BMW Steels Ltd

VARIABLE ORIFICE

Improving Coal Distribution System Performance

Introduction

The drive towards maximum efficiency of the thermal power plants with minimum pollution emissions requires that all aspects of boiler performance be optimised. The wide use of low- NOx burners and combustion techniques has shown the potential gains obtainable when the combustion process is examined in detail. Combustion systems are very sensitive to the balance of fuel and air delivered to the furnace. In the era of high efficiency and low emissions it can only be met by carefully controlling the fuel and air at each burner.

The primary issue is that the pipes have different destinations, thus creating differences in the length, number of bends, and flow resistance of each pipe. Imbalance creates either high coal flow or low coal flow to burners. A carefully designed system will ensure that the resistance of each of those branches is equal so that the coal and air split uniformly between the burners.

Imbalance in Coal Flow

- **High coal flow to burners**
  It shall create carbon-rich zones of reducing atmosphere which leads to increase in: Slagging, Carbon Monoxide (CO) Emissions, and LOI (Loss of Ignition).
- **Low coal flow to burners**
  Shall create oxygen-rich zones that may increase nitrogen oxides (NOx) emissions.

Imbalance in coal flow causes an associated deterioration in combustion efficiency due to “increased carbon” in fly ash level and leads to increased fuel and ash handling cost and possible deterioration in ESP collection efficiency.

BMW VOs for Equal Distribution

Two parameters controlled by 'BMW Variable Orifices' play a major role in equal distribution of Coal-Air mixture:

1. **Pressure Drop along the line;**
2. **Minimum conveying velocity.**

Minimum velocity of conveying should be sufficient enough to keep the coal powder in suspended phase. Pressure drop requirement is dependent on: Length of individual pipe, Vertical Section of pipe, Horizontal Section of pipe and number of bends.

For demonstration, a typical system is described.

Pipe Line #	Total vertical length (m)	Total horizontal length (m)	Bends in Pipe Line	Diameter of Orifice Opening
(1)	(2)	(3)	(4)	(5)
1	17.83	17.05	90^0,120^0,130^0	543 mm
2	17.83	38.67	90^0,130^0,135^0	552 mm
3	17.83	77.17	90^0,140^0, 90^0,155^0, 135^0	600 mm(ID of Pipe)
4	17.83	45.17	90^0,140^0, 155^0, 120^0	558 mm

Detail of pipes layout that exit from a Coal Pulverizer (600MW)

Hence the flow velocity in the shortest pipe will be highest (Pipe Line #1) where as it will be lowest in longest pipe (Pipe Line # 3). It is clear that pipeline # 3 has longest length and more number of bends as compared to other pipe lines. It means that pipeline # 3 has higher frictional loss coefficient, which is to be maintained in other pipe lines for balancing of Coal Air Flow by pressure drop or in other words restriction orifice plates are introduced in pipeline by manipulating variable orifice opening as shown in the above table so as to equalize the flow resistance.

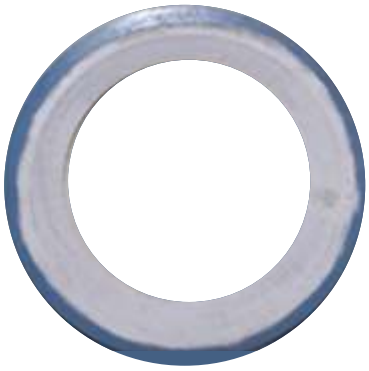
Turbulence in the Coal Pipe Line

Turbulence occurs when the inertia force in the Coal -Air mixture becomes significant compared to viscous forces and is characterized by high Reynolds Number. This phenomenon is outcome of extra squeezing of the pipe opening i.e. in excess of 25%. It can have sufficient effect on characteristics of flow by creating fluctuations in the flow field, during boiler operation. The only parameter that affects the coal distribution but cannot be controlled by variable orifices is Coal Quality i.e Coal Hardness, Moisture Content, Coal Suspended Particle Size.

