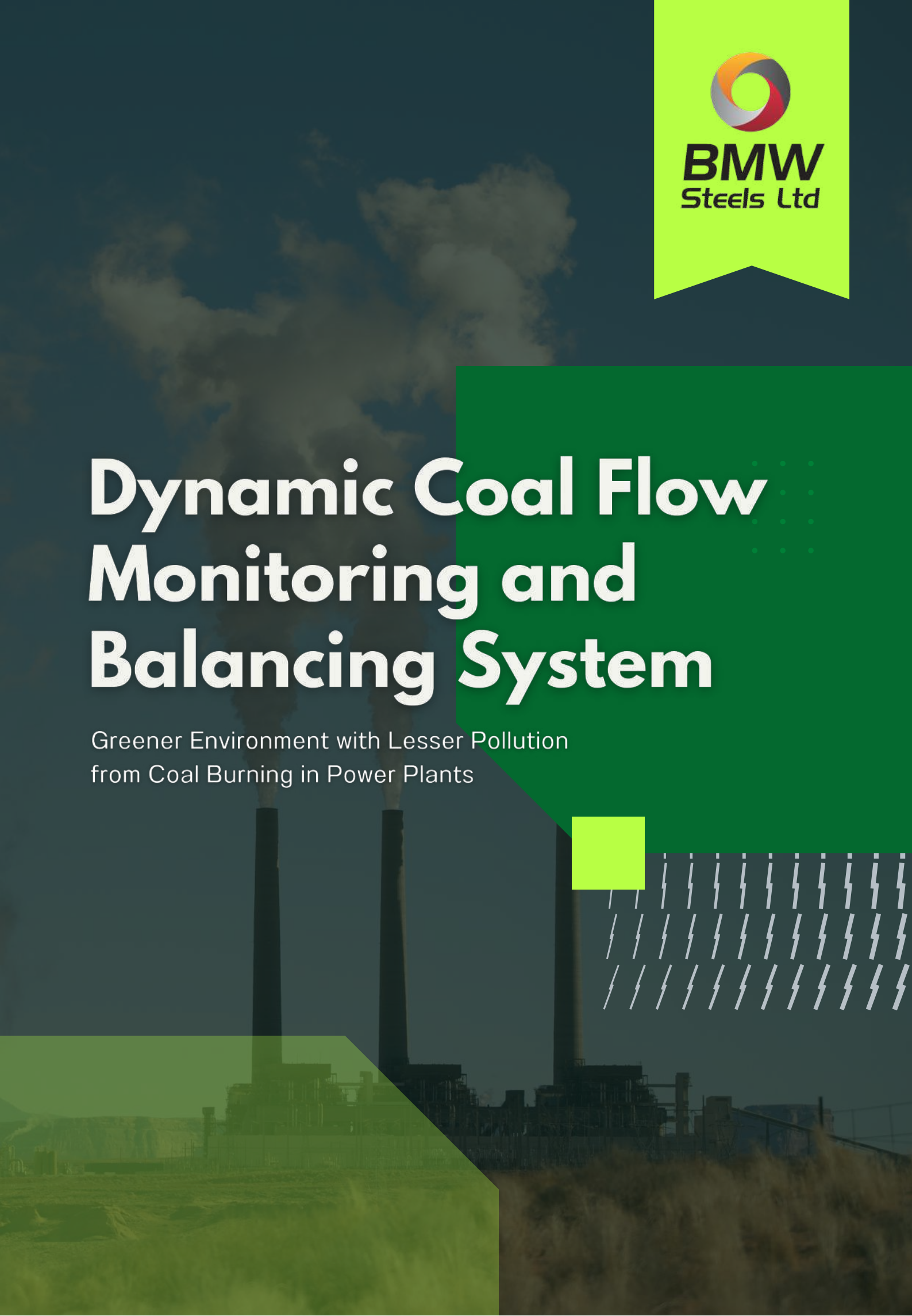
BMW Steels Ltd

Dynamic Coal Flow Monitoring and Balancing System

Greener Environment with Lesser Pollution from Coal Burning in Power Plants



NAVIGATING TOWARDS GREENER FUTURE

Navigating Towards Greener Future in Coal Combustion through Dynamic Coal Flow Monitoring and Balancing System

= Optimum Combustion After Balancing

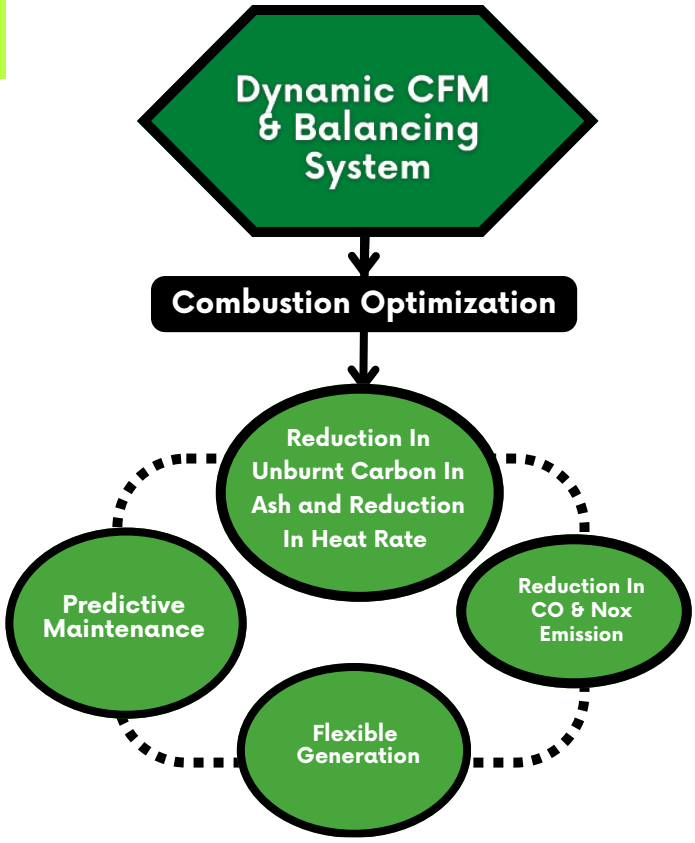
INTRODUCTION

Greener Environment with Lesser Pollution from Coal Burning in Power Plants

Energy security and CO2 emission reduction are two major concerns of today's world. Improving efficiency of the energy systems is an essential option for the security of future energy and the reduction of CO2 emissions. At COP26, in November, 2021, Prime Minister announced that India will achieve the target of net zero emissions by 2070. India's 80% electricity generation is based on coal.

It is widely recognized within the electric utility industry that coal pipe flow imbalance is responsible for a loss in boiler efficiency, higher NOx and CO emissions, increased unburned carbon in the ash, and also responsible for firing system maintenance problems. It been considered as a potential area that needs to be addressed for improving unit performance. With the introduction of new generation ultra low-NOx burners, uniform distribution of coal flow to the burners has become an important subject. In particular, CO emissions and unburned carbon in fly ash particles are very sensitive to pipe-to-pipe coal flow imbalances.

Indian coal power sector is also undergoing a radical change with advent of renewable power generation. In order to ensure grid security and stability, the variability of solar & wind generation has to be taken care by flexible generation from thermal plants as base load. Key challenges for a highly flexible power plant operation are the reduction of the minimum load and the increase of the load change rate. This requires continuous monitoring of coal flow and adjustment of coal balancing for flame stability at low loads and complete combustion at high loads.



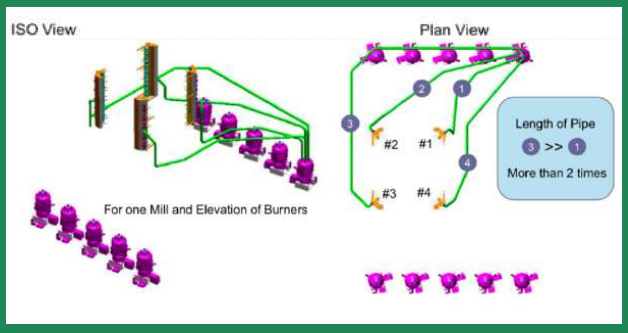
As part of the efforts to optimize combustion in order to increase efficiency, control emissions and stabilize flame for low load operations, BMW has introduced Dynamic Coal Flow Monitoring and Balancing System.

BMW Dynamic Coal Flow Monitoring and Balancing System is the only system which has been installed, commissioned and found to be accurate in the Indian operating conditions.

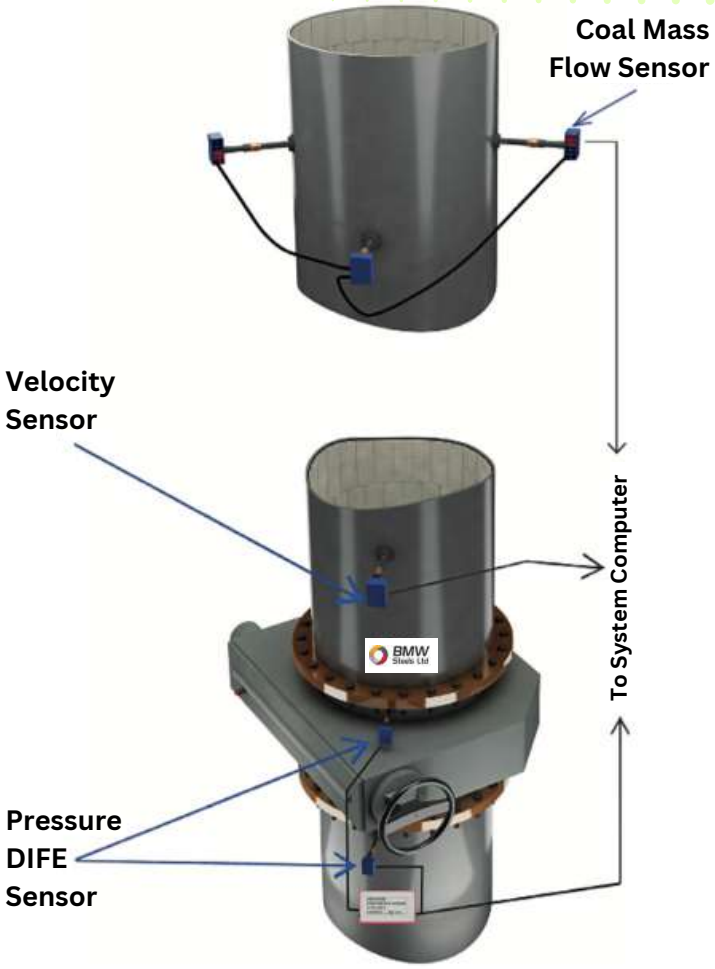
In addition to the accuracy, the system has proved and quantified the benefits by its use in running plant conditions.

Green Coal Power Generation - BMW Dynamic Coal Flow Monitoring and Balancing System

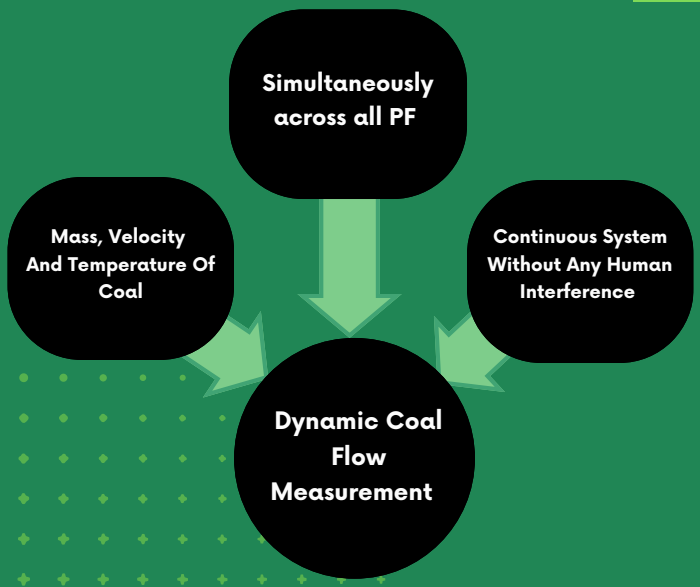
The flow distribution between the coal pipes is achieved as the mixture leaves from the pulverizer through a number of outlet pipes, each of which carries coal into one individual burner. The number of outlet pipes on a typical mill varies between 2 and 8. The distribution of primary air throughout the piping network is controlled by flow resistances of the various coal pipes. Because of differences in pipe lengths and numbers and types of elbows in each burner line, different coal pipes from a pulverizer has different flow resistances.



