheater are, Solution For Improving the Performance Of Raph and are Experimental Analysis described in Section V followed by the conclusion in Section VI.

SCOPE THE WORK

After studying the journal papers mentioned above, it is understood that there are some leakages development in the RAPH and maintenances of RAPH is to be considered for the improvement efficiency of the boiler shell and tube air preheater. The project is planned with the following work scope. To identify the problem and to give an suitable remedies for further increases in efficiency of the boiler with the help RAPH.

II. PROPOSED METHODOLOGY

The proposed methodology of the work are detailed discussed and mentioned as below and are shown in Fig.

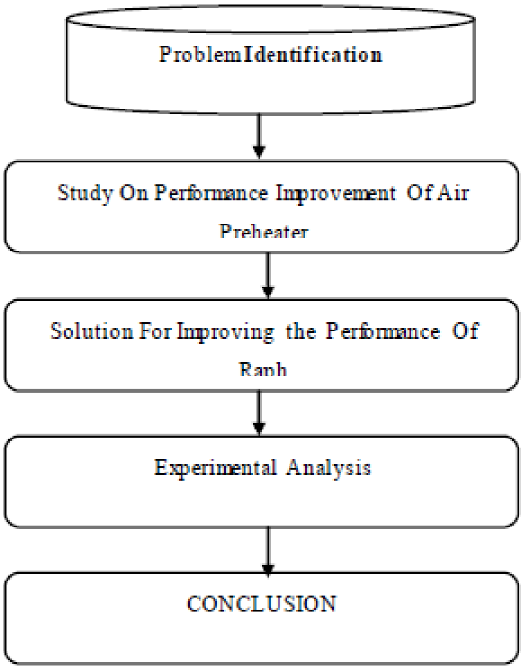

Fig.2. Flow chat of Proposed System

III. Problem Identification

Excessive air heater leakage can cause any of the following additional problems:

- Severe degradation of the performance of downstream air pollution control equipment (electrostatic precipitators, bag houses, and scrubbers).
- Lowered primary air temperatures and consequent reduction of coal mill capacity—particularly in the case of wet coals and Powder River Basin coals.
- Increased potential for mill fires or explosions.
- Load limitations and missed power sales opportunities due to inadequate fan capacity, especially during warm weather.
- Increased NO_X production and loss -on-ignition.
- Poor flame stability at lower load and unattached flame ignition points, as well as flame pulsation.
- Excessive desuperheating due to increased convective heat transfer caused by increased mass gas flow.
- Increased heat rate and air heater plugging.
- Increased rate of cold end air heater basket corrosion.

Study On Performance Improvement Of Air Preheater

Steam generators uses rotary air preheaters to absorb the heat from the flue gas and release that heat to the incoming combustion air.

Thus absorbing the waste heat from the flue gas the efficiency of the boiler in increased. It is estimated that for every 20^0C decrease in gas temperature, the efficiency of boiler goes up by 1%.

With increase in operation cost demand for power and pollution constraint today, every savings in boiler efficiency results in the big money. Recollect the slogan _every MW saved is the MW generated‘.

Air preheaters are one of the major areas of concern for efficiency improvement. It is necessary that we should go for renovation and modernization only for performance improvement.

Even maintaining the ―Regenerative Air Preheater‖ in the correct way will result in the efficiency improvement.

Sl. No.	DATA	UNIT	30-1-16 to16-02-2016	
			RAPHI	RAPH2
1	Unit Load	MW	209	210
2	Fuel consumption	T/hr	210.59	210.59
3	O_2 at Flue gas inlet	%	3.6	4.0
4	O_2 at Flue gas outlet	%	5.6	4.7
5	Flue gas Inlet Temperature	0_C	297	312
6	Flue gas outlet Temperature	0_C	170	186
7	Air Inlet Temperature	0_C	32.8	32.7
8	Air outlet Temperature	0_C	289	312
9	Air Header Pressure	mm WC	24.1	24.1
10	Air Pressure before RAPH	mm WC	30.1	26.1
11	Air Pressure after RAPH	mm WC	24	24.1
12	Pressure of flue gas outlet	mm WC	238	235
12	Draft RAPH inlet	mm WC	5.2	4.6
13	Draft RAPH outlet	mm WC	19.3	22
14	Air flow at inlet	T/hr	500	309
15	Air flow at outlet	T/hr	500	309
16	FD fan current	Amps	67	54
17	ID fan current	Amps	183	191
18	FD fan scoop position	%	50	90
19	ID fan scoop position	%	68	72

AIR INGRESS IN PREHEATER

During the study, the operating parameters like pressure, temperature and oxygen percentage along the flue gas path has been carried out. The study was conduct to analyze the performance of air heater and air ingress in the air heater. Fig 4.8 shows the Graphical illustration of AIR Leakages in RAPH

The details are follows

% Leakage of air = (Gas out-Gas in)/Gas In

Table 1.2 Air Ingress in Preheater

DESCRIPTION	PRESSURE, Mm WC	FLUE GAS TEMPERATURE ^0C	OXYGEN	EXCESS AIR, PROFILE %
RAPH I & II inlet	66 to 53 & 40 to 53.6	312 & 297	4.7 & 3.6	29.01 & 20.81
RAPH-I outlet	238	170	4.0	57.14
RAPH-II outlet	235	186	5.6	36.60

Table 1.3 % of air leakage in RAPH 1&2

AIR LEAKAGE	% LEAKAGE
RAPH1	28.1
RAPH2	13.1

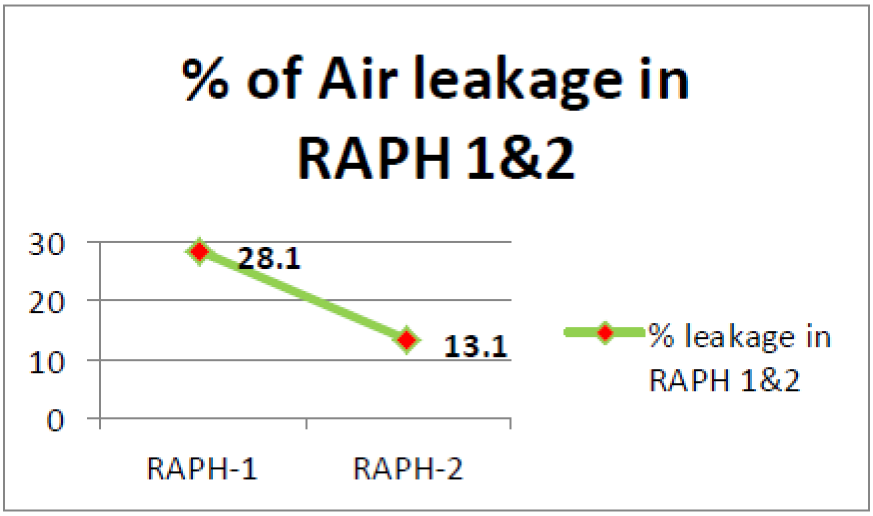

Fig 1.1 A graphical illustration of AIR Leakages in RAPH

ADVANCEMENT IN SEALS:

The air preheater is a critical component of the boiler combustion air system. Evaluating and optimizing a heater's performance is difficult with the entire combustion system and the lack of standardized calculation tools.

The regenerative air heater or air preheater (APH) on a large utility boiler often accounts for about 10% of the unit's thermal efficiency.

Its performance is so critical that just a 10F change in gas exit temperature can change the boiler efficiency by a quarter of a percent. Reducing leakage by using modern seal technology will improve combustion efficiency, maintain fan performance, and keeps the down stream air quality in control.

FLEXIBLE RADIAL SEALS: Flexible Radial seals are used to minimize the direct air to gas leakage that occurs at the center section or sealing surfaces in the air heater. The seals are attached to each diaphragm of the rotor to maintain close contact with the sealing surface that separates the air and gas streams

TYPE-1:

The type-1 radial seal incorporates a unique patented bellows architecture that ensures positive contact with the sealing surface. When sealing edge wear occurs this type of seal can be simply adjusted, rather than replaced.

