Control of Boiler Emissions in Waste Paper Based Small Paper Mill - A Case Study.

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ABSTRACT

The case study mainly focuses on stack emission and the control strategy adopted in Emami Paper Mills Limited, Unit Gulmohar, where the reduction of stack emission was not only its challenge for existence but also a social commitment to the locality. To reduce the particulate emission, the optimisation in fuel combustion and necessary changes/modification was undertaken in fabric bag filtration system, after thorough investigation and analysis. The most significant achievement was the reduction of stack emission from the coal fired FBC boiler at an average level of **254 mg/Nm^3 reduced to 50 mg/Nm^3** with a substantial savings in maintenance cost and a faster return on investment.

Introduction

The Emami Paper Mills Limited, Unit Gulmohar formerly belonged to WIMCO (Match division). In the year 1994 Emami management took over the unit and tried their best both technically and commercially to revive this sick unit under rehabilitation package approved by BIFR. The unit got RNI registration in the year 1994 for manufacturing News Print varieties.

Being in the Kolkata city limits, by the side of the famous religious place Dakshineswar Kali Temple and on the bank of river Ganges, the discharge of effluent and the emission from the stack of boiler was the prime issues before the company.

Emami management made earnest endeavours not only in the direction of rehabilitating and re-constructing the unit but also have invested considerable amount towards the betterment of environment in spite of the unit running on loss for many years.The particulate matter (PM) composition and emission are complex function of boiler firing configuration, boiler operation, coal properties and the pollution control equipment's. In FBC boiler, the emitted PM is primarily composed of inorganic residues and the particulate emission is controlled by installation of Electrostatic precipitators and fabric filter. In a well design filtration system the overall particulate removal efficiency is often found well over 99%.

The necessity in reduction of particulate emission

Particulate matter causes health effects upon inhalation. The severeness of health effects is determined by size, composition and concentration.
The exposure may cause heart and lung disease and may worsen to acute chronic bronchitis and asthma.

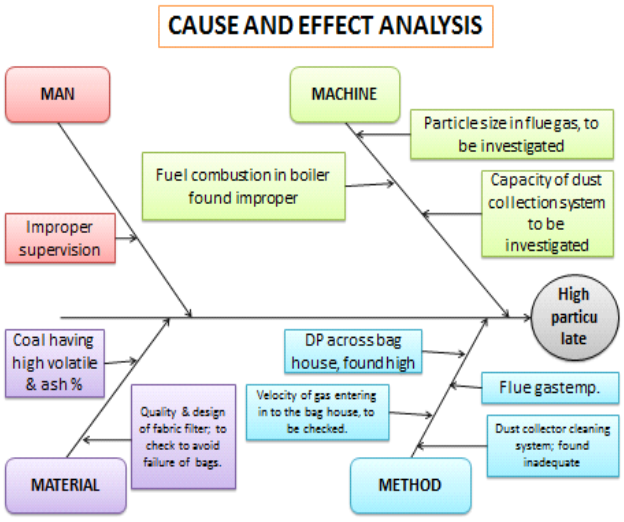
The risk of health effects is larger for certain group or individuals like elderly people with respiratory problem, young children and the people who do the heavy physical labour.

The problem & back ground of PM emission at Emami paper Mills Limited, Gulmohar-Unit, Kolkata.

- Regular objection from nearby residence for high stack emission
- Dirty environment having higher concentration of particulate cause health hazard of working people
- Difficulties in meeting emission standard
- Show cause and hearing from state pollution control board
- Repairing and maintenance of bag filter house during un-scheduled plant shut in every month to control emission.
- Loss of production due to unplanned shut
- Higher maintenance and repairing cost

Cause and effect analysis of the system

Here the analysis is made through **cause and effect diagram**, it is a representation of the systematic relationship between the



failure under investigation and all the possible **causes** influencing the failure of emission. It is a process of investigation of root causes.

Based on the above cause effect analysis, further investigation and measurement taken to reach at the root cause of failure are as follows,

I) The particle size entering into the system vis-a-vis the particles size arrest at bag filter discharge is mismatched.

Lay out of boiler with dust particle size at different stages

In the flue gas the particle size in the range of 0–5 micron are found to be 69 % whereas in the process of filtration - at APH only 6 % and in bag house 26 % i.e. total 32 % of 0–5 micron particles are arrested and the rest 37 % is escaping through stack to the atmosphere. Hence the system is inadequate to arrest the particles in the range of 0–5 micron.

