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Pulveriser Mill Performance Analysis & Optimisation in Super Critical Thermal Power Plant using imported coal

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Abstract - Most efficient way of utilizing coal for steam generation is to burn it in pulverised form. The coal is pulverised to fineness such that 70-80% passes through a 200 Mesh sieve. Normally low speed ball mills or medium speed vertical spindle mills are employed in thermal power plant for this purpose. The milling system is an important part of the auxiliary equipment of a coal-fired power plant. Pulveriser mill are one of the critical equipment of coal fired thermal power plant. They are required to feed pulverized coal in required quality and quantity to meet boiler steam output and eventually power generation.

This paper tries to give the pulveriser mill specifications, functional, operational details and performance analysis at different operating loads. Paper also mentions the measures for optimization of the pulveriser mill to improve the availability & reliability of super critical thermal power plant using imported coal.

Keywords - Pulveriser, BMCR, PA fan, Availability, Reliability.

I. INTRODUCTION

Coal Pulveriser Mill - Function and Operation details.

Pulverizer as shown in fig.1 is used in power plant to reduce the size of the incoming raw coal to a fineness that will efficiently burn in a furnace [1].

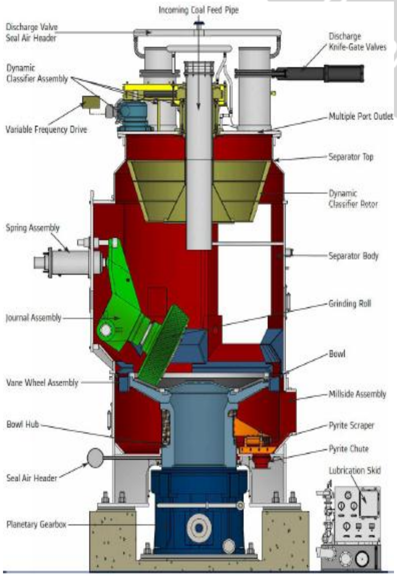

Fig 1. H P Pulveriser actual view and parts

As in fig.2 the raw coal (normally 25 mm) is fed into a rotating bowl through a centre feed pipe

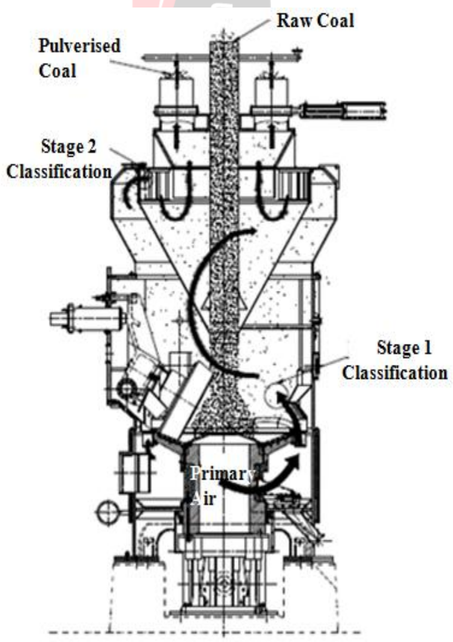

Fig.2. HP Pulveriser Coal & Air Flow

The rate of coal feed is normally determined automatically by a combustion control system, taking into account the MW demand on the unit, coal quality, and the number of pulverizer in service. Centrifugal force causes the coal in the bowl to move radially outward, building up a bed of coal on the grinding ring. The bed of coal passes under

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pivoted grinding assemblies called journals. Here, spring produced loads are imparted to the coal by the rotating rolls. Size reduction takes place in the localized area between the grinding ring (called the bullring) and journal roll through a process known as attrition or friction grinding. The radial and circumferential movement of the coal carries the crushed coal up over the edge of the bowl into the path of a transport medium. The transport medium, typically hot air, has three primary functions [2]

1. It supplies the dynamics necessary within the pulverizer to classify the coal (control coal fineness).
2. The heated air aids the grinding process by partially drying the coal as it is reduced in size.
3. It is responsible for transporting the pulverized coal from the pulverizer to the furnace.

As the coal is continuously reduced in size, the smaller/lighter particles are swept from the bowl by the gaseous transport medium, hot air transport air is normally supplied by primary air (P.A.) fans located up stream of the pulverizer. However, in some cases it is provided by individual exhausters located downstream of the pulverizer. In both systems, the air is admitted below the pulverizer bowl into an area known as the mill side. The mill side is at a positive gauge pressure as air is supplied by a primary air (PA) fan. From the mill side, the air flows upward around the outside diameter of the rotating bowl. Vanes attached to the bowl (called the vane wheel) change the air flow to a vertical direction. The smaller lighter particles of coal at the edge of the bowl are carried upwards in the air steam, dense, difficult to grind foreign material falls through the air stream into the mill side. Above the bowl, the lighter airborne coal particles undergo a three-stage classification process (refer to figure 2).

1. The first stage of classification takes place just above bowl level. Stationary air deflectors mounted on the separator body causes the heaviest coal particles to abruptly change direction, they lose momentum and are returned directly to the bowl for further size reduction.

2. The lighter particles are carried by the transport medium to the separator top where the second stage of classification occurs. Here curved adjustable vanes (deflector blades) impart a cyclonic motion to the coal/air mixture again causing the heavier particles to lose momentum and fall out of the air stream.

3. After this, the mixture is passed around a vertical “dip-tube” called the venturi collar. Further classification takes place, and the desired fineness level is achieved.

The heavier coal particles separated by the deflector blades and venturi collar return to the mill bowl grinding zone by sliding down the inside of the inner cone. The cone separates the pulverizer's “turbulent” flow area from the classified particles. The absence of turbulence in this area allows gravity to return these particles to the bowl.

An inverted cone is positioned inside of the inner cone to reduce the velocity of the transport medium entering the inner cone through .the cone spout and ensure that the heavier coal particles are not prevented from returning to the bowl. The exiting coal air mixture passes through a venturi where the mixture is first concentrated, and then expanded to obtain an even coal/air distribution in each fuel pipe. The fuel piping carries the coal/air mixture to the furnace, where the combustion process takes place as shown in fig. 3. The difficult to grind foreign material which falls through the air stream into the mil side is moved by scraper assemblies, attached to the bowl hub skirt to an opening in the mill side floor. The rejected foreign material enters the pyrite system. The reject material usually consists of rock found as over or under burden in the coal seam and/or parts of the machinery used in the mining or coal processing operations.

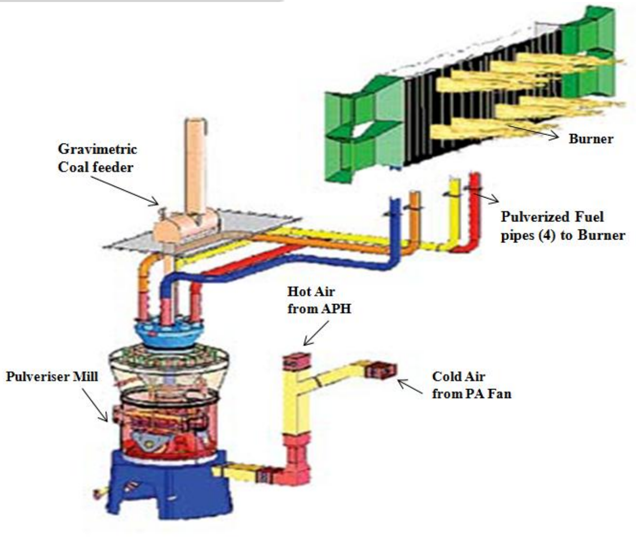

Fig.3 Mill fuel piping connections to furnace.

II. COAL MILL SPECIFICATIONS & PERFORMANCE ANALYSIS

Typical Coal Pulveriser Mill Details in 660 MW Super-Critical [3] Unit is as given in table

Table No. 1.