In order to have complete and effective combustion, the coal mass flow and velocity of all coal pipes from each pulveriser should be within a permissible deviation limit of +/-5%.



BMW Dynamic Coal Flow Monitoring and Balancing System



BMW'S DYNAMIC COAL FLOW MONITORING AND BALANCING SYSTEM IS CAPABLE OF CONTINUOUSLY MEASURING COAL FLOW IN REAL TIME CONDITIONS USING MICROWAVE BASED SENSORS AND BASED ON OUTPUT OF COAL FLOW SYSTEM, COAL FLOW VALVES ARE USED FOR BALANCING THE COAL FLOWS AND VELOCITY.

PROJECTED IMPROVEMENTS

The system will benefit in the following areas:

1

EMISSION CONTROL

Combustion optimization techniques results in NOx reduction. Although NOx emissions from boilers are influenced by many factors. The most significant factor is flame temperature and excess primary air velocity. NOx is formed by reaction of nitrogen and oxygen present in air at flame temperature of more than 1700 deg C (Fusion temp of ash).

This high temperature results in increase in NOx and ash slagging on boiler tube.

2

HEAT RATE IMPROVEMENT AND REDUCTION IN UNBURNT ASH

As against designed efficiency of 39% Indian projects operate between 28-32% efficiency. Prime objective of Dynamic Coal Flow Monitoring and Balancing System is to maintain Air to Fuel ratio for optimized combustion., Reduction in Fly ash and bottom ash unburnt and reduction in super heater temperature and reduced slagging. The most frequent cause of extreme fuel imbalances is poor tuning of mass flow and velocity in coal pipes. Slagging leads to poor heat absorption by boiler tubes that lowers boiler efficiency. High Velocity of more than 27m/s and high volume of coal in burner results in high flame temperature (Fusion Temperature).

3

FLEXIBALISATION

Rapid ramping of generation as per grid demand, down upto 40% technical minimum. NTPC has targeted readiness of plants to operate at 40% technical minimum.

Siemens has carried out Minimum Load Pilot Test at Unit-6 of NTPC Dadri TPS - 500 MW consisting of 6 Mills (Make : BHEL).

Finding of this report suggest that one of the most limiting factors preventing the minimum load being reduced further is "Flame intensity / combustion optimization at low load if specific coal is less than 0.6". Report also suggests that main challenges at low load is combustion behavior, Mill operation behavior and Mill operation data like coal mass flow patterns in pipes, coal/air temperature to burner.

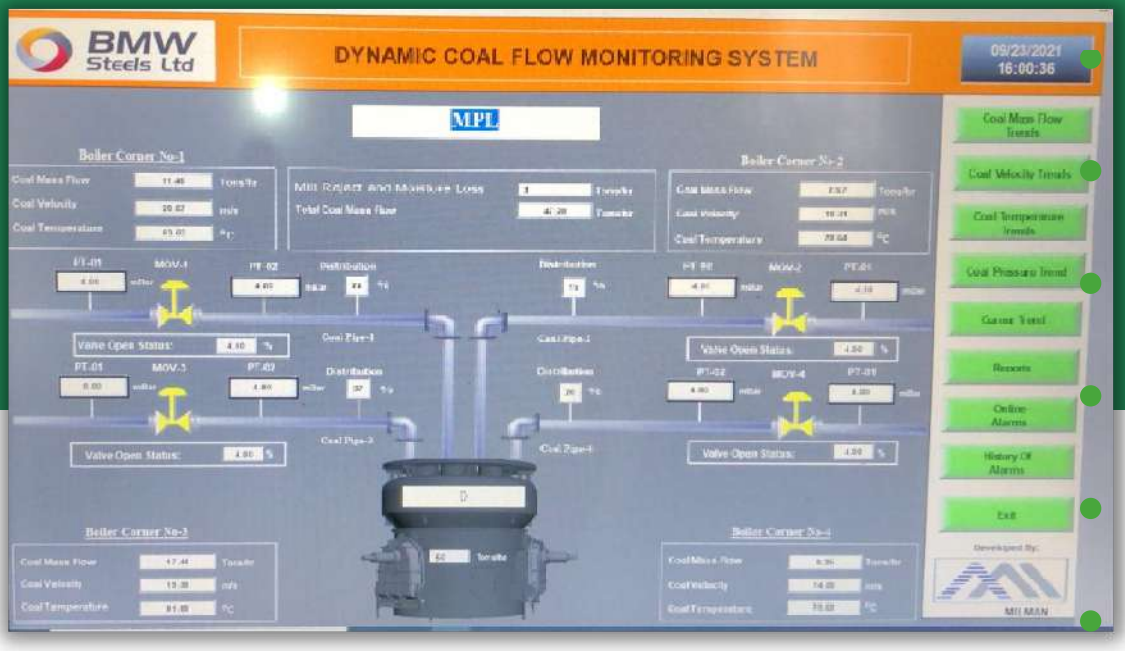
THE SYSTEM

BMW has adopted a novel approach

"Unless we can measure continuously, we cannot improve."

