Soot Blower Optimization Technique in Recovery Boiler

C.Dinesh, G.Saravanan, A.Mohamed Ibrahim and V.Kumar Chinnaiyan
1,2,3,4Department of Electrical and Electronics Engineering
1,2,3,4Kpr Institute of Engineering and Technology, India
dinesh.chml@gmail.com, sarapro@gmail.com, mohamedgct06@gmail.com, kumarchin@gmail.com

B.Karthik
Junior Manager
Chemical Recovery Plant
Seshasayee Paper Board Ltd, India
bkarthikdurai@gmail.com

Abstract - The Chemical Recovery boiler is the profit earning section of Paper Industry. By properly reutilizing the resources like wood, water and steam for manufacturing, there would be a chance of the paper cost can be reduced. To be the proper functioning of the boiler Soot blowers is necessary. There are 28 Soot blowers available in Seshasayee Paper Board Ltd., Pallipalayam, procured from Clyde Bergemann Inc., Atlanta, USA. Optimization of High-Pressure steam during soot blowing saves green energy and effectively controls the plugging tendency. The fouling management of the boiler was enhanced and the soot blowing steam consumption was reduced. Soot Blowing performed only where and when needed. This project focuses on how to reduce the high-pressure steam during Soot blowing process. Heat transfer from flue gas to water and steam to get maximum potential. This will increase the efficiency of the Recovery Boiler.

Keywords - Chemical Recovery Boiler (CRB), Soot Blowing, High pressure Steam, Plugging

1. Introduction

Chemical Recovery Boiler (CRB)

CRB is a piece of the kraft cycle and pulping where synthetics for white alcohol are recuperated and improved from black liquor, which contains lignin from recently handled wood. The black liquor is scorch, producing heat, which is utilized simultaneously and in creation power, much as in a regular steam power plant. The creation of the recuperation kettle by G.H Tomlinson in the mid-1930s was an achievement in the headway of the kraft cycle.

Description

The CRB at SPB Ltd is a Single Drum, Finned Tube, Top-upheld, Natural Circulation, drainable water tube heater. The black liquor is scorch, creating heat, which is generally utilized all the while or in creation power, much as in a customary steam power plant. The Recovery evaporator is additionally utilized in the sulfite cycle of wood pulping

The CRB has two fundamental capacities. On one hand, it produces steam from the warmth energy endless supply of the natural constituents of black liquor consumed in the tank, whereby the CRB fills in as a steam evaporator. Then again, the synthetic compounds from mash processing - sulfur and sodium-are back from the black liquor, the CRB at that point filling in as a substance reactor [1]. This twofold capacity makes the plan of a recovery boiler rather unpredictable and the activity of such kettle considerably more convoluted than that of, our case, a force plant evaporator consuming regular powers in the evaporator. When seeing the CRB as a substance reactor, its development is very remarkable. In the recuperation evaporator heater, by and large in a similar space and simultaneously, various completely separate physiochemical measures occur CRB is utilized to recover inorganic salts utilized in the pulping of paper [2]. Black liquor, the arrangement left in the wake of eliminating pulp, is decreased through vanishing and is then combusted in the evaporator. The ignition of a consuming a bio-mass fuel just as cycle salts prompts a heater that encounters to some degree fast sooting of said salt cake [3]. Decrease of inorganic sulfur mixes to sodium sulfide, which exits at the base as smelt. Creation of liquid inorganic progression of primarily sodium carbonate and sodium sulfide, which is later recycled to the digester in the wake of being re-disintegrated. Recuperation of inorganic residue from pipe gas to spare synthetic compounds [4]. Creation of sodium smoke to catch ignition buildup of delivered sulfur compound. Recovery boiler is used to recapture inorganic salts used in the pulping of paper. Black liquor, the solution left after removing pulp, is reduced through evaporation and is then combusted in the boiler. The combustion of a burning a bio-mass fuel as well as process salts leads to a boiler that experiences somewhat rapid sooting of said salt cake [5]. Reduction of inorganic Sulphur compounds to sodium sulphide, which exits at the bottom as smelt. Production of molten inorganic flow of mainly sodium
carbonate and sodium sulphide, which is later recycled to the digester after being re-dissolved. Recovery of inorganic dust from flue gas to save chemicals. Production of sodium fume to capture combustion residue of released sulphide compound.