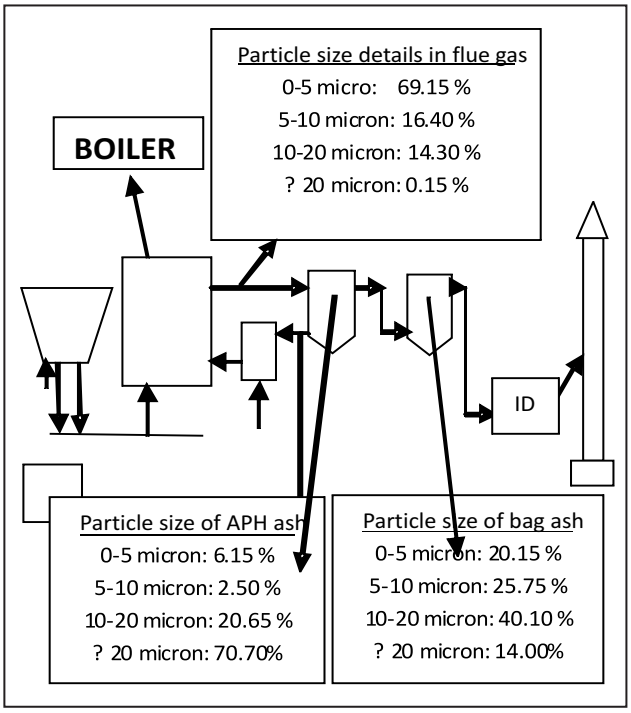
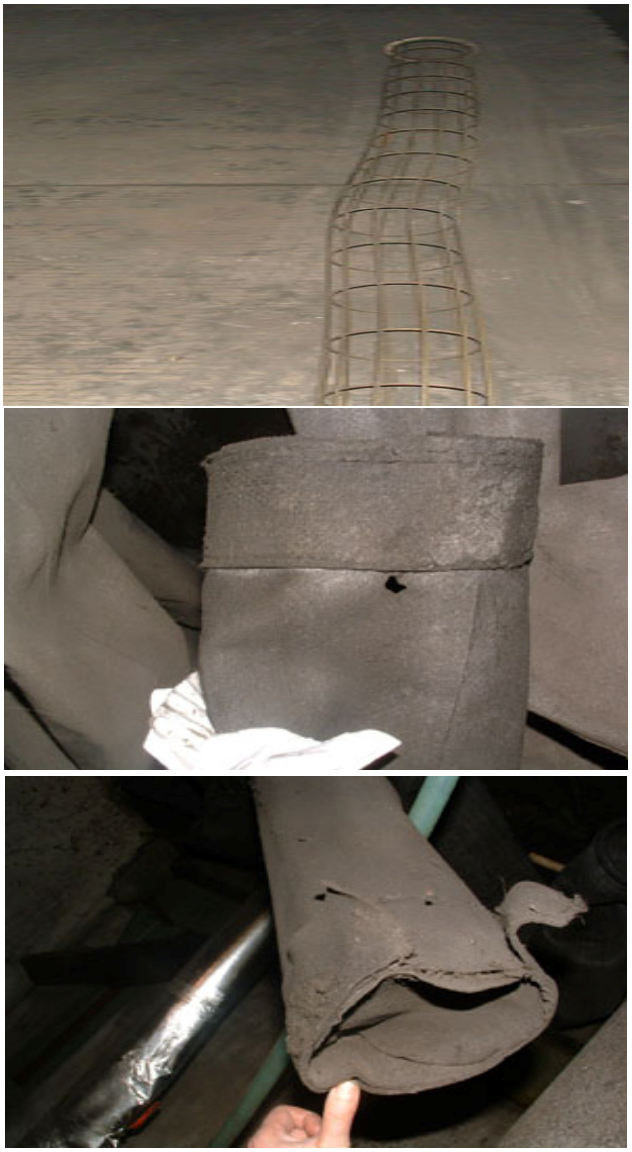