BMW Dynamic Coal Flow Monitoring and Manipulation System is an engineered system specifically designed to meet the requirements of Indian Power Plants operating at high ash content. With German collaboration - MIC Worldwide, BMW has developed a package for real time measurement of important Coal flow parameters. These include :

1. Coal Mass Flow in each pipe
2. Coal Roping Area identification
3. Coal Temperature in each pipe
4. Coal Velocity in each pipe
5. Coal Flow Balancing with Coal Flow Valves



Coal Flow Monitoring - Onsite Display Home Page

BMW Dynamic Coal Flow Software is user friendly software, which has been designed keeping in view the parameters which would be most useful from operations and maintenance point of view. Software has evolved over the years after feedback from plants as well as understanding coal flow application and find tuning from time to time.

Placement of Microwave Based Mass Flow Sensors

Three microwave based mass flow sensors are installed in each coal pipe 120 degree apart as shown below. Mass flow sensors are placed in vertical section of the coal pipe, as close to the burner as possible. These sensors are responsible for measuring mass flow in each pipe and for indicating the areas of coal roping within the pipe.

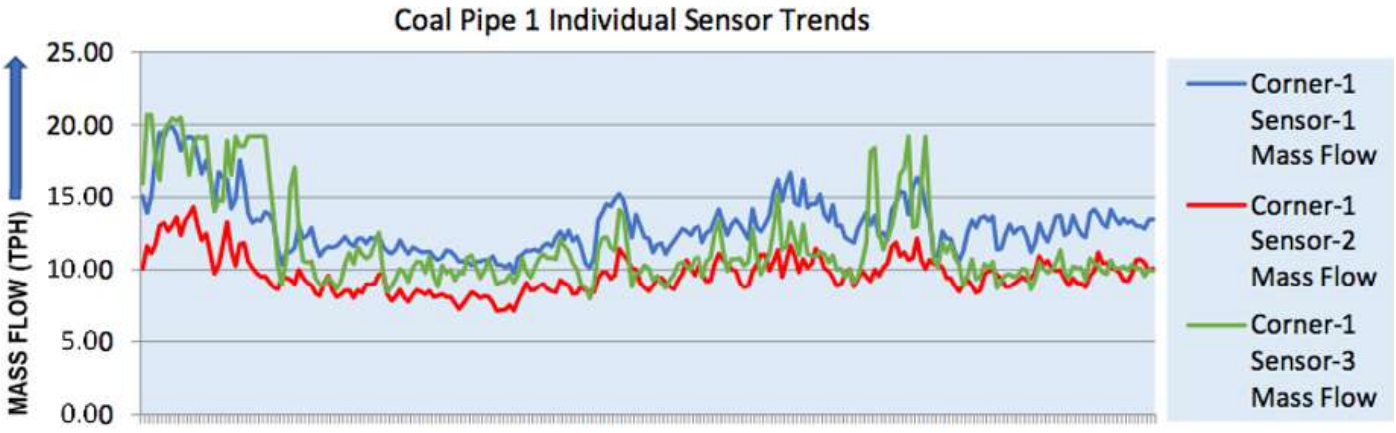
Placement of Electrostatic Based Velocity Sensors

Velocity sensor is installed 500 mm above the mass flow sensors. This is electrostatic sensor which measures the velocity of coal particles and temperature of coal particles within coal pipe.

Placement of Coal Flow Valves in Pipeline

Coal Flow valves are recommended for installation on mill outlet in order to Dynamically adjust the cross-sectional area of area pipe, thereby controlling the pipeline resistance and coal distribution from coal mill to coal pipe.

NEED FOR CONTINUOUS MONITORING SYSTEM
FOR EFFICIENT OPERATION



Graph represents coal mass flow of 1 coal pipe in 3 sections of same plane for a duration of almost 20 hours with constant feeder loading. It can be noticed that Mass flow is changing from 8-9 TPH to 20 TPH in this duration.

One section of pipe represented by Sensor-1 has very high coal flow as compared with other two sensors
Manual equipment currently deployed, Dirty Pitot Tube can be measuring at any point in this pipe as there can be no knowledge of coal flow characteristics. Any point reading cannot be considered representative of the coal flow in the pipe.

The coal flow in coal pipes is a Dynamic 2-phase system. Coal flow conditions in coal pipes are continuously changing based on various parameters like moisture in coal, temperature, velocity, coal type, coal classification, coal density and many more. It extremely difficult to simulate / predict the actual pattern of flow in pipes. It varies not only from mill to mill but from pipe to pipe under various conditions.

Manual techniques like Dirty Pitot Tube test assumes that coal flow in each pipe and at all time intervals is homogeneous. Hence, 1 or 2 readings in each pipe are considered to be representation of that pipe for entire duration.

Coal flow cannot be conclusively by measured by any point analysis. It is only the study of trends which can prove useful for analysis of coal flow parameters. This necessitates the use of Dynamic and real time system for Coal Flow Monitoring.