Specifications
Table 1 represents Specifications of Chemical Recovery boiler.

| Details                  | Data Required |
|--------------------------|---------------|
| Type of Boiler           | Water tube Boiler |
| Manufacturer             | Enmas Andritz |
| Type of Spray            | Stationary Gun |
| Liquor inlet Temperature | 110 C          |
| Boiler Capacity          | 900 TPD        |
| Evaporation of Boiler    | 140 kg/hour    |
| Main Steam Temperature   | 460 C          |
| Working Pressure         | 84 Kg/cm       |
| Black liquor firing rate | 36 tons/hour   |
| Steam flow rate          | 70 tons/hour   |

2. Peripheral Apparatus
Notwithstanding the heater itself, there is a great deal of peripheral apparatus that is basic to the activity of the CRB which incorporates:
- The system of black liquor
- Streams and Dissolving container
- Soot blowers
- Electrostatic precipitator

The System of black liquor
The main fuel of the recuperation evaporator is the concentrated black liquor which contains natural disintegrated wood buildup notwithstanding sodium sulfate from the cooking synthetic substances added at the digester. Burning of dark alcohol in the recuperation kettle heater should be controlled cautiously [6]. Exceptionally grouping of sulfur requires ideal cycle conditions to maintain a strategic distance from creation of sulfur-dioxide and decreased sulfur gas outflow. Notwithstanding ecologically clean ignition, decrease of inorganic sulfur must be accomplished in the scorch bed.

The black liquor framework incorporates the gear for setting up the liquor for terminating and presentation it into the furnace [7]. In a common place framework, the alcohol firearms are joined physically to a heater header for example ring header through which alcohol prepared for terminating is provided. The primary substance of dark alcohol is  Na₂CO₃, Na₂SO₄, NaOH, Na₂S. Warmth energy is halfway used to change over the natural mixes and mostly utilized as fuel to create steam.

Semi concentration Black Liquor at 70% concentration is supplied to mixing tank where salt cake (Na₂SO₄) is added as make-up chemical and boiler hopper ash is also mixed with black liquor. The black liquor is then heated up to 110°C through direct heating of the steam and then fired in the boiler through stationary Spray guns. The organics are converted into Na₂CO₃ and is further reduced to Na₂S through chain of reactions. All the inorganic flow through cooled spout as molten smelt into dissolver.

Streams and dissolving container
The liquid smelt that is created inside the CRB is taken out from the heater through the smelt spouts into a dissolving tank where it is broken up to shape green liquor. The spur openings can be exposed to changing smelt levels and streams and require some type of erosion insurance [8]. Spout cooling water frameworks are intended to limit the weight inside the spur while giving a sufficient progression of cooling water [9].

The gathered cooling water is then cooled and siphoned back to the head tank. An unsettled tank is utilized to break up the smelt and structure green alcohol. Break jets are utilized to separate the smelt stream as it streams out the heater to forestall the collection of liquid smelt inside the tank [10]. Control of the thickness of the green alcohol inside the dissolving tank is a vital aspect for balancing out the whole recuperation cycle.

Soot blowers
Soot-blowers are used to remove deposits from the heat transfer surfaces (super heater, boiler bank, and economizer) within the boiler. The soot-blower lances are mounted on carriages outside the boiler. When a soot-blower is activated, the lance moves into the boiler and rotates [11]. Steam jets located near the front of the lance strike the deposits and blow them off the tube surfaces. Most soot-blowers blow continuously as they move into the boiler and then retract. Some are set up to blow while travelling in but to retract quickly with a second part of the cycle [12]. We will discuss in detail about the parts and working of the soot blowers in the following section.

Electrostatic Precipitator
The electrostatic precipitator is utilized to eliminate dust from the vent gas leaving the CRB. It is situated toward the finish of the train only in front of the stack [13]. The residue that is taken out at the precipitator is principally sodium sulphate (salt cake) and it is reused to the dark liquor. Precipitator dust likewise will in general be advanced in chloride and potassium [14]. On the off chance that the plant has stopping issues because of chloride gathering in the recuperation cycle, a portion of the precipitator dust is unloaded to cleanse chloride. Some chloride expulsion measures additionally start with precipitator dust.
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3. Objective and methodology

The general target of this examination was to distinguish the main driver blocking the compelling presentation of the residue blowers. The particular goals were:

- To recognize a thorough rundown of issues and the main driver that contrarily sway the presentation of residue blowers like spout harm, steam spillage, and so forth,
- To give a premise to creating suggested arrangements that address the recognized underlying drivers issues and moderate or dispose of the negative effects on execution
- The method of improving the energy efficiency of the plant by reducing the soot blower steam consumption needed to maintain economizer cleanliness.

4. Approach and Procedure

The methodology for leading the underlying driver examination on ash blower execution oddities included gathering information by taking the estimation of Main steam pressure, ID fan RPM, Furnace pressure, Main steam Temperature, Main steam stream, High-Pressure steam to break down where the fouling is more and took surveys and meetings with the architects and administrators working in the synthetic recuperation heater [15].

The system used to play out the RCA incorporated the accompanying advances:

Step–1: Characterize an issue: The smooth activity of the sediment blower in the evaporator is influenced by different reasons as announced by the business.

