Pulverizing coal for a boiler is very important factor in overall cycle efficiency. There are many types of pulverizers available, but proper selection will ensure consistent boiler and cycle efficiency. This helps in reduction of carbon dioxide emission per million units of electricity generated.

Boilers for steam generation in power plants and process industries use coal as fuel. The percentage of boilers operating with coal as fuel outnumbers the boilers using all other fuels combined. Coal is pulverized before firing for achieving a stable and efficient combustion. Many types of pulverizers are used in boilers by different designers.

**History of pulverization**

The history of pulverization dates back as early as 1824 and was envisioned by Carnot in a coal fired engine. In 1890 Diesel made use of pulverized coal in his diesel engine. Pulverized coal firing was first developed in the cement industry and then migrated to the power and process industries. Actually Thomas Alva Edison and the Niepce brothers of France were pioneers in pulverized coal firing. This technology gained momentum after World War I in the power generating industry. It was John Anderson, chief engineer of power plants at the Wisconsin Electric Power Company who introduced pulverized coal firing in power stations.

Pulverized coal is the most efficient way of using coal in a steam generator. The coal is ground so that about 70 % will pass through 200 mesh (0.075 mm) and 99 % will pass through 50 mesh (0.300 mm). A pulverized coal boiler can be easily adapted for other fuels like gas if required later without much difficulty. However, during the design stage it is possible to make boilers firing multiple fuels. With pulverization technology, large size boilers could be designed, manufactured, erected, and run much more efficiently.

**Types of pulverizers**

Mainly there are three types of pulverizer used in industry: the slow speed mills like ball tube mills, the medium speed mills like bowl, ball and race, roller mills fall in this category, and the third type is the high speed impact mill. The slow speed and medium speed mills are selected for coals ranging from sub-bituminous to anthracite. The high speed mills are used mainly for lignite.

**The purpose of a pulverizer in a coal fired boiler**

- To supply pulverized coal to the boiler as per requirement of steam generation
- Transport the pulverized coal from pulverizer to the burners in the boiler
- To remove moisture in coal to an acceptable level for firing in boiler
- To remove high density inorganics from coal during pulverization
- To classify coal particles to the required level of fineness, normally 70 % through 200 mesh and less than 2% on 50 mesh

**Coal parameters affecting pulverizer output**

While selecting a pulverizer, the coal characteristics play an important role. The Hardgrove index, total moisture, input coal size, output fineness, and mill wear have direct impact on the mill output.

- The Hardgrove index of coal tells us about the ease with which it can be pulverized. A higher Hardgrove index indicates the coal is easier to grind. 50 HGI normally is taken for calculating the base capacity of the mill.
When coal with HGI higher than 50 is fed to the pulverizer, the output will be higher than base capacity, and below 50 HGI, the output will be lower.

- The total moisture in coal has a high effect on mill output. The higher the moisture, the lower the output.
- Higher pulverized coal fineness increases the recirculation in the mill and the output reduces.
- The inlet size of the coal also affects the mill output directly.
- Mill air flow variations result in changes in mill outlet temperature and fineness as well as capacity.

**Ball tube mill**

Ball tube mills are either pressurized or suction type. In the pressurized type, the hot primary air is used for drying the coal and to transport the milled coal to the furnace. In this type, leakage in the mill area is high.

In the suction type, the exhauster is used for lifting the milled coal from the pulverizer to the furnace through a cyclone. The tube mills have a large circular drum, with adequate ball charge, which is rotated at about 70% of the speed at which the ball charge would be held against the inner surface by centrifugal force. In this mill the grinding balls can be replenished on the line.

Normally the ball mill designers use three types of balls with three different diameters. These balls reduce in size as the mills operate and so the highest size ball is normally used for recharging. In earlier days, most of the ball mills had a single inlet and outlet, but now designers use both ends to feed coal and also for taking out pulverized coal. The control systems are well made to understand the requirement of ball charge and the output from the mill. Ball mills are always preferred to be operated at full capacity because the power consumption of this type of mill is very high at lower loads when compared with other types. Ball mills can be designed for a very high capacity like 75 tons per hour output for a specific coal.

**Vertical spindle mill**

There are many different varieties of vertical mills. Designers use large steel balls ranging from 2 to 6 or more between two grinding rings for pulverizing. There are also other types like conical rollers with shallow bowl; deep bowl, etc. where load is applied on the rollers and the bowl rotates while pulverizing. These types of mill are designed normally up to 60 tons per hour for a specific coal; however there are vertical mills with 90 tons per hour output. A vertical spindle mill is also designed for pressurized and suction type requirements. Boiler designers use this type of mill for poor quality coal as this type of mill rejects foreign materials like stones and other high density materials. The power consumed by the mill per ton of coal ground is only two-thirds of the ball mills. However if the primary air fan power is also taken into account, in the case of a pressurized mill the power consumption is lower only by about 15%.

**High speed impact mill**

This type of mill uses a central horizontal shaft which has a number of arms, and a beater of different design is attached to these arms to beat the coal to be pulverized. High speed impact mills are mainly used in pulverizing lignite. Today all boiler designers opt to use ball or vertical spindle mill for coal other than lignite.

While selecting the type of mill boiler designers must clearly understand the coal characteristics, the overall system being used, and the maintenance requirement. It is always seen that if the advantage of the mill alone is considered, then the overall boiler economics can prove to be different.
Source: