International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 -6435 (Online)), Volume 15, Issue 11 November 2026)

Fuel firing and flame stability in a coal-fired boiler of a thermal power plant

Dr.A.Hyacinth Diana Sagayamary
Assistant Engineer/Mechanical, Thermal Training Institute and Research Centre, Human Resource Development
Tamil Nadu Power Distribution Corporation Limited, Chennai-600 120, Tamil Nadu, India

***Abstract*— The combustion process involved in a boiler is very complex as it involves the breakdown of the fuel into useful heat energy. Coal is the most commonly used fossil-fuel energy resource in India. The method of burning coal is mainly involves pulverising the coal and mixing it with air to form a air-fuel mixture and ignite the mixture to produce hot gases. The enthalpy in the hot gases is used for the conversion of water to steam in the water wall of the boiler. Hence, it is very essential that the firing method of fuel plays a significant role in the efficiency of the power plant.**

***Key Words*— Burner, Flame, Enthalpy, Efficiency, emissions, Pulverisation**

INTRODUCTION

The global energy consumption goes on increasing and at the same time, the natural reserves of fossil fuel goes on decreasing with time. International Energy Agency states that the world reserves of oil and gas are expected to deplete within few years and coal reserves will stay for a few hundred years [1]. Coal is regarded to be the main source which accounts for around 38% of world's electricity generation [2]

The energy conversion process involved in the conversion of chemical energy into electrical energy involves a complex process of tapping useful energy which is associated with huge.

The High efficiency systems and ecologically friendly processes has to be promoted and implemented [3]. Since boiler involves the major enthalpy conversion for the conversion of water to steam, the fuel combustion process is needed to be most efficient and economical.

I. COAL FIRING

Coal from the coal bunker in fed into the feeder and then to pulverising mill. The coal is generally conveyed to the plant site is sized already to meet the feed size of the crusher in the pulveriser. Then further the coal is crushed into microns in the pulverising mill.

The primary air fan sucks the heated air form the air heater and blows the pulverised coal to the furnace through a burner as shown in Figure No.1. The fuel feeder should automatically control the fuel fee rate according to the boiler demand and the air flow rate for blowing the coal and burning it completely.

After the feeder, the coal is dried because the coal have moisture content inherent with it. The drier is an integral part with pulveriser and the primary air which is already heated by outgoing flue gases blows the coal into the pulveriser and gets mixed and often called as air-fuel mixture. The pulveriser is called to be the heart of the fuel-firing system which comprises of these processes: pulverising, transport of the pulverised coal, and burning of the same with proper air-coal ratio.

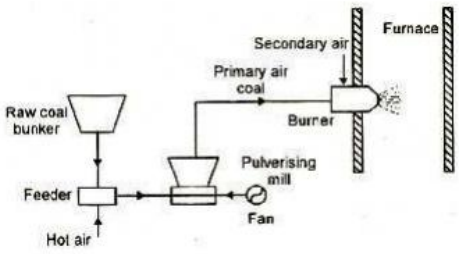


Figure No.1 Coal-firing system in a boiler

Two requirements should be met in order to effectively burn pulverised coal in a furnace. One is the existence of huge quantities of very fine particles of coal to ensure ignition and other is the existence of a minimum quantity of coarser coal particles to ensure complete combustion.

The coal-air mixture is carried through insulated pipes to the burner. The burner blows the coal in pulverised coal along with primary air. The secondary air is also supplied for complete combustion of coal particles. For initial

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 -6435 (Online)), Volume 15, Issue 11 November 2026)

ignition, oil is sprayed. Then the coal gets burned and flame stability is reached.

A. Burner with adjustable length

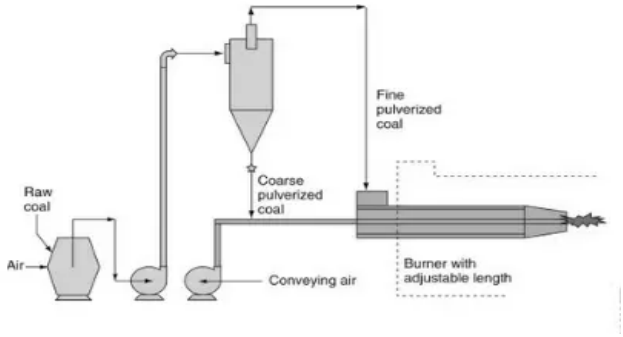


Figure no.2 Burner with adjustable length

The primary air and coal mixture is forced axially to ignite the stream of coal as shown in Figure No.2. The secondary air is fed through the outer concentric rings and thereby turbulence is created. The combustion is made complete by ensuring the emission level out to the atmosphere.

B. Flame stabilization:

The burners are placed at four corners of the furnace. The coal-air mixture is blown tangentially from four corners and a imaginary fire ball is created. This provides the cross-ignition energy which stabilize the flame.

Figure No. 3 shows the optimised flame stableness over the rich mixture and lean mixture with respect to adiabatic flame temperature of coal.

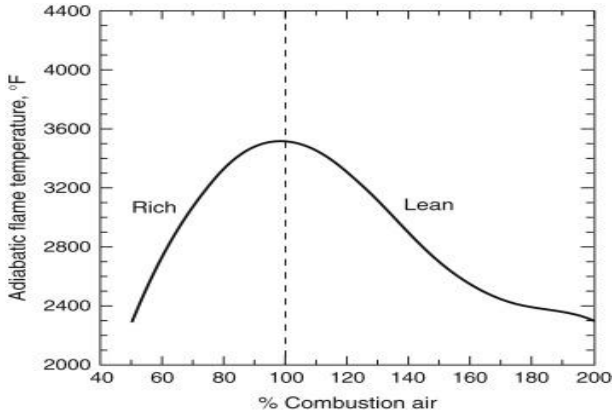


Figure No.3 Percentage of combustion air and Adiabatic flame temperature

The three parameters of temperature of the furnace, time of retention of the coal particles and the turbulence created by the burners decide the flame stability and hence the complete combustion of the coal particles.

II. Conclusion

Improvement in boiler efficiency can be done such that the heat transfer ability is extended by high temperature flue gases and complete combustion is ensured [4]

The change in load demand is met easily by this process of fuel firing system, since control of the fuel-air mixture can be done easily. Pulverising coal sent through the burner increases the surface area of coal and hence the combustion rate is higher and complete combustion is possible.

Even the low-grade coal is burnt completely since the surface area of the volatile matter is exposed to the burning suspension of hot gases once ignited and flame stability is achieved. By proper maintaining of three Ts: Temperature, time, and turbulence, the combustion efficiency can be optimised for a thermal power plant.

References

[1] International Energy Agency (IEA), Key world energy trends excerpt from: world energy balances.

[2] Share of electricity production from coal. 2021.

[3] Robert Junga, Przemysław Chudy, Janusz Pospolita, Uncertainty estimation of the efficiency of small-scale boilers, Measurement 97 , 2017, Pg.No.186–194.

[4] G. Qi, S. Zhang et al, “Combustion adjustment test of circulating fluidized bed boiler” Appl. Therm. Eng. 124 , 2017, Pg no.1505–1511.