PULVERISED COAL BURNERS

Burners are devices that allow uniform mixing of fuel with air hence lead to efficient and complete combustion. The burner receives the fuel along with the primary air in a central passage, while the secondary air is supplied around the passage. A good design of the burner is essential to achieve complete combustion of the fuel. Thus a good burner should meet a number of design requirements.

The important requirements of an efficient pulverised coal burner are as follows:
1) It should mix the fuel and primary air thoroughly and inject the mixture into the furnace.
2) It should create proper turbulence for air-fuel mixing and maintain a stable combustion.
3) It should be able to control the flame shape and flame travel by varying the amount of secondary air.
4) Coal-air mixture should move away from the burner at a rate equal to the flame travel so as to avoid flash back.
5) It should be projected properly to avoid over heating, wear and internal fires.

Types of burners
There are four types of burners used for the pulverised fuel burning.
1) long-Flame or U-Flame or Stream lined burner
2) Short Flame or Turbulent Burner
3) Tangential Burners
4) Cyclone Burner

1) Long-Flame or U - Flame or Stream lined burner

The arrangement of a long flame, U-shaped burner is schematically shown Fig. The burner is placed such that it produces a long, u-shaped flame. The burner injects a mixture of primary air and fuel vertically downwards in thin streams practically with no turbulence and produces a long flame.

Secondary hot air is supplied at right angles to the flame which provides necessary turbulence and mixing for proper and rapid combustion. A tertiary air is supplied around the burner for better mixing of the fuel with air. In this burner due to long flame travel, high volatile coals can be burnt easily. Velocity of the air-fuel mixture at the burner tip is around of 25 m/sec.
Short Flame or Turbulent Burner
The schematic arrangement of a short-flame or turbulent burner is illustrated in fig. These burners are generally built into the furnace walls, so that the flame is projected horizontally into the furnace. Primary air and the fuel mixture is combined with secondary air at the burner periphery, before the entry into the furnace as shown in figure. This burner gives out a turbulent mixture which burns rapidly and combustion is completed within a short distance. Therefore, the combustion rate is high. The velocity of mixture at the burner tip is about 50 m/sec. In such burners, the bituminous coal can be burnt easily. Modern **high capacity power** plants use such burners.

Tangential Burners
These burners are built into the furnace walls at the corners. They inject the air-fuel mixture tangentially to an imaginary circle in the centre of furnace. As the flames intercept, it leads to a swirling action. This produces sufficient turbulence in the furnace for complete combustion. Hence in such burners, there is no need to produce high turbulence within the burners. Tangential burners give fast and high heat release rates.

Cyclone Burner
This burner burns the **coal particles** in suspension, thus avoiding fly-ash problems, which is common in other types of burners. This burner uses **crushed coal** (about 5 to 6 mm size) instead of pulverised coal. This burner can easily **burn low grade coal** with high ash and moisture content. Also, this can burn biofuels such as rice husk. The principle of operation of a cyclone burner is illustrated in Fig.

The cyclone burner consists of a horizontal cylinder of about 3 m diameter and about 4 m length. The cylinder wall is water cooled, while the inside surface is lined, with chrome ore. The horizontal axis of the burner is slightly inclined towards the boiler. The coal used in cyclone burner is crushed to about 6 mm size. Coal and primary air (about 25% of the combustion or secondary air) are admitted tangentially into the cylinder so as to produce a strong centrifugal motion and turbulence to the coal particles. The primary air and fuel mixture flows centrifugally along the cylinder walls towards the furnace. From the
top of the burner, the secondary air is also admitted tangentially, at a high velocity (about 100 m/s). The high velocity secondary air causes further increase in the centrifugal motion, leading to a highly turbulent whirling motion of the coal-air mixture. Tertiary air (about 5 to 10% of the secondary air) is admitted axially at the centre as shown in fig, so as to move the turbulent coal-air mixture towards the furnace. The coal is burnt completely within the burner and only hot gases enter the furnace. Such burners produce high heat and temperatures (about 1000°C). Due to high temperature burning, the ash melts in the form of slag, and is drained out periodically at the bottom.

