SOOT BLOWER OPERATION TO IMPROVE THE BOILER HEAT PEAK UP

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***Abstract**: Soot blowers are used to free from the direct gas side of heat transfer surfaces to permit the boiler to control at high potency. They additionally accustomed stop plugging of the gas passes. They're mechanical devices used for on-line cleanup of gas side boiler ash and slag deposits on a periodical basis. Soot blowing is used to control the level of ash and slag deposits on the boiler heat transfer sections and maintain the heat transfer efficiency. They direct a operating medium through nozzles against the soot or ash accumulated on the heat transfer surfaces of boilers to get rid of ash deposited on coils, and improve heat transfer potency. Hence optimization of soot blowers operation will improve the Boiler efficiency and reduce the steam wastage. Also reduce the boiler outage due to boiler tube leakage.*

***Keywords:** Boiler, Soot blowers, Super heater, Re-heater, Economizer.*

I INTRODUCTION

Soot is generally formed as an unwanted by-product of incomplete combustion or pyrolysis. Soot generated within flames consists essentially of aggregates of spheres of carbon. Soot found in domestic fireplace chimneys contains few aggregates but may contain substantial amounts of particulate fragments of coke or char. Soot from diesel engines consists essentially of aggregates together with tars and resins. For historical reasons, the term soot is sometimes incorrectly used for carbon black. This misleading use should be avoided.

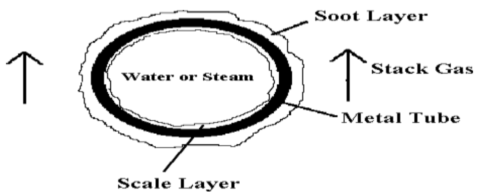

Fig 1 Water Tube With Soot Outside and Scale Inside

Soot is a mass of impure carbon particles resulting from the incomplete combustion of hydrocarbons.

Soot is a randomly formed particulate carbon material and may be coarse, fine, and/or colloidal in proportions dependent on its origin. Soot consists of variable quantities of carbonaceous and inorganic solids together with absorbed and occluded tars and resins.

Fig 2 Soot Formation in Boiler Coils

Boilers are delivered clean with no soot, slag and scale. Consequently a soot and scale problem is a classic management and operational problem that has very little to do with boiler design. Soot and slag is a mixture of solid carbon, ash, and molten ash that sticks to the fire side of the tube and prevents heat transfer. Slag will also cause corrosion.

Fig 3 Boiler coil damage

In any combustion process of a fuel there will be always some unburned carbon (soot) generated and some ash carried with the stack gas stream. Soot, ash, and molten ash (slag) will accumulate at the tube banks of the heat exchangers. Some ash will even melt down at the tube surface. The final result is a layer insulating the tubes against the hot combustion gases.

II OBJECTIVE

This work consists of soot blower operation. The objectives are

- To make soot blower clean the soot deposition on the boiler tube more effectively and increase the overall working efficiency of the boiler.
- To reduce damage on furnace wall tubes due to excessive blowing.
- To reduce steam wastage.
- In this project right and appropriate scheduled time is mentioned.

III. LITERATURE REVIEW

Chayalakshmi c.l.et.al (2014) Boiler is a power house of any process industry. Soot and scale formation in boilers is still a great concern for increasing the efficiency of the boiler. At present, soot blowers are operated manually once in a shift. This paper presents one of the embedded based industrial automation technique for efficient operation of soot blowers. An automation technique is designed and implemented in real time using ARM7 platform. Stack temperature is used as the criteria for controlling the soot blower. Embedded C language is used for implementing the automatic control algorithm. The performance of the designed system is tested in the laboratory.

Bharathi.et.al (2016) Boiler is one of the main equipment in thermal power plant. The Soot, ash on the surface of boiler tubes is still a great concern and affecting the efficiency of the coal fired boiler. At present soot blowers are operated manually in every shift. This project presents one of the embedded based industrial automation techniques for efficient operation of the soot blowers in both auto and manual mode, which also adopts the stack based temperature controlling of soot blower for optimization of soot blower control to increase the boiler efficiency. An automation technique is simulated in real time using proteus.