TABLE NO - 1
Calculation For Filtering Area Requirement

S.N.	PARTICULARS	PRESENT DETAILS	REQUIREMENT FOR PROPER WORKING OF THE SYSTEM
1	Coal consumption per hour	875 Kgs	875 Kgs
2	Flue gas generation per hour	14,300NM^3	14,300NM^3
3	Volume of flue gas after temp. Correction	19,800AM^2	19,800AM^2
4	Area of each bag	1.38M2 (14400 x 3060 long)	1.49M2 (15500 x 3070 long)
5	Total nos. Of bag	144	200
6	The available filtering area	198 M2	298M2
7	As per std. Air to cloth ratio for fly ash 70m3/hr/m2, filtering area required	282M2	282 M2

II) The inadequate filtering area compared to the volume of flue gas generated and not as per the required standard of "**Air to cloth ratio**" for fly ash i.e. **70 m^3/hr./m^2**

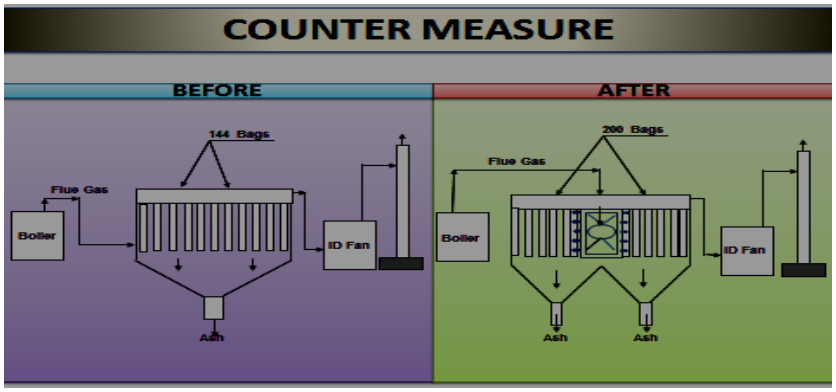
The filtering area requirement as calculated and given in Table no. - 1 found to be inadequate. This results in higher gas velocity and disturbs the total filtration system.



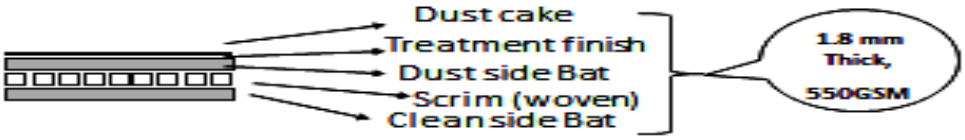
The above photograph of bending cage is also a clear indication of high flue gas velocity and uneven distribution of gas inside filtering area.

III) The damage of bags indicates that the fabric is not suitable for an operating temperature range of 150 to 160 ^{O}C and needs revision.

Looking at the photograph of bag condition after 3 months of life span, it shows that the bag design is not suitable for an operating temperature range of 160 to 170 ^{O}C.



PULSE VALVE



Action taken for reduction in particulate emission:

1) Re-arrangement of gas supply & distribution in to filtering area

The "**Brownian movement**" of gas laden filtration system says that the sub-micron particles are diffused in nature, which increases the probability of contact between the particles and collecting surface, provided the fabric surface is suitably designed for the application.

To improve the probability of contact between the particles and collecting surface of the bags, the gas distribution inside filtering area has been modified as shown in the photograph.

Here the Flue Gas Feed Line in to the filtering area is shifted from one end to the centre of the bag house and the distribution of gas is arranged in such a way that the gas will cover the total length of the bag. A baffle plate is also provided to inject the gas and the impingement of gas laden fine particles in a direction perpendicular to the length of the filter bag. This results in increase in the probability of contacts between the particles and the collection surface hence there is more deposition of dust on fabric surface.

2) Selection of Ideal fabric

An ideal fabric was selected to withstand the operating temperature range of 160 ^{o}C and above, the details of which are shown below;

3) Revision in Pulse jet cleaning equipment

Suitable design equipment with timer control is provided to achieve the designed filtering efficiency and to handle the range of temperature & moisture levels. Inadequate cleaning can affect the bag house operation like, high inlet air velocity,

ELECTRONIC TIMER

inadequate filtering surface, dust drop out area and re-entrainment of collected dust.