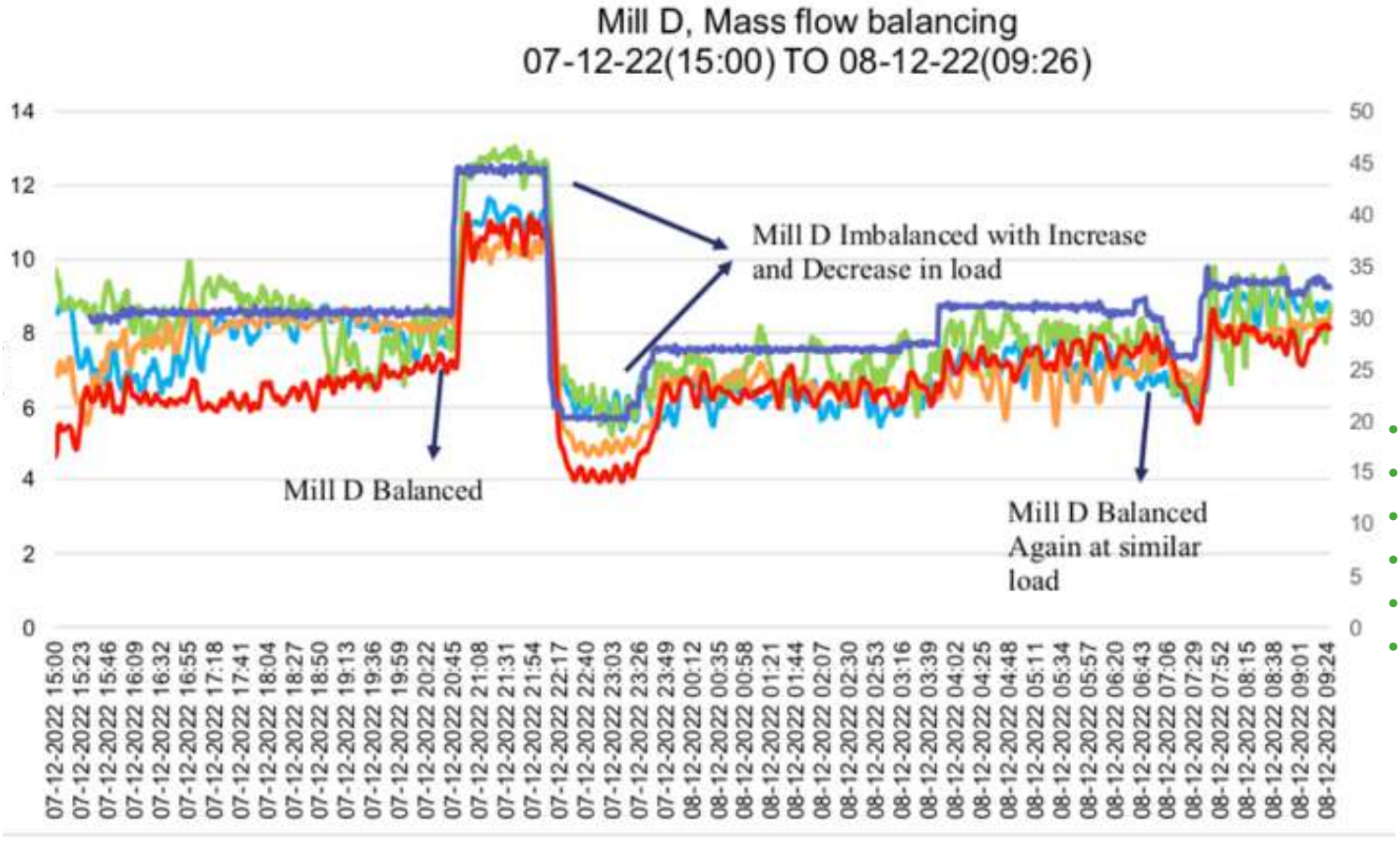
Expected Benefits

- **Heat Rate Improvement**
- **Reduction In Unburnt Ash**

NEED FOR CONTINUOUS MONITORING SYSTEM FOR FLEXIBILISATION

Balanced coal flow is the requirement of power station as per recommendation of all OEMs. Traditionally, fixed orifices installed within the pipes are used to balance the clean air flows. While this can be an effective way of balancing air flow, evidence from field measurements suggests primary air flow balancing has little effect on distribution of coal flows between the coal pipes. Instead, the coal flow distribution among the outlet pipes is a dynamic phenomenon and is strongly influenced by factors such as mill loading, moisture in coal and coal type.

In order to study the impact of coal flow balancing with changing mill loads BMW has carried out a test in 250 MW corner fired boiler in India.



It is evident from the graph that balanced coal flows in the mill gets imbalanced with steep changes in load without any change in valve position. For steep changes in load, it is essential to have continuous monitoring for mills and manipulation of valves in order to have a balanced flow and flame stability for low load operations.

These findings are in sync with test runs low load carried out by Task Force at various plants where lack of flame stability at low loads was found to be one of the most limiting factors in flexing the thermal units.

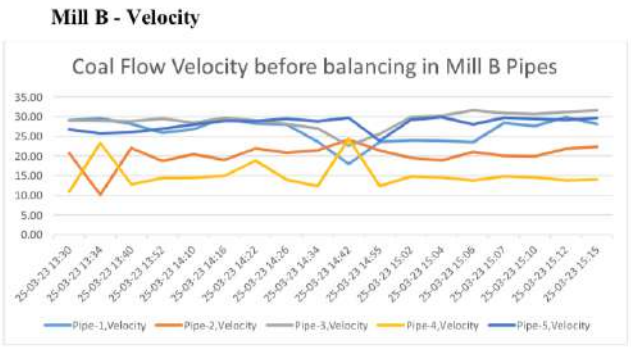
Real Time Data of Demonstrations at Power Plants:

BMW has carried out multiple measurement and balancing assignments in India. To name few Power Plants:

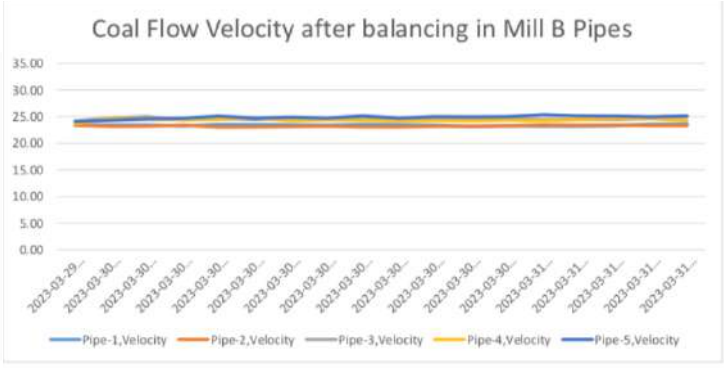
- **2X600 MW LANCO ANPARA (Wall Fired Boiler)**
- **2X250 MW DSPM CSPGCL - Korba (Corner Fired Boiler)**
- **2X500 MW DVC - Andal (Corner Fired Boiler)**
- **2X500 MW TATA - Maithan (Corner Fired Boiler)**

COAL VELOCITY BALANCING IN WALL FIRED BOILER

– Velocity (Pre Balancing)