IV THERMAL POWER STATION-I EXPANSION

The soot blowers system is capable to provide superheated steam to the boiler soot blowers for heat exchanging surface cleaning to the regenerative air heaters soot blowers and to ventilation mills Re suction duct soot blowers for cleaning duty.

Steam is taken from super heater SH $_2$coil outlet header with a pressure control station where the pressure is reduced to 24 bar. The temperature of the super heated steam is approximate 400^{0}C. Quantity of steam consumed per blower per operation is 750Kg.

Performance of operation of is five minutes. Total time consumed for one cycle is one hundred twenty minutes. Every soot blower can cover3 meter diameter and 50% of the furnace width. The soot blower includes a tube element with 2-venturi nozzles through that steam is blown on the tube bundles round the specific blower. The tube element Will be getting into the flue gas flow, with a rotating movement and obtain back to its original position.

During this, the nozzles movements in a helical direction. The two nozzles opposed each other and the spreading blowing jets ensure complete cleaning coverage during the whole movement of the tubes.

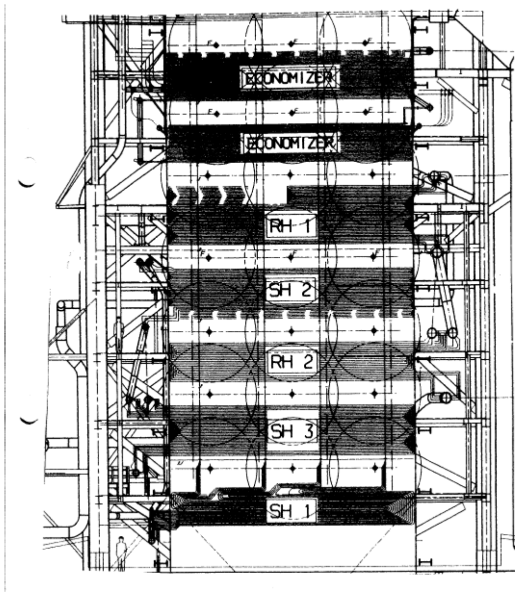

Fig.4 Soot blowers covering areas in boiler TPS-I Expansion

V TABULATION FOR ENTIRE COILS

Table 1 Temperature reading in soot blowers operation

Temperature Readings	Unit	8.10.2018 9.15-10.15 Before	8.10.2018 14.15-15.15 After	09.10.2018 10.00-11.00
Drum Pressure - SH1 Inlet Pressure	Barg	160	159	158
SH1 Inlet Temperature	˚C	350	348	348
SH1 Outlet Temperature (Left)	˚C	403	413	408
SH1 Outlet Temperature (Right)	˚C	399	410	400
SH2 Inlet Temperature (Left)	˚C	361	363	361

SH2 Inlet Temperature (Right)	°C	365	366	368
SH2 Outlet Temperature (Left)	°C	458	457	452
SH2 Outlet Temperature (Right)	°C	456	454	453
SH2 Inlet Pressure	barg	157	156	156
SH3 Inlet Temperature (Left)	°C	428	418	422
SH3 Inlet Temperature (Right)	°C	430	419	429
SH3 Outlet Temperature (Left)	°C	533	536	537
SH3 Outlet Temperature (Right)	°C	533	535	539
SH3 Inlet Pressure	barg	155	153	153
SH3 Outlet Pressure	barg	152	151	150
Total Steam Flow	T/Hr	609	604	602
SH2 Spray water flow	T/Hr	62	68	62
SH3 Spray water flow	T/Hr	28.5	38.4	27.5
RH1 Steam Pressure	barg	35.6	35.5	35.5
RH1 Inlet Temperature	°C	341	343	346
RH1 Outlet Temperature (Left)	°C	436	432	433
RH1 Outlet Temperature (Right)	°C	437	435	435
RH1 Outlet Pressure	barg	33.9	33.8	33.5
RH2 Inlet Temperature (Left)	°C	386	382	384
RH2 Inlet Temperature (Right)	°C	393	383	391
RH2 Outlet Temperature (Left)	°C	534	536	535
RH2 Outlet Temperature (Right)	°C	534	536	537