Variable Orifice in Operation at 660 MW Coal Piping System

BMW Variable Orifice over Fixed Orifice - Advantages

In the coal feed system described above and analogous system elsewhere which involves passage of particulates suspended in fluid such as gas, the nature of phases involved causes large erosive forces to be exerted against flow control elements incorporated in the passage ways. These forces are particularly disadvantageous in fixed orifices where erosive flow forces the inner diameter of the orifices to increase and therefore, result in the main purpose of flow control being lost. It is an adjunctive need for flow control elements to be adaptable to varying flow rates/pressures while being fortified against erosive forces exerted by impinging particulates.



New Alumina Ceramic
Lined Fixed Orifice

Eroded Fixed Orifice

Alumina Ceramic Lined
Variable Orifice 100% open

Alumina Ceramic Lined
Variable Orifice 40% open

BMW Variable Orifice®&℗ For High Operating Life and Control

The variable orifice dual slide gates are covered with a valve body with inlet and outlet openings. Two slide gates are connected to a patent pending movement system which on maximum closing becomes face to face. Simple movement operates the valve slide gates in opposite direction through a single hand wheel. The BMW registered design and patent pending technology has done away with gear mechanism or single actuator system.

The slide gates and the inlet and outlet opening are covered with the wear resistant Alumina Ceramic / Silicon Carbide Liner. The subject gate slides are designed for maximum 100% opening and minimum 25 % opening.

Technical Specifications and Methodology

BMW Variable Orifices comprises of:

Steel Casing; Self-Centering Slide Gates; Movement Mechanism; Alumina Ceramic Liners;
Silicon Carbide blade edges; Coal Pipe Gate Guides; Clean Out Valves 4 Nos; Gate Position indicator; Hand Wheel.

Technical Specifications

1. Maximum Design Pressure: 1 kg/cm^2
2. Operating Pressure: 0.32 kg/cm^2
3. Velocity of Coal Air Mixture: 25 mtr/sec (max)
4. Mounting: In line on Coal Pipe
5. Mounting Attachment: Shoulders with Grooved Couplings. (Not the part of Orifice)
6. Maximum Opening: 100%
7. Minimum Opening: 25%
8. Models Suitable to Coal Pipe ID: 200 mm to 1,000 mm
9. Area in Contact of Coal: Lined with Alumina92TM. (For Wear Resistance)
10. Edges of the Slide Gates: Lined with Silicon Carbide Strips
11. MOC: IS-2062 (High mechanical strength of the shaft and body)
12. Life Expectancy: 25,000 running hours.

Important methodology to be followed

Coal Pipe System commissioning:

Utilize the software program for Coal Flow Measurement (CFD) in each coal pipe branch to accurately measure both air flow and coal flow rate so as to operate the shrink hole of Orifice in the coal piping system.
Analyze the data to determine if the balance is within ±5% for the air flow Balance and
± 10% for the coal flow balance.
For best results repeat testing with the software driven Coal Flow Device(CFD) at regular intervals to re-adjust orifice for balanced flow in the coal piping system.

Manipulation of Orifice Elements during operation

Coal–Air feed system with suspended coal particulates cause erosive wear; resulting in increase of inner diameter and reduction in velocity. The change in velocity can be readjusted by shrinking the orifice gates further to match velocity decided at the time of commissioning.

BMW Variable Orifice Models (Patent pending)

Sr. No.	Model	NB	A	A1	B	B1	C	C1	D	D1
1.	BMW 200	200-249	480	560	200	125	1050	825	200-249	256-305
2.	BMW 300	250-300	530	610	250	125	1100	875	250-300	306-356
3	BMW 350	301-349	580	660	300	125	1150	925	301-349	357-405
4.	BMW 400	350-400	630	710	380	140	1200	975	350-400	406-456
5.	BMW 500	401-500	680	760	380	140	1250	1025	401-500	457-556
6.	BMW 600	501-600	780	860	380	140	1350	1125	501-600	557-656
7.	BMW 700	601-700	880	960	380	140	1455	1225	601-700	657-756

www.bmwsteels.com
www.bmwsteels.co.in

BMW Steels Ltd

ORIGINAL

No. 34903

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THE PATENT OFFICE
CERTIFICATE OF REGISTRATION OF DESIGN

Design No. 259785
Date 29/01/2014
Reciprocity Date*
Country

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