Regardless of their endeavors to control them, the total destruction of the cases stayed a test

Step–2: Assemble information and proof: information was accumulated to archive past inadequacies in execution. These information were dominantly assembled from surveys archived reports that explicitly tended to the maintenance works embraced in the residue blowers. The huggeness and estimation of the discoveries in a large number of these reports were as yet fitting. The discoveries from these reports were approved and enhanced with meetings of individuals straightforwardly liable for residue blowers in the evaporator.

Step–3: Identify problems that contribute to the delinquent: On the origin of the data grouped, found the fouling is maximum in the area of bull nose in chemical recovery boiler, which means the area covered by the extended side wall and super heater A sides. So, the most significant issues that plague the soot blower’s performance were identified.

Step–4: Find the root cause: When the basic issues contrarily influencing residue blower execution were discovered, a more intensive survey of the top issues was embraced to decide the motivation behind why they proceed, the RCA procedures regularly alluded to information assortment and found a way to take care of the issue of utilization of steam energy [16].

Step–5: Develop recommended solutions: after deciding the fundamental underlying drivers, a progression of potential arrangements was examined as restorative measures pointed toward settling these issues.

Step–6: Implement the suggested solutions: Each quantity taken from the valve which I put in the boiler near by the soot blowers of 13 & 14 to test whether fouling is taken place or not, and most fouling places also found by testing with manometer testing. By resulting the manometer testing we were found the fouling is taken place before and after soot blowing process. Our aim to reduce the steam consumption during the soot blowers.

Step–7: Detect and measure concert for desired results: Ensure the commitment and allocation of the necessary source which means the differential pressure transmitter (DPT) in the perfect ranges to measure how much water column in the furnace pressure to reduce the steam consumption.

5. Results and Discussion

In the Chemical recovery boiler of Soot blower analysis involved the collecting data by the measurement of Furnace Pressure, ID fan RPM, Main steam Pressure, Main steam flow, Main steam temperature, High pressure steam, SB steam temperature outlet flow.

- Burning of natural material in black liquor to produce superheated steam
- Decrease of inorganic Sulfur mixes to sodium sulfide, which exits at the base as Smelt
- Creation of liquid inorganic progression of basically sodium carbonate and sodium sulfide called Smelt, which is later, reused to the digester subsequent to being re-broken down
- Recuperation of inorganic residue from vent gas to spare synthetic compounds in ESP

In the CRB, by and large in a similar space and simultaneously, various completely separate physiochemical measures occur:

- Feeding of air and blending it in with the heater gases
- Feeding of dark alcohol and scattering it into beads
- Drying of the dark alcohol beads
- Pyrolysis of the dark alcohol and burning of the pyrolysis gases
- Gasification and burning of the singe buildup
- Reduction of the alcohol sulfur mixes to sulfate
- Tapping the liquid salt comprising of sodium sulfide and sodium carbonate from the heater base

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This is sample reading for the observation of furnace draft control by taking all the related readings like main steam temperature, main steam flow, main steam pressure etc., for more than 15 days to where the fouling is taking place is shown in Table 2. After observations the above details I came to conclusion the fouling is more in the bull nose area. The bull nose area is primary super heater and Extended side wall area where the 13th and 14th soot blowers is present.

The operators and the Engineers were clean the soot according to the furnace draft and ID fan by experience they are providing High pressure steam to clean the soot. They are providing the High pressure steam four times per day. On observation with the furnace pressure with the ID fan, the relationship is cascaded to the system because the firing of the weak black liquor is 70 tpd in the CRB. During firing of the weak black liquor the organic components present in the substance is 45% and Inorganic components presence is 55%. The organic component has Carbon, Hydrogen, and Oxygen present in it. So during the firing of the weak black liquor the components carry over through the path of super heater, Boiler bank, economizer zone and went to chimney through ID Fan. If the firing is increased the furnace pressure will be more so ID fan has to suck the flue gas immediately to maintain the Furnace pressure at particular set point.

The furnace pressure and ID fan are cascadelly programmed. The reading were taken during soot blowing time at morning and evening at every day for finding where the fouling is more in the Recovery boiler. All the soot blowers are electrically operated long retracable. The furnance pressure measure is difference between the inlet and outlet of each super heaters and through draft gauges at two particular point in reovery boiler. Superheated soot-blowers have impact on super heated temp control and longevity of material. Boiler bank will help in reducing the furnance exit gas temperature because of increased heat absorption. Economizer will help in improving thermal efficiency of the boiler. For super heater and boiler bank 6.072 TPH is required and for economizer is 5.472 TPH is required.