RH2 Outlet Pressure	barg	33	33	33
RH Spray water flow	T/Hr	17.4	18.7	16.5
Economiser Inlet temperature	˚C	242	241	241
Economiser Outlet temperature (Left)	˚C	316	317	312
Economiser Outlet temperature (Right)	˚C	316	316	312
Feedwater Pressure at Economiser	barg	163	161	161

VI CALCULATION OF HEAT PICKUP OF BOILER

DAY-1 (8-10-2018) Before operation

Super heater$_1$ coil Heat pickup (Enthalpy values calculated used to steam table)
Inlet Temperature =347˚C
Inlet pressure (drum pressure) = 160 barg
Enthalpy =2577.58 KJ/Kg
Outlet Temperature =401˚C
Outlet pressure = 157 barg
Enthalpy =2957.56 KJ/Kg
C_p = 4.3874 KJ/Kg k
Steam flow rate = 497.4 TON/hr

$$Q = m (h_2 - h_1)$$

Here,
$h_1$and h_2=enthalpy
m = mass flow rate
Q = 518.5 × (2957.56 – 2577.58) × 1000
=197019630 KJ/Hr

Super heater$_2$ coil Heat pickup (Enthalpy values calculated used to steam table)
Inlet Temperature = 363˚C
Inlet pressure (drum pressure) = 157barg
Enthalpy = 2749.76 KJ/Kg
Outlet Temperature =457˚C
Outlet pressure = 155barg
Enthalpy =3170.07 KJ/Kg
Steam flow rate = 580.5 TON/hr

$$Q = m (h_2 - h_1)$$

Here,
$h_1$and h_2=enthalpy
m = mass flow rate
Q = 580.5 × (3170.07–2749.76) × 1000
=243989955 KJ/Hr

Super heater$_3$ coil Heat pickup (Enthalpy values calculated used to steam table)
Inlet Temperature = 429˚C
Inlet pressure (drum pressure) = 155barg
Enthalpy = 3073.75 KJ/Kg

Outlet Temperature =533°C
Outlet pressure = 152barg
Enthalpy =3400.53 KJ/Kg
Steam flow rate = 609 TON/hr

$$Q = m\,(h_2 - h_1)$$

Here,
$h_1$and h_2=enthalpy
m = mass flow rate
$Q = 609 \times (3400 - 3073.75) \times 1000$
=198686250 KJ/Hr

Re heater$_1$ coil Heat pickup (Enthalpy values calculated used to steam table)
Inlet Temperature = 341°C
Inlet pressure (drum pressure) = 35.6 barg
Enthalpy = 3079 KJ/Kg
Outlet Temperature =436.5°C
Outlet pressure = 33.9 barg
Enthalpy =3307.17 KJ/Kg
Steam flow rate = 45 TON/hr

$$Q = m\,(h_2 - h_1)$$

Here,
$h_1$and h_2=enthalpy
m = mass flow rate
$Q = (609-45) \times (3307.17 - 3079) \times 1000$
=128687880 KJ/Hr

Re heater$_2$coil Heat pickup (Enthalpy values calculated used to steam table)
Inlet Temperature = 389.5°C
Inlet pressure (drum pressure) = 33.9barg
Enthalpy = 3198.76 KJ/Kg
Outlet Temperature =534°C
Outlet pressure = 33barg
Enthalpy =3529.56KJ/Kg
Steam flow rate = 581.4 TON/hr

$$Q = m\,(h_2 - h_1)$$

Here,
$h_1$and h_2=enthalpy
m = mass flow rate
$Q = 581.4 \times (3529.56 - 3198.76) \times 1000$
=192327120 KJ/Hr

Ecnomiser coil Heat pickup (Enthalpy values calculated used to steam table)
Inlet Temperature = 243°C
Inlet pressure (drum pressure) = 163barg
Enthalpy = 1048.670 KJ/Kg
Outlet Temperature =316°C
Outlet pressure = 163barg
Enthalpy =1427.398 KJ/Kg
Steam flow rate = (609+2) TON/hr

$$Q = m\,(h_2 - h_1)$$

Here,
$h_1$and h_2=enthalpy
m = mass flow rate
$Q = (609+2) \times (1427.398 - 1048.670) \times 1000$
= 231402808 KJ/Hr

VII GRAPH DIAGRAM

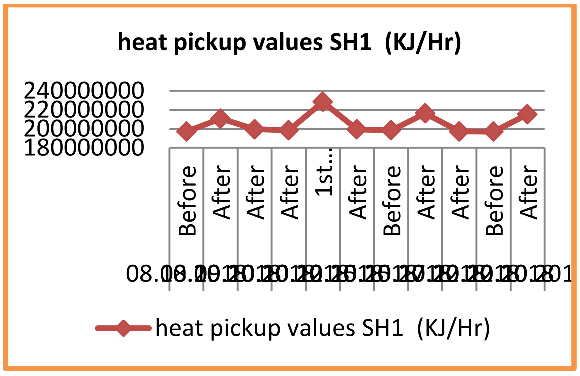

Fig 5 SH$_1$ Coils heat Pickup Value

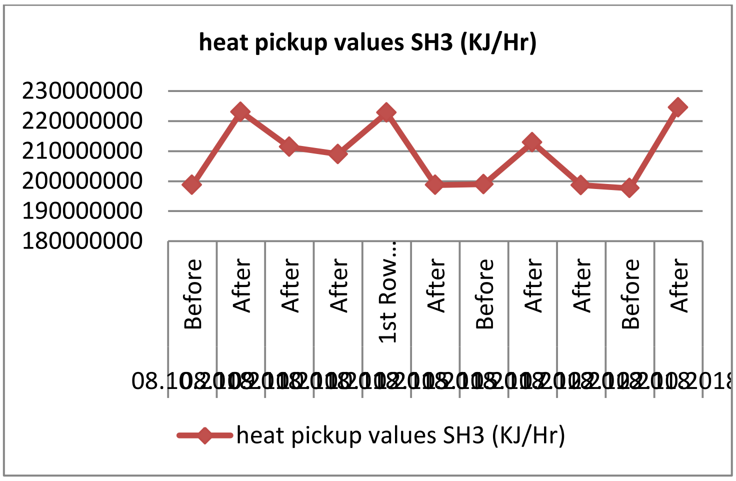

Fig 6 SH$_3$ Coils heat Pickup Value

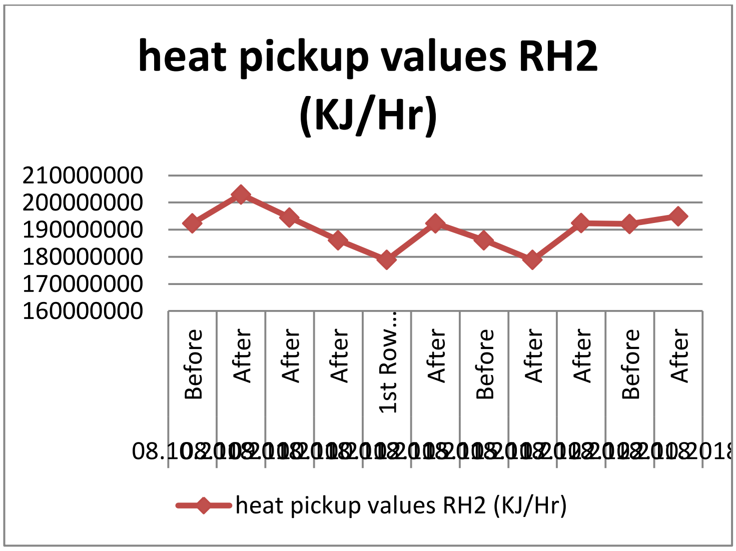

Fig 7 RH$_2$ Coils heat Pickup Value

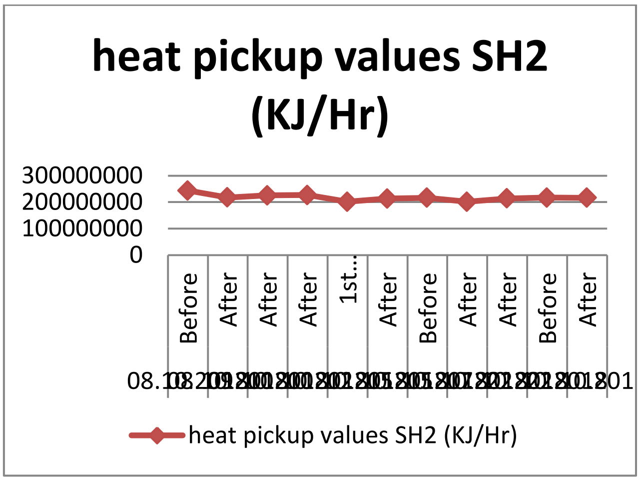

Fig 8 RH$_2$ Coils heat Pickup Value

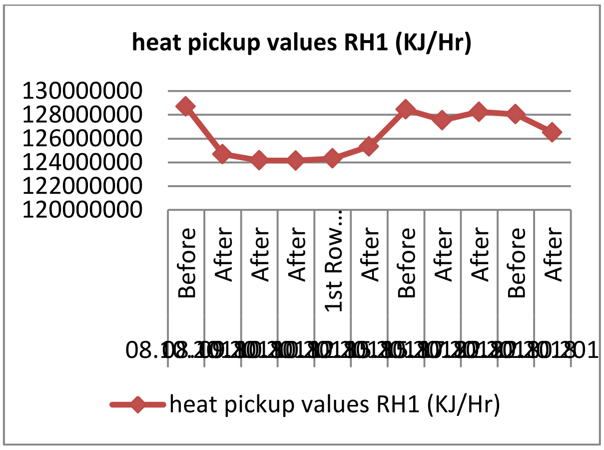

Fig 10 RH1 Coils heat Pickup Value

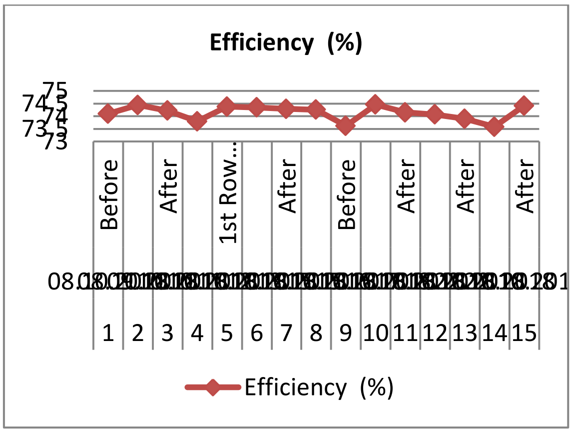

Fig 11 Efficiency of boiler

VIII RESULT AND DISCUSSION

We have monitored the efficiency of the soot blowers in TPS-I expansion Boilers for the period of two weeks before and after operating soot blowers. It is observed that efficiency of soot blowers operation is more in SH$_1$, SH$_3$and RH$_2$ coil area. we found that slag is more in this area and heat pick-up increases after sootblowers operation immediately and slag formation starts within 2 days

In RH2 and SH2 area slag formation is moderate the heat transfer remains clean for 3-4 days after soot blowing.

In the RH1 and Econ area no slag formation is absorbed only find accumulation is note this because of sootblowers operation ,exhaust flue gas temperature came down 6-7 degree centigrade. After sootblowing increases the boiler efficiency by about 0.5%.

IX CONCULATION

Now all the sootblowers operation are carried out in 7 days. The slag deposits is not uniform in the all coils the sootblowers schedule shall been modified as follows.

- 1st row of coil shall be operated once in a day.
- 2nd and 3rd row of coil shall be operated twice in a week.
- 4th row of coil shall be operated as per schedule

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