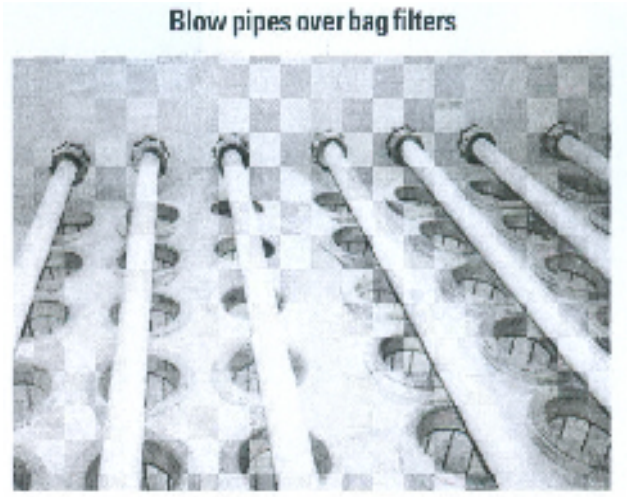
The source of poor filter cleaning was under size of pulse valve, which was taken care of and also provided enough cleaning energy to pulse the filters and to dislodge the dust. The under size pulse valve leads to early failure of diaphragm and ultimately to wear out of pulse valve.

The pulse valve as shown gives high pressure air shock to bag filter for a short interval of time. It is a 2-way valve works like a solenoid valve but does not give continuous flow. The valve is controlled by electronic timer.

The timer gives signal to pulse valve at every short interval of time for opening and closing of valves.

4) Alignment of Blow Pipes

The misalignment of blow pipes with improper blow hole shape and sizes drastically reduces the amount of cleaning energy directed into filter. The blow holes in the pipes are



Condition of bags after six month

maintained perfectly round and centered with filter bag ID, as shown in the photograph.

The cleaning air comes out of blow hole at an angle of approx. 20^{o} in a conical pattern; this cone of air jet hit's the filter bag center at a distance of 2" above the top of the bag. An off centre blow hole is sufficient enough to wear one side of filter bag and may not clean the bag adequately.

Result & Discussion

The above changes/modification results in increase of bag's life from one year to 3 year.

The emission of particulate matter from the stack was very much within the limit. There is a substantial benefit obtained out of this modification, the most important one was the end of botheration relating to emission. The summary of results and achievements are given in Table no. 2 & 3.

Conclusion

The fabric filter in general provides high collection efficiencies of both coarse and fine (submicron) particulates. It is relatively insensitive to fluctuation in gas stream condition. The efficiency and pressure drop are also relatively un-affected by momentary changes in inlet dust loading, as because the fabric filters are cleaned continuously at a definite interval. The outlet air of the filter is much cleaned and may be recirculated within the plant (for savings in heat energy). The operation is relatively simple. There are varieties of filter collectors available. The use of suitable grade fibrous or granular filter (pre-coating) improves the collection efficiency of submicron smokes and gaseous contaminates.

Acknowledgment

The author is very much grateful to Emami Management for according permission to publish / present this technical paper

TABLE NO - 2

S.N.	PARTICULARS	ACHIEVEMENTS
1	Particulate matter emission	Well within the prescribed limit i.e.□ 40 mg/Nm3
2	Reduction in filter bag consumption per annum	105 Nos.
3	Cost of savings in filter bag	3.15 lacs per annum
4	Reduction in maintenance Cost of bag house	1.20 lacs per annum
5	reduction in plant down time	48 .00 hr. per annum
6	Savings in cost of production against down time	2.88 lacs per annum
7	Total financial gain	7.23 lacs per annum
8	Total investment made	8.0 lacs
9	Return on investment	13 month

TABLE NO - 3 SUMMARY OF STACK EMISSION

BEFORE MODIFICATION		AFTER MODIFICATION	
Sampling date	**Value in mg/Nm3**	**Sampling date**	**Value in mg/Nm3**
14.03.2007	**174**	11.12.2009	**39**
17.07.2007	**206**	14.05.2010	**38**
13.09.2007	**306**	07.09.2010	**40**
19.01.2008	**238**	30.10.2010	**34**
24.04.2008	**350**	10.11.2010	**19**

References

1) Air pollution control technology fact sheet; EPA 452/F 03 025

2) 2003 ASME, International Mechanical Engineering Congress Exposition, Nov 16 23.

3) Lenntech B.V, copy right 1998 2011. Kobetsu Kaizen Manual, CII.