TYPE-2:

This type-2 seal is a full contact flexible radial seal. This seal complements robust protection system, augmenting the benefits and features found in the type-1 flexible full contact seal. They are highly erosive and are exposed to high -pressure water washing, as well as air preheaters that have been enhanced with carbide overlaid sector plates. These seals are typically recommended for larger rotor sizes (greater than 25) where the aggressive rotor turndown encountered in these size rotors can be as large as 2-4 inches

EXPERIMENTAL ANALYSIS AIR PREHEATER PERFORMANCE CALCULATION:

(Readings as observed in the RAPH of a Thermal Station)

1. Before implementing flexible seal:

% of oxygen in the flue gas outlet: 5.6

% of oxygen in the flue gas inlet : 3.6 Leakage % in APH is given by

(% o_2 out - % o_2 in) / (21- % $o_2$out). =(5.6-3.6) / (21-5.6)

=13.1%

2. After implementing the flexible seal:

% of oxygen in the flue gas outlet: 4.7 % of oxygen in the flue gas inlet : 4.02 Formula to find leakage % is given by (% o_2 out - % o_2 in) / (21- % o_2 out). =(4.7 -4.02) / (21-4.7)

=4%

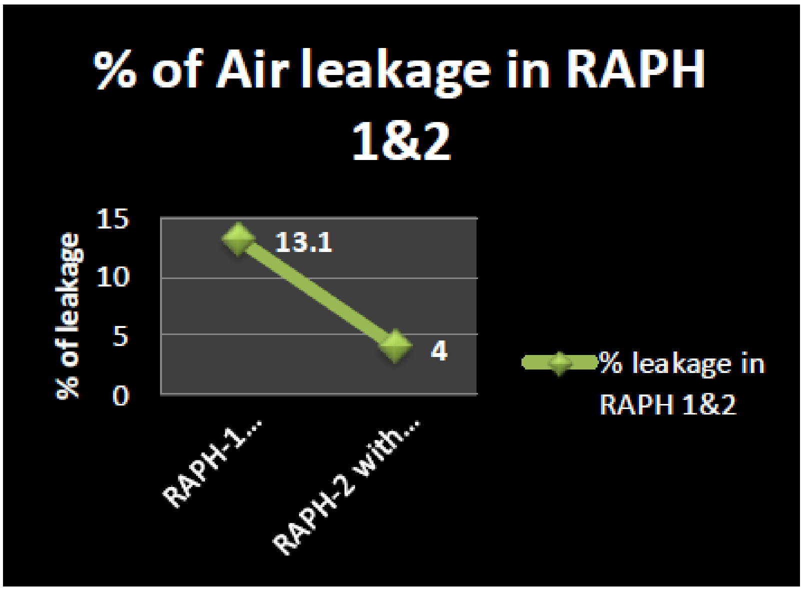

Fig 1.2 A Graphical illustration of Air leakage in RAPH

VII. CONCLUSION

By this paper it is concluded that the efficiency of the Regenerative Air Pre-Heater was improved by reducing the leakage of air into flue gas in the RAPH, and it is minimized by replacing the ordinary radial seals into

"Flexible Seals" and also by proper maintenance of the RAPH. Thus the air leakage is reduced 30% by using RAPH-2

REFERENCE

[1.] Shah, R.K., Sekulic, D.P., ―*Fundamentals of Heat Exchanger Design*‖, John Wiley & Sons Inc., Canada, 2003.

[2.] Juangjandee, P. and Sucharitakul, T., ―*Performance Evaluation of Cross Flow Heat Exchanger in Coal Fired Power Plant under Particulate Condition*‖, 18th Conference of Mechanical Engineering Network of Thailand, Khon Kaen University, Thailand, 2004.

[3.] Juangjandee, P. and Sucharitakul, T., ―*Performance Evaluation of Leakage Cross Flow Heat Exchanger in Coal Fired Power Plant*‖, 19th Conference of Mechanical Engineering Network of Thailand, Phuket, Thailand, 2005.

[4.] Juangjandee, P. and Sucharitakul, T., ―*Effect of High Ash Content Lignite on Cross Flow Heat Exchanger Performance in Mae Moh Lignite Fired Power Plant*‖, HAPUA Fuel Procurement & Utilisation Forum, Kuala Lumpur, Malaysia, 2006

[5.] Juangjandee, P. and Sucharitakul, T., ―*Air Heater Performance and Enhancement under Low Rank Coal*‖, *16th Conference of Electric Power Supply Industry*, Mumbai, India, 2006.

[6.] Bostjan Drobnic, Janez Oman. ―*A numerical model for the analyses of heat transfer and leakages in a rotary air preheater*‖ , International Journal of Heat and Mass Transfer 49,PP.5001–5009, 2006.

[7.] Pipat Juangjandee ―*Performance Analysis of Primary Air Heater Under Particulate Condition in Lignite FiredPower Plant*‖ *Engineering, Computing and Architecture*, ‖ISSN 1934, 7197,vol 1,issue 2,2007