**Advantages of cyclone burner**

1) Since it uses crushed coal, it saves the cost of pulverization.
2) All the incombustible are retained in cyclone burner, and hence the boiler fouling problems are reduced. 3) It requires less excess air, as it uses forced draught.
4) Slag-recovery is around 80% and dust passing to the stack is about 10%. Thus simple equipment can be used for dust removal.
5) Fly ash problem is reduced to a great extent.
6) Low grade fuels can be used.

**Disadvantages**

1) It requires high pressure draught and consumes higher power.
2) It produces more oxides of nitrogen, which creates atmospheric pollution.

**Pulverising Mills.**

The various types of mills used for pulverising the coal are listed below:

1. Ball mill
2. Ball and Race mill
3. Impact or Hammer mill

**Ball Mill.** The line diagram of the ball mill is shown in Fig. It consists of a large cylinder partly filled with various sized steel balls (2.5 to 5 cm in diameter). The coal (6 mm) is fed into the cylinder and mixes with these balls. The cylinder is rotated (130 m/min peripheral velocity) and pulverization takes place as a result of action between the balls and the coal.

The mill consists of coal feeder, pulveriser, classifier and exhauster. The feeders supply coal to classifier and then it is passed to the pulveriser with the help of screw conveyor. A mixture of tempering air and hot air from air-preheater is introduced in the pulveriser as shown in figure. These streams of air peak up the pulverised coal and pass through the classifier. The over-sized particles are thrown out of the air stream in the classifier and fine material is passed to the burner through exhaust fan.

The output of the mill is controlled by the dampers located in the exhaust fan inlet duct. These damp vary the flow of air through the mill and thereby control the rate of fuel removed from the mill. The dampers are operated by the boiler's automatic combustion control. The feeder output is regulated by the coal level in the cylinder. When the coal level in the cylinder attains sufficient height to seal off the lower channel then the differential control operates to stop the coal feed.

A ball mill capable of pulverising 10 tons of coal per hour containing 4% moisture requires 28 ton of steel balls and consumes 20 to 25 kW-hr energy per ton of coal.

The principal features of this pulveriser are listed below:

1. The grinding elements in this mill are not seriously affected by metal scrap and other foreign material in the coal unlike the grinders in most other pulverisers.
2. There is considerable quantity of coal in the mill which acts as a reservoir. This pulveriser prevents the fire from going out when there is slight interruption in fuel feed caused by coal
clogging.

(3) This mill can be used successfully for a wide range of fuels including anthracite and bituminous coal which are difficult to pulverise.

(4) The system is simple in operation, low in initial cost but operating cost is high.

**Ball and Race Mill.** This is also known as contact mill which consists of two elements which have a rolling action with respect to each other. The coal passes between the rotating elements again and again until it has been pulverised to the desired degree of fineness. The pulverization is completed by a combination of crushing, impact and attrition between grinding surfaces. The line diagram of ball and race mill is shown in Fig. The coal is crushed between two moving surfaces: balls and races. The upper stationary race and lower rotating race driven by a worm and gear, hold the balls between them. The coal is supplied through the rotating table feeder at the upper right to fall on the inner side of the races. The moving balls and races catch coal between them to crush it to a powder. Springs hold down the upper stationary race and adjust the force needed for crushing.

Hot air is supplied to the mill through the annular space surrounding the races by a forced draft fan. The air picks up the coal dust as it flows between the balls and races and then enters into the classifier above. The fixed vanes make the entering air to form a cyclonic flow which helps to throw the oversized particles to the wall of the classifier. The oversized particles slide down for further grinding in the mill. The coal particles of required size are taken to the burners with air from the top of the classifier.

The mill is provided with a means of separating heavy impurities from the coal and thus reducing wear and possible damage to the grinding element. These heavy particles resist the upward thrust caused by the primary air stream and collect in a compartment in the base of mill, and then they are removed periodically.

The automatic combustion control regulates the flow of primary air through the pulveriser and feeder and maintains the coal supply. When more coal is required, the primary air flow is increased automatically and its higher velocity in the mill carries additional coal in the furnace. This action