

Effect of Tilt Angle in a Tangentially Coal Fired Sub-Critical Boiler

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— Tangentially fired coal fired boilers finds majority use in power generation due to its flame stability. The rear pass temperature of the sub-critical boiler is dependent on the burner tilt angle. The deposit of ash in pulverized coal fired boilers causes the unbalance between both sides of the furnace due to the change in tilt angle. The burner tilt angle has a great influence on the combustion characteristics of furnace. The effects of the upward and downward tilt are studied.

Keywords—Combustion, tilt angle, upward tilt, downward tilt, fire ball, turbulence

I. INTRODUCTION

The turbulence, chemical reactions involved in the furnace affect the heat transfer rate in a coal fired boiler. The effects of increase of burner tilt angle with respect to turbulence intensity in the burnout zone furnace increases. This leads to significant increase in the reaction rate combustion. The emission rate also reduces considerably. The Increase in burner tilt angle varies the char burnout because the kinetic reaction rate and oxygen diffusion rate increase with decrease in particle retention time.

II. TANGENTIALLY COAL-FIRED BOILERS

Power generation sectors mainly use the tangentially coal-fired boilers as the combustion process involves phenomena such as turbulence, heat transfer mostly by convection and radiation involve with chemical reaction.

The following factors like air velocity, mass flow rate of the heated air, furnace scale thickness affect the temperature distribution inside the furnace. The flame envelope of the tangentially firing system ensures uniform heat distribution and provides complete combustion as the fuel air mixture is thoroughly mixed inside the furnace.

The coal-air mix is forced along the four corners of the furnace tangentially to form a imaginary circle of certain height according to the mass flow rate of coal. The coal is pulverized and fine dust particles are trapped by the primary air and it is fired under suspension.

As the firing is continuous a fire ball is created which traps the un-burnt coal particles to completely burnt. The deposition of combustion particles can be reduced if the temperature at which the particle becomes sticky is higher than the particle temperature as it hits the surface of the boiler causing the non-uniform temperature distribution on the surface of the wall [1].

The schematic of the tangentially fired boiler is shown below in Figure No.1.

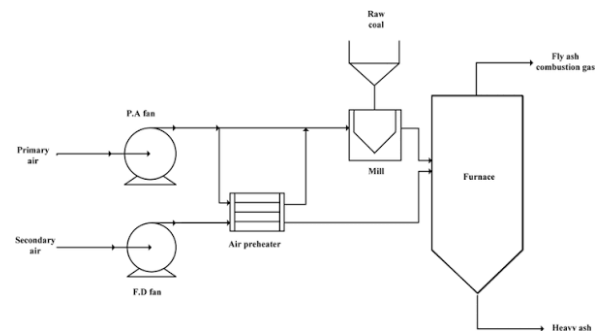


Figure No.1 Schematic view of tangentially fired Boiler

The tangential fired boilers yield sufficient resident time of the coal particles to burn and thus increase in the combustion efficiency is achieved.

Tangential firing produces a swirling action to the coal which residential time of fuel in the furnace leading to complete combustion. The flame stability is maintained and thus is suited for adaptability to varying loads as shown in Figure No.2.

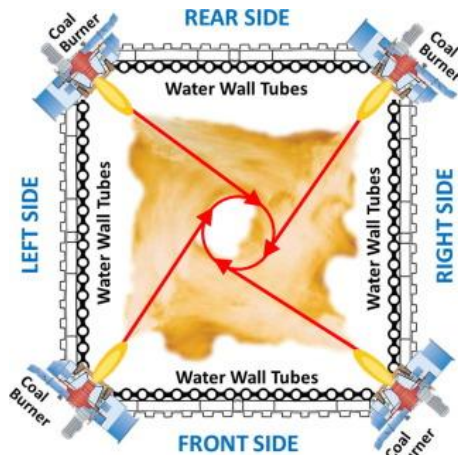


Figure No.2. Flame stability in a tangentially fired burner

The main disadvantage of the system is the residual swirling of hot gas at entrance of the burning zone and is the primary cause of deviation of hot gas temperature in the crossover pass.

The effect of the burner arrangement on the furnace combustion performance was studied and it was said that a wall centered tangentially fired boiler is the optimum use which can facilitate the burnout of particle reducing overheating and thereby high-temperature corrosion along the outer side of the water wall tubes [2].

III. OPERATIONAL EFFECTS OF TILT ANGLES

The upward tilt of the burner shifts the fireball position higher upwards in the furnace. This shift increases the heat transfer causing the super heater and re-heater steam temperatures to raise.

The downward tilt of the burner lowers the position of the fire ball towards the bottom of the furnace. The thermal efficiency of pulverized fuel boiler in a steam power plant increase with heat input parameters [3].

The effects of operating conditions in a tangential fired furnace with respect to the surface temperature, velocity is directly proportional to the perfect air-fuel ratio mix during the combustion process [4].

The major influencing factors like particle size distribution, heat release oxygen concentration, must be considered to get higher combustion efficiency [5]. If the combustion air increases, furnace temperature increases while the furnace average temperature decreases as the excess air fuel ratio increase for a fixed flow rate of air [6].

IV. CONCLUSION

The use of proper tilt angles ensures even heat transfer by radiation and convection to the water wall tubes. The incorrect tilt angle creates uneven heating of surface leading to thermal stress at various surfaces resulting in localized hot spots, tube metal overheating, temperature imbalance across surfaces leading to boiler tube failure.

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