Table.1

Coal mill		
Type	Bowl Type Medium-speed Coal mill	
Number of Mills	6set/ boiler	
Type of loading	Spring-biased/spring-opposed loading	
Item	**Unit**	**Designed coal**
Maximum output	t/h	99.6
Calculated output	t/h	75.26
Firm output	t/h	89.64
Minimum output	t/h	24.9
coal mill inlet drying medium temperature	°C	274
Coal mill outlet temperature	°C	65 - 70

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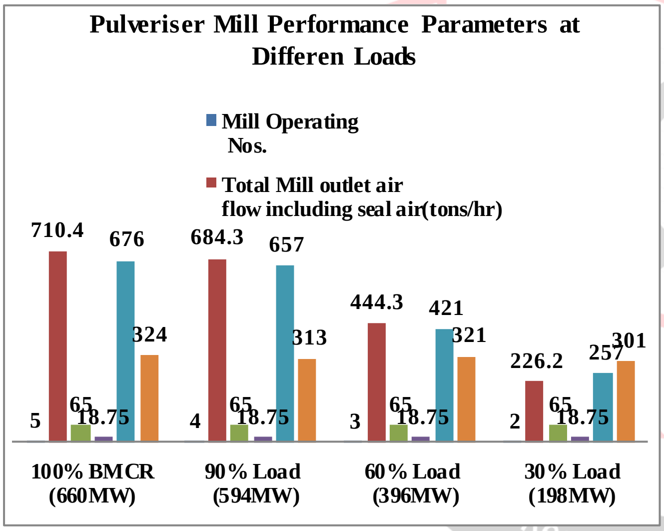
Coal mill rotational speed	r/min	27.7
Unit power consumption of coal mill	kwh/t	9.2

Table 2 with graph represents the Pulveriser mill performance parameters [4] at different loads.

Table 2. Mill Performance parameters at different loads.

Sr. No	Item	Unit	BMCR	90% BMCR	60% BMCR	30% BMCR
1.	Coal Fineness(% through 200mesh)	%	20	20	20	20
2.	Mill Operating Nos.		5	4	3	2
3.	Total Mill outlet air flow (including seal air)	t/h	710.4	684.3	444.3	226.2
4.	Mill outlet temp.	°C	65	65	65	65
5.	Mill outlet coal moisture.	%	18.75	18.75	18.75	18.75
6.	Mill inlet Primary air flow	t/h	676	657	421	257
7.	Mill inlet Primary air temp.	°C	324	313	321	301

* BMCR – Boiler Maximum Continuous Rating.



III. MEASURES FOR OPTIMIZATION OF PULVERISER MILL

1. Pipe-to-pipe fuel balance within ±10 percent of the mean fuel flow [5].
2. Pipe-to-pipe dirty airflow balance within ±5 percent of the mean airflow.
3. Optimized mill air to fuel ratio.
4. Minimum fineness level: greater than or equal 75 percent passing 200 mesh and less than or equal 0.1 percent remaining on 50 mesh.
5. Mill-to-mill mass air and fuel balance within ±5% of the mean.
6. Mill outlet temperatures optimal (65°C) and based on volatility, inlet temperature limitations and considering the mills heat balance for a respective fuel [6].
7. Minimum fuel line velocity of 1,005 meter/min. or 16.75 meter/second (or 3,300 ft./min.)
8. During start up along with steam cold air can be given in mill just before starting mill to avoid coal spillage to under bowl.

IV. CONCLUSION

Pulverizer mill performance optimization is the first step to a successful combustion optimization program and the inter-relationships of the pulverizers must be considered when attempting to optimize combustion, overall unit performance, operability, reliability, and capacity. Pulverizer capacity seems to be an challenge for power plant while many units today are undergoing drastic coal quality (calorific value) changes. Considering there seems to be a huge disconnect when correlating mill performance with such issues as fuel line distribution, heat rate, NO_X and environmental control equipment performance, from this technical paper tries to provide better understanding of performance, how mechanical optimization & tuning of the pulverizers can yield overall improved plant performance.

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