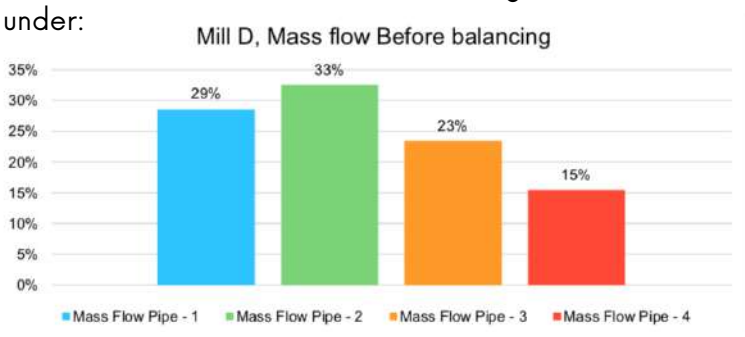


Velocity (Post Balancing)

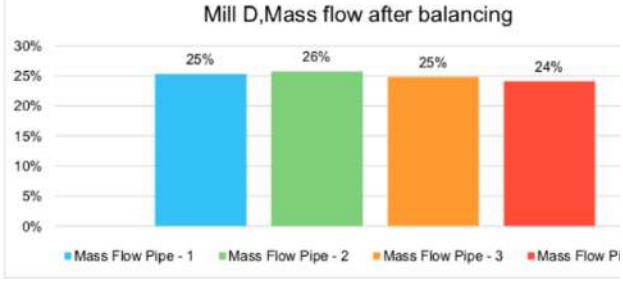


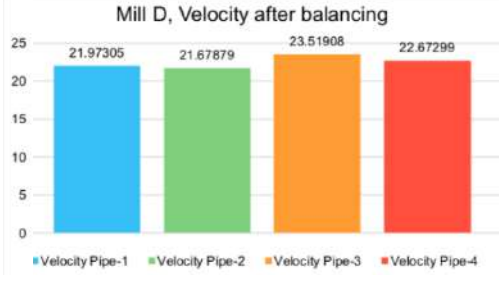
MASS FLOW BALANCING BY BMW COAL FLOW VALVES

Before commencing the test, Coal Flow Valve setting was kept at the equivalent setting of BHEL recommended fixed orifice ID. At original fixed orifice settings, mass flow distribution obtained is as under:



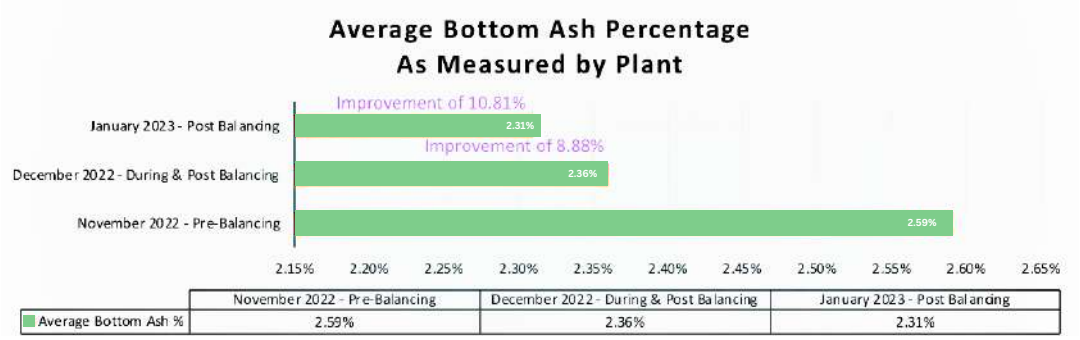
Mass flow signals received from BMW CFMS were used for manipulation of coal flow valve in order to achieve the balanced flow in all coal pipes. Coal balancing was achieved in all coal pipes by manipulating valves. Data after balancing is as under:



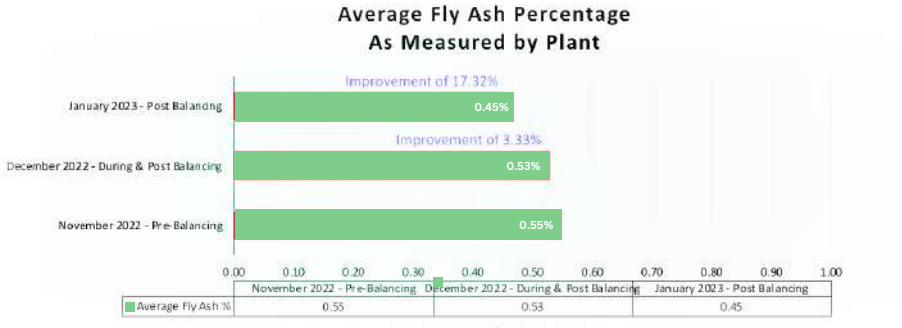


REDUCTION IN UNBURNT CARBON AND ASH

PLANT-1 : CORNER FIRED BOILER - 250 MW

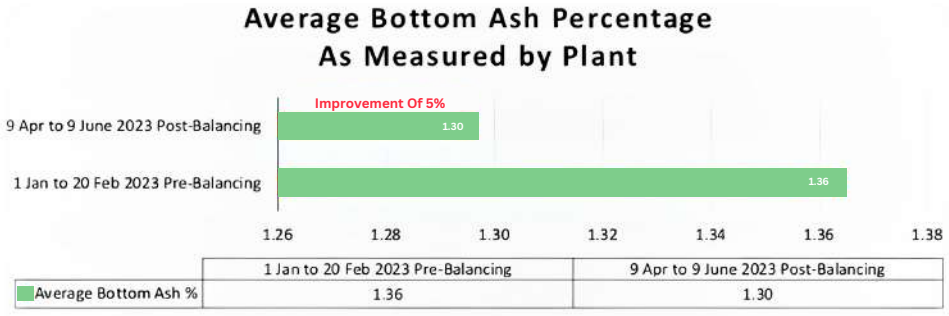


Improvement of 10.81%

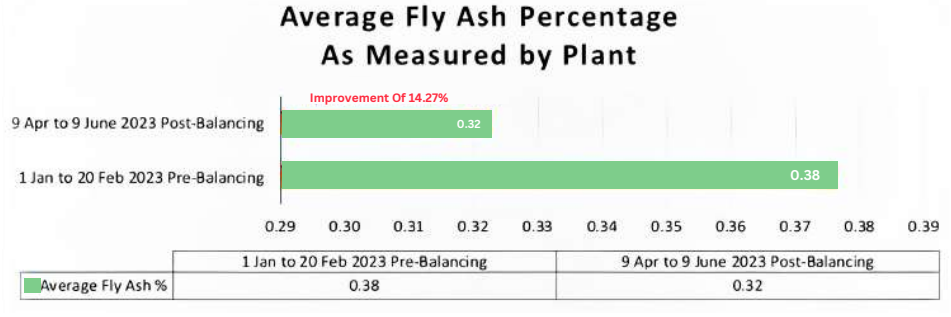


Improvement of 17.32%

PLANT- 2 : WALL FIRED BOILER - 600 MW



Improvement of 5%

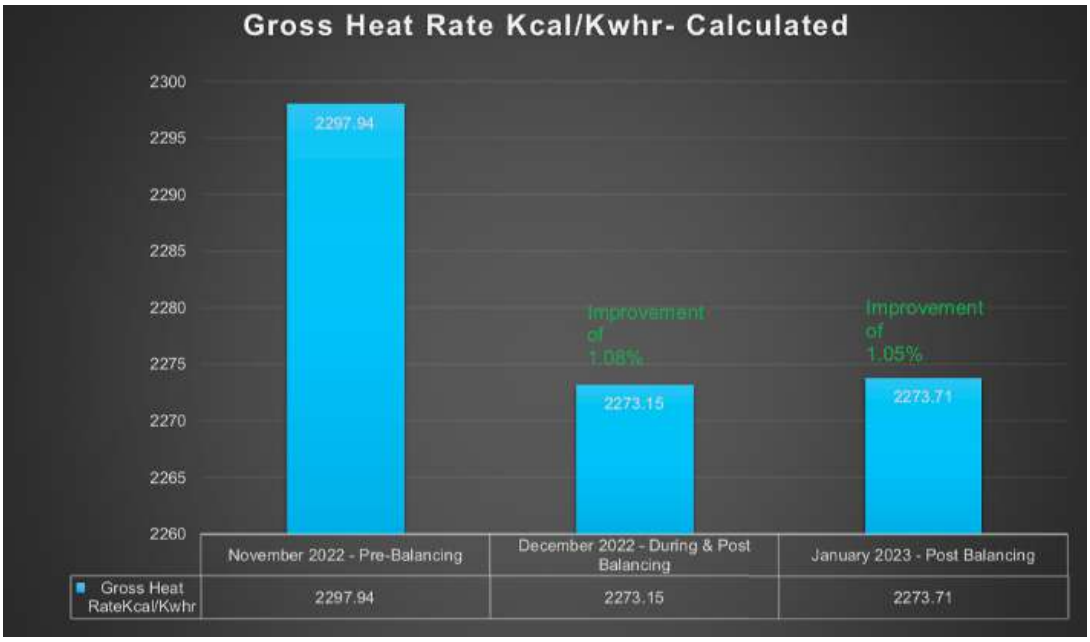


Improvement of 14.27%

There has been an improvement of 19.27% in ash generation resulting in benefit of Rs. 0.77 Lacs per day to plant considering coal cost of Rs. 3,000 PMT.

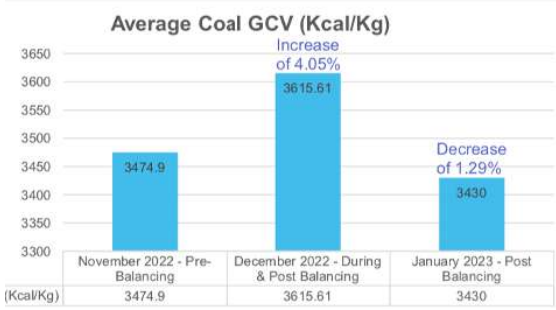
REDUCTION IN GROSS HEAT RATE

Gross Heat Rate Post Balancing - 2273.71; Pre Balancing 2297.54



Improvement of 1.05%

REVENUE GENERATION FROM COAL SAVING



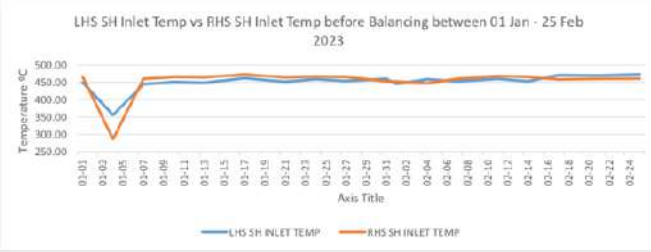
		GCV		COAL CONSUMPTION		
Month	Coal Consumption per MW	GCV	Change from Nov	Change from Nov	Change from Nov	Change from Nov	Net Improvement
Nov	0.6627	3475	Kcal/Kg	%	MT	%	
Dec	0.6283	3615	140	4.03%	-0.0344	-5.19%	1.16%
Jan	0.6645	3430	-45	-1.29%	0.0018	0.27%	1.02%

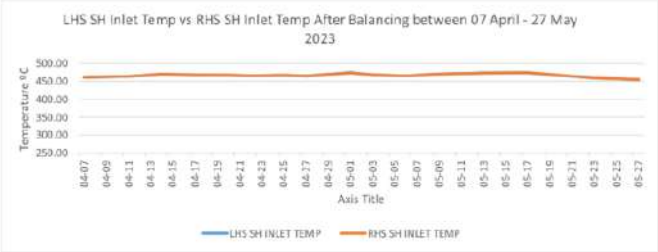
MONTH	NET IMPROVEMENT	COAL CONSUMPTION	COST OF COAL	SAVINGS
		MT	RS./MT	
DEC	1.16%	95,659	4,500	₹50,02,477
JAN	1.02%	1,05,196	4,500	₹48,44,345
			TOTAL SAVINGS	₹98,46,822