The area of firing and the placed of the heat transfer tubes in super heater are different location in Recovery boiler. The area which super heater coiler having

### Table 2: Reading for fouling

| S.NO | TIME | SOOT BLOWER Nos | FUR PRES IN mmWC | ID FAN in RPM | MS PRE Kg/cm2 | MS FLO TPH | MS TEMP DEG | HP STEAM | SB STEAM TEMP | OUTLET FLOW |
|------|------|----------------|------------------|---------------|---------------|-------------|-------------|----------|----------------|-------------|
| 1    | 9.59 | 13             | 17.94            | 765.11        | 66.34         | 97.332      | 458.1       | 36.247   | 286.39         | 286.39      |
| 2    | 10.03| 15             | 18.14            | 789.08        | 65.18         | 94.883      | 461.49      | 32.079   | 288.54         | 288.54      |
| 3    | 10.1 | 16             | 17.07            | 785.05        | 64.05         | 90.366      | 460.47      | 33.107   | 291.82         | 291.82      |
| 4    | 10.15| 17             | 17.74            | 774.83        | 63.9          | 90.555      | 459.22      | 34.286   | 293.75         | 293.75      |
| 5    | 10.2 | 18             | 17.04            | 784.38        | 65.54         | 90.129      | 457.74      | 33.899   | 288.34         | 288.34      |
| 6    | 10.24| 14             | 15.68            | 783.86        | 62.6          | 91.314      | 458.31      | 29.637   | 288.77         | 288.77      |
| 7    | 10.28| 19             | 18               | 772.43        | 62.02         | 88.075      | 463.96      | 31.668   | 297.48         | 297.48      |
| 8    | 10.34| 20             | 18.03            | 773.87        | 61.65         | 89.15       | 457.18      | 30.542   | 288.82         | 288.82      |
| 9    | 10.39| 21             | 15.9             | 758.44        | 61.25         | 90.224      | 455.13      | 31.231   | 287.19         | 287.19      |
| 10   | 10.43| 22             | 17.84            | 750.72        | 60.4          | 90.494      | 453.2       | 29.703   | 284.81         | 284.81      |
| 11   | 10.48| 23             | 17.3             | 744.46        | 60.31         | 88.376      | 452.19      | 31.372   | 280.4          | 280.4       |
| 12   | 10.53| 24             | 20.34            | 771.08        | 61.45         | 82.847      | 453.55      | 32.174   | 281.87         | 281.87      |
| 13   | 10.58| 1              | 15.2             | 769.14        | 62.11         | 82.974      | 459.9       | 28.421   | 288.58         | 288.58      |
| 14   | 11.02| 6              | 15.59            | 765.15        | 61.64         | 87.744      | 474.31      | 31.202   | 294.43         | 294.43      |
| 15   | 11.06| 10             | 15.7             | 778.34        | 61.23         | 86.938      | 472.04      | 29.165   | 288.54         | 288.54      |
| 16   | 11.11| 7              | 15.46            | 775.26        | 61.17         | 84.142      | 467.95      | 29.571   | 296.49         | 296.49      |
| 17   | 11.15| 11             | 15.5             | 771.15        | 61.94         | 82.105      | 466.7       | 27.949   | 303.14         | 303.14      |
| 18   | 11.19| 3              | 14.73            | 774.28        | 62.1          | 82.263      | 467.04      | 28.779   | 302.46         | 302.46      |
| 19   | 11.23| 8              | 15.85            | 776.11        | 62.66         | 82.942      | 468.97      | 31.297   | 305.2          | 305.2       |
| 20   | 11.28| 12             | 15.74            | 777.67        | 63.49         | 81.062      | 462.9       | 29.514   | 307.46         | 307.46      |
| 21   | 11.34| 4              | 15.86            | 778.77        | 63.98         | 82.61       | 472.49      | 30.57    | 311.66         | 311.66      |
minimum space of carry over the flue gas path. The flue gas which came out after firing the weak black liquor is minimum space so the flue gas path is reduced when compared to firing place. So if the area is reduced the velocity will be increased. If the velocity is increased the pressure is reduced and pressure drop can be increased. Depends upon the pressure variation in which is having minimum space of boiler we can get the differential pressure by measuring the draft. Because of the pressure drop the ID fan can be vary because it is caseded connection to the furnace draft of the Boiler.

6. Conclusion
The CRB is huge, furnished with most recent innovations intended to work at high steam temperature and strain to accomplish high electric force change efficiencies, and simultaneously to agree to, progressively severe ecological guidelines. With the implementation of Differential Pressure Transmitter (DPT) at the Bull nose area where the fouling is maximum in recovery boiler. Because of this, we reduced the high-pressure steam from 120 tons to 83.5 tons per day during soot blowing process. We got signal from DPT as current signal and given it to the Control panel through junction box. After that communication were developed from control panel to DCS room to control the soot blowing optimization process. This will increase the boiler availability, that is unscheduled outages and increase the efficiency of the Boiler also.

This reduction of steam for using soot blower gives maximum heat generation in the recovery boiler compared to the implementation of the Optimization techniques. Using this technique, we can reduce the soot- blowing maintenance and increase the super-heated Steam temperature also

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