FAILURE ANALYSIS AND DESIGN IMPROVEMENT OF LONG RETRACTABLE SOOT BLOWER

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Abstract - *Soot blowing is an often neglected aspect of the operation of a pulverized coal boiler, yet the way Soot blowers are used can have a significant impact on the boiler efficiency in turn financial bottom line. Left unattended, the deposits can become unmanageable in size and require an expensive outage for removal. Optimizing soot blowing practice can help reduce emissions, reduce losses due to high temperature dry flue gases, reduce the spray and improve unit heat rate.*

The purpose of the project is to eliminate the loss in the heat rate on account of failure in long retractable soot blower (LRSB) operation due to sagging of the lance tube which is extended up to 7 meters inside the boiler in cantilever form and jamming supporting rollers that provides inward and outward movement to the lance tube inside the boiler. Basically, this work deals with the failure analysis and design development of Long Retractable Soot Blower (LRSB). Initially the CAD model for the existing system is prepared followed by finite element analysis. After analyzing the results of failure suitable supports to the lance tube inside the boiler were designed and analyzed for sagging and stresses acting on it. Also, the driving rollers initially exposed to the atmosphere are given the protection shield with external lubrication arrangement.

Keywords: *LRSB, CAD, Finite Element Analysis, Heat Rate*

1. INTRODUCTION:

Power plants must balance the need for maximum heat transfer with minimum operating costs. As a boiler accumulates excess soot, boiler walls and heat exchanger surfaces become clogged and inhibit heat transfer. While the common solution is soot blowing, the soot blowing schedule often fails to clean surfaces either due to mechanical, electrical or C&I problems resulting in degradation of heat transfer rates. Excessive soot deposition may lead localized heating of the tubes resulting in tube failure and it requires an expensive outage for soot removal and tube leakage attending work. Effective soot blowing at scheduled interval without failure delivers up to a 0.36 % heat rate improvement, minimizes soot accumulation, improves heat transfer rates, improves overall boiler efficiency, reduces exhaust flue gas temperature, extends pressure parts life, and avoids forced outages due to soot accumulation.

Fig 1.1: Actual image of LRSB inside the boiler

The basic principle of **long retractable soot blowers** is to periodically keep cleaning the multi surface tube banks by high impact of air, steam or water through the nozzle attached in LRSB through transverse as well rotary motion. Several soot blowers are usually found on each level of boiler tower.

2. DATA ACCUMULATION:

For this project, it is planned to design prototype of the existing system in CAD. All the relevant data pertaining to the system is fetched from the sources. I have chosen zone in between upper and lower LTSH for the project implementation. First, I took the LTSH coil parameters to design prototype. The parameters are listed in the table 2.1.

S.No.	Item Description	Dimensions
1.	Furnace Roof Elevation	50654mm
2.	LTSH inlet header elevation	37029mm
3.	LTSH terminal tube size	44.5 x 6.3 mm
4.	LTHS coil size	44.5 x 5 mm

5.	Vertical pitching between coils	95 mm
6.	Horizontal pitching at ends	100 mm
7.	Front and rear gap	135 mm
8.	Left and right gap	184 mm

Table 3.1: LTSH coil dimensions

Further, in order to design the prototype for Long Retractable Soot Blower (LRSB), all design data related to the dimensions, material of LRSB is obtained from the sources available. The factors like boiler efficiency, root cause of failures are also taken into consideration. These parameters are tabulated in table 2.2. With the help of these dimensions, CAD model of LRSB is generated.

S. No.	Description	Unit
1.	LRSB Model	T.30.MK.1E dual motor
2.	No of LRSB	24 nos
3.	LRSB lance tube material	Stainless Steel 310
4.	Length of travel	7.0 Mtr
5.	Diameter of the lance	80 mm
6.	Thickness of the lance	5 mm
7	Transverse speed of LRSB	1.63 mpm
8.	Rotational speed of LRSB	5.2 rpm
9.	Medium of flow	Superheated steam
10.	Operating temperature & pressure	12 kg/cm^2 at 330^0 C
11.	Frequency of operation	Once in 24 hrs

Table 2.2: Design Parameters of LRSB

3. CAD MODELING:

CAD Model of existing system is designed:

Existing CAD Model

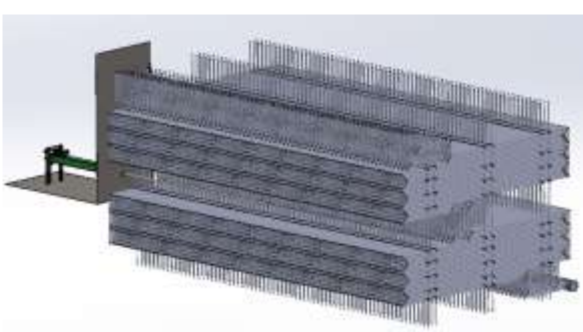

Fig 3.1: Isometric view of LRSB position in LTSH coils

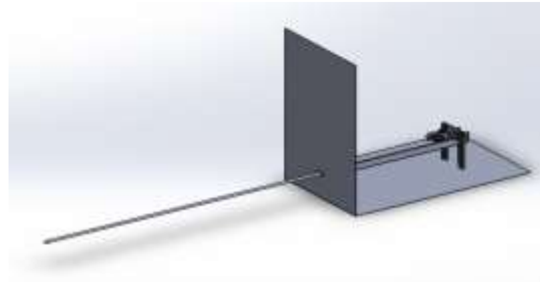

Fig 3.2: Isometric view of LRSB

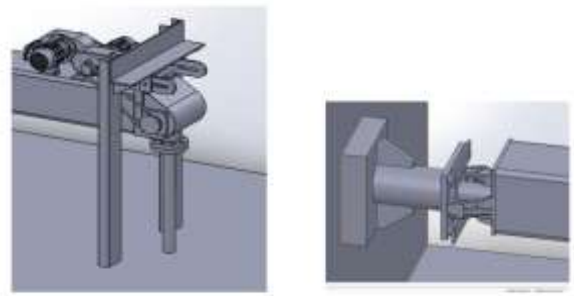

Fig 3.3: CAD model of LRSB Drive mechanism and LRSB guide mechanism

Proposed design:

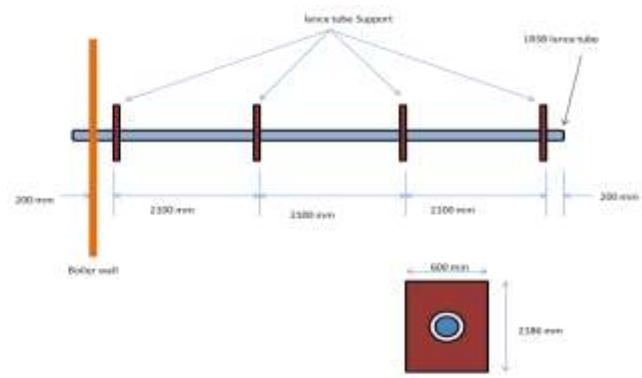

Fig. 3.4: Supports provided to the LRSB lance tube

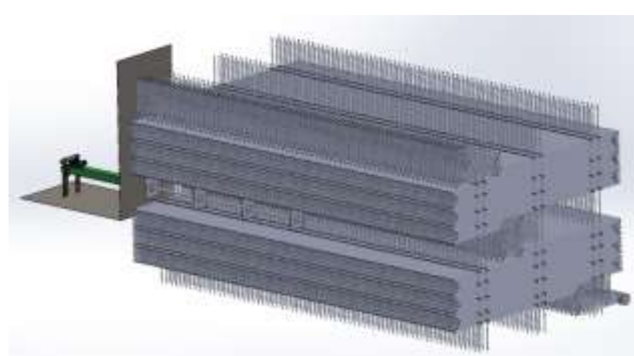

Fig 3.5: Isometric view of LRSB position in LTSH coils with supports to lance tube

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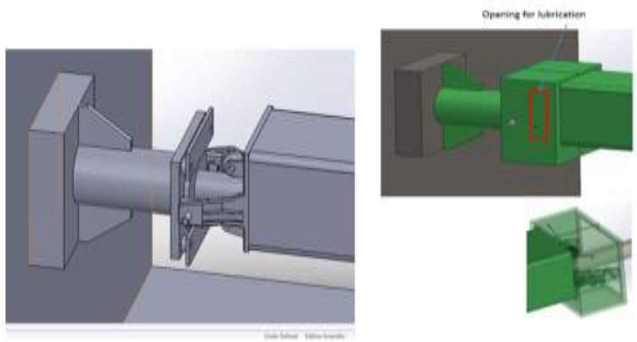

Fig 3.6: CAD model of LRSB guide mechanism with cover

4. FINITE ELEMENT ANALYSIS:

FEA Results of Existing Model:

Fig 4.1: Maximum Displacement 60mm in Lance tube

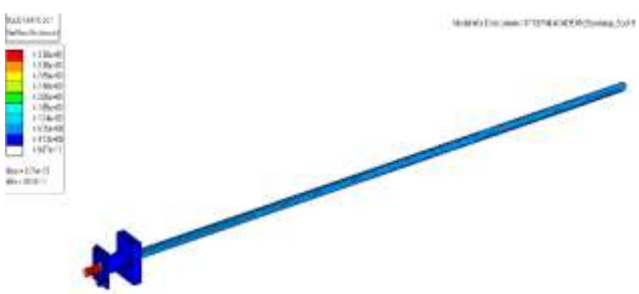

Fig 4.2: Maximum Stress 119 MPa in Lance tube

FEA Results of Proposed Model:

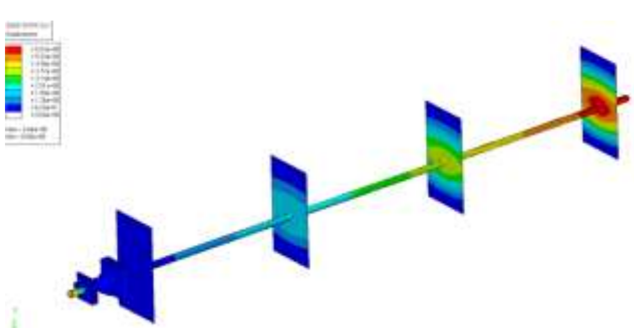

Fig 4.3: Maximum Displacement 5.6 mm in Lance tube

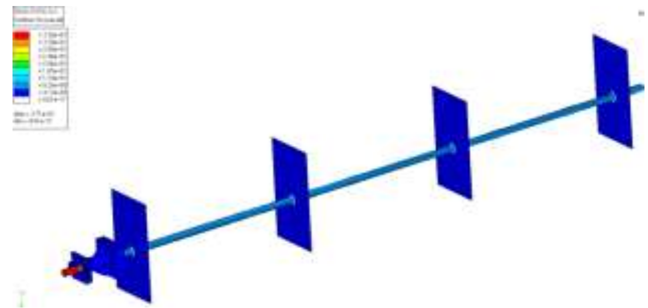

Fig 4.4: Maximum Stress 37.1MPa in Lance tube

Fig 4.5: Actual image of lance tube with supports

5. RESULT DISCUSSION:

In present system, the LRSB travelling inside the boiler is supported at the water wall only i.e. it is in the cantilever form for the length of 7 meters. In the situation, when the LRSB fails to operate in advanced position due to any reason, lance tube was prone to sag or bend. Also, sometimes when LRSB moves inwards and outwards the guiding rollers get jam due to exposure to dust sticking up the lance inside. Keeping the lance inside the furnace in running condition for prolonged time resulted in its damage. It is then required to remove it manually which is a tedious task. These two critical problems caused soot blower operation failure. From the Linear static analysis of existing LRSB it is seen that lance tube is bent by 6 cm due to self-weight and steam pressure of 12 kg/cm2 at full extend position. Maximum stresses developed in the Lance tube is 119 MPa.

By applying modifications and performing linear static analysis, it is seen that maximum vertical displacement of LRSB lance tube with supports reduced to 5.66 mm and Maximum stresses reduced to 37.1 MPa.

The tedious task of removing the sagged lance tube stuck up inside the boiler manually was eliminated.

Project objective was to reduce operation failure due to sag or bend of lance tube and to avoid roller jam due to exposure to dust. By applying the supports to lance tube and protection shield to the guide mechanism with external lubrication arrangement, these problems are eliminated.

6. FINANCIAL PERFORMANCE OF THE UNIT AFTER MODIFICATION

Sr. No.	Particular	Unit	Pre-mo difn	Post-modifn	Gain/L oss
1	Heat rate	Kcal/kwh	274 7	2737	10

Calculations :-

1	Heat Rate Gain	Kcal/kwh	10
2	Yearly Generation (Considering 79.52 % PLF)	Mus	1426
3	Yearly Heat Value Saved	Mcal	14253765
4	Yearly Average GCV (2017-18)	Kcal/kg	3231
5	Yearly Coal Saved	MT	4412
6	Yearly Average Coal Rate (2017-18)	Rs./MT	3794
7	Yearly Saving	Rs in Lakhs	167.37
8	Monthly Saving	Rs in Lakhs	13.95

7. CONCLUSION

- The modifications made in the lance support and rollers covering are validated with finite element analysis. From the results of FEA, it was observed that developed stresses are less than the material yield stress and sagging movement is also reduced. Hence, it is proved that design is safe.

- The project objective was achieved by applying the supports to lance tube and protection cover to the roller with lubrication system.

- There was improvement in the boiler efficiency, in turn, heat rate because of effective heat transfer resulting in reduction in dry flue gas losses and reduction in spray steam consumption by regular and uninterrupted operation of the LRSB.

- The yearly saving in the coal cost of the unit on account of the above was to the tune of Rs. 156.65 lakhs.

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