IMPROVEMENT IN PLANT OPERATING PARAMETERS :

1. SUPER HEATER INLET AND OUTLET TEMPERATURES :

LHS & RHS Super Heater Inlet Temperature Difference Pre and Post Balancing:





Plant-1 Corner Fired Boiler - 250 MW

Super Heater Inlet Temperature (Pre Balancing)
1 Month Average: Inlet Temperature Difference 8.7 DegC
3 Month Average: Inlet Temperature Difference 9.0 DegC

Super Heater Inlet Temperature (Post Balancing)
1 Month Average: Inlet Temperature Difference 8.0 DegC
A reduction of 0.7 DegC in Inlet Temperature (8% reduction in inlet)

Pre-balancing:
Temperature difference between LHS & RHS Super Heater Inlet Temperature was 3.88%.
Post-balancing:
Temperature difference between LHS & RHS Super Heater Inlet Temperature was 0.09%.
A reduction of 3.79% in temperature difference between LHS & RHS Super Heater Inlet Temperature.

2. OXYGEN LEVEL IN FURNACE - WALL FIRED BOILER :

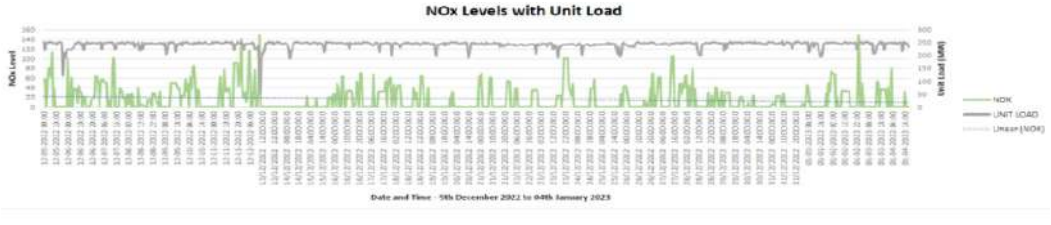
LHS & RHS O2 Level difference Pre and Post Balancing:

	APH A INLET O2 LHS	APH A INLET O2 RHS	Difference
Pre Balancing	4.93	3.96	0.97
During Balancing	3.77	3.36	0.41
Post Balancing	3.35	3.39	-0.04

3. NOX EMISSION :

NOx Level Pre Balancing: Average 21.72

NOx Level Post Balancing: Average 16.25.



SYSTEM HIGHLIGHTS

- **BMW Dynamic Coal Flow Monitoring System is a Make in India initiative**
- **It's an import substitute fully developed and indigenised by MSME**
- **Balancing Valves is Patented Technology with more than 1,000 installations in India.**
- **Dynamic Coal Flow Monitoring and Balancing is a proven technology under Indian conditions with the quantified benefits**
- **Excellent ROI of 8 months to 1.5 Years depending on plant to plant and operations.**
- **Mass Flow Balancing and Coal Velocity Balancing has potential to improve following plant operation parameters :**

i. Unburnt Carbon Percentage in Bottom Ash.
ii. Unburnt Carbon Percentage in Fly Ash.
iii. Gross Heat Rate
iv. Super Heater Inlet and Outlet Temperature differences
v. Oxygen Level Differences in LHS and RHS of furnace
vi. NOx Reduction

- **Dynamic Coal Flow Monitoring and Balancing System is a very important tool for flexing the Thermal Power Fleet, where fast ramping is requirement.**

TESTIMONIALS

CHHATTISGARH STATE POWER GENERATION COMPANY LIMITED

Performance report of "Variable orifices & coal flow monitoring system".

With reference to above subject, an order for supply of "Variable orifices measurement of online coal flow" for XRP-883 coal mills of DSPM TPS Korba East placed on M/s BMW Steel Ltd. Hathras, vide P.O. No. under ref (3). The above order has been completely executed and the material was received on td. 30.06.2022. These Orifices have been installed in mills 1A, 1B, 1C & 1D of U#1 during AOH in AUG-22. Also, the balancing of coal pipes were carried out in all 4 mills in Nov-22. The following observations were found after balancing of coal pipes:

Improvement in GUHR as compared to pre-balancing.

1. Reduction in Unburnt carbon in Bottom Ash as compared to pre-balancing.
2. Reduction in Unburnt Carbon in Fly Ash as compared to pre-balancing.
3. Reduction in NOx values of flue gases at exit.

MAITHON POWER LIMITED

M/s BMW STEELS LTD had installed Variable Orifices and Coal Flow Monitoring System in Mill D of Unit 2. BMW Coal Flow Monitoring & Balancing tests were conducted between 23rd to 25th of September'2021.

The system has effectively demonstrated it's capability to mesure coal mass flow and other coal pipe parameters in each pipe dynamically and accurately. The data provided by system is almost correlating with DCS data and physical condition of coal piping. They have also been able to balance the coal mass flow in all the 4 PF pipes of Mill 2-D by manipulating their Variable Orifices, within 5% of the Mean Average Coal Flow.

The diagnostic ability of the system is expected to enable in plant operations for improving combustion and controlling NOx emissions.

HINDUSTAN POWERPROJECTS PRIVATE LTD

FORMERLY KNOWN AS MOSER BAER PROJECTS PVT LTD

Certified that M/s. BMW Steels Ltd. Had supplied ceramic variable Orifices in unit 1 & 2 of MB power, Annupur, via order No. #LITL/MB ATPP/MECH/PCP/PO/4960000899 in 2015. These orifices have crossed the 25,000 running hours & are still running successfully. Therefore wear & erosion resistance is satisfactory. Further, manipulation of variable orifices was smooth whenever it was required during mill operation to adjust the area of flow. Hence, overall performance of variable orifices is satisfactory after 25,000 running hours. Also, the quality of ceramic tile fixing of variable orifices is good.

BMW Steels Ltd

THANK YOU

Your decision to partner with us is not just a business transaction; it's a commitment to efficiency, sustainability, and a brighter future.

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